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About

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From the Editor

Dear IEJES reader,

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Thank you to *Prof.Dr. Jose Luis UBAGO JIMENEZ* for supporting to IEJES in 2023 years.

In the present issue, there are thirty two articles. One of them is review article. Our authors present in this issue are composed of researchers working in different universities and institutions.

We look forward to seeing you in 2024 July Volume 8 Issue 16 of the International e-Journal of Educational Studies (IEJES). We are inviting you submission of manuscripts for the forthcoming issue.

Yours Sincerely

Prof.Dr. Tamer KUTLUCA

International e-Journal of Educational Studies (IEJES)

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Abstract

The purpose of the current study is to reveal the difficulties encountered by special education teachers who provide homeschooling services. The study employed the phenomenological design, one of the qualitative research designs. The study group of the current study was determined by using the convenience sampling method and consists of ten participants. In the study, data were collected through a semi-structured interview form developed by the researchers. The collected data were analyzed by using the descriptive analysis technique. According to the findings of the study, homeschooling services has some advantages such as the establishment of teacher-student-parent communication, yet, has many disadvantages such as lack of educational planning, lack of materials, transportation problems, low student motivation, low wages and unsuitable physical environment. In the study, it was also concluded that for the improvement of homeschooling services, many public and private institutions should carry out joint work for homeschooling services, teachers should be aided in issues such as wages and transportation and families should be supported in terms of physical conditions and materials.

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Research Article

Determination of the Difficulties Encountered by Special Education Teachers Carrying out Homeschooling Services *

Yusuf ALPDOĞAN [1], **Semra OMAK** [2], **Müzeyyen ELDENİZ-ÇETİN** [3]

Abstract

The purpose of the current study is to reveal the difficulties encountered by special education teachers who provide homeschooling services. The study employed the phenomenological design, one of the qualitative research designs. The study group of the current study was determined by using the convenience sampling method and consists of ten participants. In the study, data were collected through a semi-structured interview form developed by the researchers. The collected data were analyzed by using the descriptive analysis technique. According to the findings of the study, homeschooling services has some advantages such as the establishment of teacher-student-parent communication, yet, has many disadvantages such as lack of educational planning, lack of materials, transportation problems, low student motivation, low wages and unsuitable physical environment. In the study, it was also concluded that for the improvement of homeschooling services, many public and private institutions should carry out joint work for homeschooling services, teachers should be aided in issues such as wages and transportation and families should be supported in terms of physical conditions and materials.

Keywords: Homeschooling services, special education, individuals with special needs

1. INTRODUCTION

Education is the process of nurturing the human personality in the desired direction and the investment made in human capital, and it is about transferring the values, moral standards, knowledge and experiences of the society to new generations (Senemoğlu, 2018). Education, which is the process of creating behaviour in the desired direction, can be conducted in formal and informal ways. While informal education can be conducted anywhere such as the street, home, formal education is usually given in various types of schools, since it is a process of changing behaviour in the desired direction by adhering to a plan (Baykul, 1992). Some individuals who develop differently cannot benefit from the education given in schools due to various deficiencies or disorders. Regulations for individuals who cannot continue their education in formal education institutions due to various reasons are carried out by states on the basis of a social state approach (Kara, 2017). In Turkey, according to the Special Education Services Regulation of the Ministry of National Education (MoNE), the education of individuals who need special education is given on the basis of their individual characteristics and in environments suitable for their developmental characteristics and the education of individuals who develop differently is provided in mainstream schools, special education centres, hospital-based environments or delivered in home-based settings (Cavkaytar, 2019). In addition, with the Regulation

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on Education Services at Home and Hospital, numbered 2629 and re-published in February 2010, the Ministry of National Education has made various arrangements for students who cannot continue their education at school for different reasons (https://orgm.meb.gov.tr). According to this regulation, homeschooling services is defined as the education carried out for the execution of education and training services at home for the individuals who cannot directly benefit from the formal education institutions that carry out any of the pre-school, primary or special education processes due to their health conditions (https://orgm.meb.gov.tr).

Homeschooling services are the education carried out in the house where individuals live (Heward, 2013). In other words, homeschooling services can be explained as the student' continuing his/her education at home instead of continuing at school. When the historical process of homeschooling services is examined, it can be said that it first emerged as an alternative education system to mainstream schools in the United States after the second half of the 1900s (Seo, 2009). It is seen that homeschooling services has started to become widespread in recent years around the world for religious, philosophical, cultural, academic, social and special educational reasons (Knuth, 2010). In Turkey, homeschooling services are mostly provided for students who need special education. In Turkey, when an individual is unable to leave the house for six months or more due to health problems, he/she can receive homeschooling services with a report to be received from a health board and to be approved by a guidance research centre. During homeschooling services, special education teachers go to the homes of individuals with disabilities and work with the family based on the needs of the child and family at home (Akgün-Akçamuş, 2016). It can be said that educational activities conducted in this form of education have benefits as they are conducted in the natural environment of the student and the family is a part of education (Birkan, 2002). The most serious disadvantage of homeschooling services is that it is against the principle of continuing education in the least restrictive environment, which is one of the basic principles of special education (Özyürek, 1983).

Homeschooling services are becoming increasingly widespread both in the world (Isenberg, 2007) and in Turkey. While one of the important reasons for homeschooling services to be prevalent in other countries is the existence of problems experienced by families regarding their children's institutional education (Kaya, 2015), the main reason for homeschooling services in Turkey is the health problems hindering some children from attending formal education institutions. Homeschooling services is an effective method for individuals who have health problems and cannot attend formal education institutions for them to show a similar development to their peers, participate in daily life activities and eliminate the disadvantages of being at home. Along with these advantages, it is known that there are certain difficulties in the implementation of homeschooling programs. Financial problems, the quality of the education given to the child and the constant questioning of their own competences by the families are the main problems mentioned in the literature in the process of conducting homeschooling services as an alternative to the formal education system (Tösten & Elçiçek, 2013). When the studies on homeschooling services, which have become widespread in recent years for different reasons, are examined, it is seen that the studies are limited (Arslan, 2015; Susam, 2019; Yıldırım, et al., 2015) and that there is no study focused on the investigation of the difficulties experienced in the homeschooling process (Atbaşı & Pürsün, 2021). For this reason, it was considered important to conduct such a study. Accordingly, the general purpose of the current study is to reveal the difficulties encountered by special education teachers who provide homeschooling services. In line with this general purpose, answers to the following research questions were sought:

a) How do teachers plan and structure homeschooling services?
b) What are the difficulties of homeschooling services from teachers' perspectives?

2. METHOD

In this part of the study, there is information about the research model, the study group, the data collection tool and process, the analysis of the data and the ethics of the study.

2.1. Research Model

The current study was carried out through the phenomenological design, which is one of the qualitative research methods, to determine the difficulties encountered by special education teachers who provide homeschooling services. The phenomenological design examines the study group's experiences in depth about a problem situation and helps to reveal the meaning of their lives and experiences on the basis of the thoughts of the study group (Smith & Fowler, 2009).

2.2. Study Group

In line with the purpose of the study, the participants were determined from among the teachers who carry out homeschooling services. The study was carried out in the city of Bolu in Turkey. In order to determine the participants of the study, firstly, a total of 13 teachers residing in the central district of Bolu and conducting homeschooling services were contacted. Then, they were talked about the study and 10 of them wanted to volunteer to participate in the study. Thus, a total of 10 teachers constituted the study group. The teachers in the study group were coded as P1, P2, P3,… and P10. Demographic information of the study group is presented in Table 1.

Table 1. Demographic information of the participants

Participant Code	Gender	Age	Education Level	Department Graduated	Length of Service
P1	Female	40	Bachelor's degree	Primary teaching	17 years
P2	Female	28	Bachelor's degree	Special teaching	6 years
P3	Female	33	Bachelor's degree	Primary teaching	10 years
P4	Male	33	Bachelor's degree	Primary teaching	11 years
P5	Female	41	Bachelor's degree	Special teaching	20 years
P6	Male	38	Bachelor's degree	Special teaching	15 years
P7	Female	29	Bachelor's degree	Primary teaching	4 years
P8	Female	31	Bachelor's degree	Primary teaching	6 years
P9	Female	30	Bachelor's degree	Primary teaching	9 years
P10	Female	32	Master's degree	Primary teaching	5 years

When Table 1 is examined, it is seen that 8 of the participants are female and 2 are male. It is seen on the table that the ages of the participants are between 28 and 41. While 7 of the participants graduated from the department of primary teaching, 3 of them graduated from the program of special education teaching and one participant who graduated from the department of primary teaching holds a master's degree. All of the participants who graduated from the department of primary teaching in the current study received certificates from various courses related to the field of special education and switched to the field of special education. It is seen that the professional experience of the participants is between 5 and 20 years.

2.3. Data Collection

In qualitative studies, data are obtained mostly by using the interview technique in studies employing the phenomenological design (Yıldırım & Şimsek, 2018). In this study, which was carried out with a phenomenological design, data were obtained by using a semi-structured interview form from the teachers who provide homeschooling services. A semi-structured interview form consisting of 13 open-ended questions was used to obtain data in the study. While preparing the interview form, the literature was reviewed and the opinions of three faculty members and a special education teacher who were experts in the field of special education and had studies on education of individuals with special needs were sought. On the basis of the feedback from the experts, the questions in the interview form were corrected and finalized. Interviews were conducted face-to-face with the teachers who provide homeschooling services. A voice recorder was used during the interview, and the answers of the teachers were recorded on the voice recorder. During the interview, the participants were told that the data obtained would not be used for any other purpose anywhere else, and would only be used within the framework of this study. In the research, the data were collected based on the questions (Appendix-1) in the interview form used as a result of the research.

2.4. Data Analysis

In the current study, the analysis of the collected data was conducted through descriptive analysis, which is one of the qualitative analysis methods. In the study, the transcription of the data collected by means of the interview form and recorded on the voice recorder was performed by the second author. After the second author performed all the transcriptions, the third author took samples randomly from records and checked them. After the research data were transcribed and then read in detail by the second and third authors, categories and sub-categories were formed by adhering to the research questions. As a result of this categorization, the research findings were presented under thirteen categories.

2.5. Validity and Reliability

One of the strengths of qualitative studies is to reveal whether the findings obtained are correct when validity is evaluated from the perspective of the sample, reader and researcher. From this point of view, some situations should be taken into consideration to ensure validity while conducting qualitative studies (Creswell, 2017; Yıldırım & Şimşek, 2018). In order to ensure validity in this study; while creating semi-structured interview questions, the opinions of three faculty members and a special education teacher who are experts in the field of special education and have studies related to the education of individuals requiring special education were consulted.

When qualitative researchers are carried out, it is recommended to write the steps of the processes in order to ensure the consistency or stability of their research (Creswell, 2017). In this study, in order to ensure reliability, the researchers acted in line with the recommendations specified for qualitative research. For this purpose, in the analysis phase, the data obtained through the interview form and recorded on the voice recorder were transcribed by the second author. After the second author performed all the transcriptions, six randomly selected transcripts were checked by the third author. After the research data were transcribed and read in detail by the second and third authors, categories and subcategories were formed based on the research questions. Then, the contents of the themes were printed out and the theme and content consistency was checked by all three authors. Thus, the qualitative consistency of the research data was ensured. On the other hand, in order to increase the reliability of the research data, a quantitative reliability calculation was made. As a result of this reliability study, inter-coder reliability was calculated as 98% with the formula “Reliability = Agreement/ (Agreement + Disagreement) x 100” suggested by Miles and Huberman (1994) (Baltacı, 2017).

3. FINDINGS

Findings of the current study, conducted to determine the difficulties encountered by special education teachers who provide homeschooling services are presented under thirteen main categories in line with the interview questions of the study. The findings are presented in tables consisting of different sub-categories under each category accompanied by interpretations of the data in each table with the support of quotations from the participants.

3.1. Findings on How Special Education Teachers Plan for Homeschooling Services

In order to obtain the findings for the first research problem of the study, the participants were asked, "How do you plan for homeschooling?" The sub-categories reflecting the answers of the research participants to this question are presented in Table 2.

Table 2. Opinions of the special education teachers on how they plan for homeschooling services

Sub-categories	f
I always prepare a plan just as in school	5
I plan as daily teaching sessions	2
I do not make any extra planning for homeschooling	1
I make a plan according to the conditions of the home environment	1
The education level of the family is an important variable	1
I make a plan by considering all the variables for the target skill	1

As seen in Table 2, the participants' answers given to the question of how they plan for homeschooling are gathered under six sub-categories; I always prepare a plan just as in school, I plan as daily teaching sessions, I do not make any extra planning for homeschooling, I make a plan according to the conditions of the home environment, the education level of the family is an important variable and I make a plan by considering all the variables for the target skill. Half of the participants (50%) stated that they always make a plan just as in school. In this regard, some participants expressed their opinions as follows; P4: *"As in school, we make individual education planning in advance. We print out the individual syllabus, obtain the materials we will use, and go home and start teaching."* P7: *"I always prepare by taking into consideration the objectives that the child needs to accomplish."* Some of the participants (20%) stated that they carry out their homeschooling by making plans as daily teaching sessions. In this regard, one participant expressed his/her opinion as follows; P5: *"I plan in the form of daily teaching sessions according to the homeschooling plan, the characteristics of the lesson to be taught that day, and the characteristics of the objectives to be accomplished."* Moreover, one of the participants (10%) stated that he/she does not make any extra planning for homeschooling and another participant (10%) stated that he/she makes plans considering the education level of the family. One of the participants on the other hand stated that he/she makes a plan according to the conditions of the home environment and another participant stated that he/she makes a plan by considering all the variables for the target skill. In this sub-categories, some of the participants expressed their opinions as follows; P1: "*I do not have a special plan for homeschooling"* P8: "*In order to plan homeschooling, to get to know the student, I research the family and the education they have received; I learn the thoughts of the family. After meeting with the previous teachers and the school and getting to know the student, I determine the appropriate objectives and teaching techniques and make my plan. In short, I consider all the variables for the target skill."*

3.2. Findings regarding the Opinions of the Special Education Teachers on Homeschooling Services

In order to obtain the findings for the second research problem of the study, the participants were asked, "What would you like to say about homeschooling, about its advantages and disadvantages?" The sub-categories reflecting the answers of the research participants to this question are presented in Table 3.

Table 3. Opinions of the special education teachers on homeschooling services

Sub-category	f
It is advantageous for students who cannot come to school	4
It has more disadvantages	3
It is not as efficient as the school environment	2
There is a discipline problem	2
The education level of the family is an important variable	1

As seen in Table 3, the participants' opinions about homeschooling services are gathered under five sub-categories. It is seen that some of the participants (40%) emphasized that homeschooling services is advantageous for students who cannot come to school. In this regard, some participants expressed their opinions as follows; P9: *"The positive side of homeschooling is that the student, who has no opportunity to complete his/her education at school, completes his/her education in this way."* P2: *"There are advantages for students; I think it is an advantage for students who cannot come to school. For us as teachers, it is a great pleasure to help them.*" Some participants (30%) on the other hand stated that homeschooling services has more negative sides. In this regard, one participant expressed his/her opinion as follows; P1: *"I think it has more disadvantages because it is in the home environment anyway. You do not establish a silent classroom environment that the child needs. No matter how many materials you bring with you, you may not have the materials you can reach at school..."* While some participants (20%) stated that homeschooling services is not as efficient as the education given in the school environment, some participants (20%) stated that they have discipline problems in homeschooling services. In addition, one participant (10%) stated that the education level of the family is an important variable. In these sub-categories, some participants expressed their opinions as follows; P3: *"It's not like a school environment. It's a problem that parents come in and out every now and then…"* P4: *"It depends on the house you're going to. The most important point here is the education level of the family."* P9: *"A very important problem I see in homeschooling is the problem of establishing discipline."*

3.3. Findings on How the Special Education Teachers Structure the Teaching Phase in Homeschooling

In order to obtain the findings for the third research problem of the study, the participants were asked, "How do you structure the teaching phase in homeschooling, what are the difficulties and conveniences you experience?" The sub-categories reflecting the answers of the participants to this question are presented in Table 4.

Table 4. Opinions of the special education teachers on how they structure the teaching phase in homeschooling and the difficulties and conveniences they experience

Sub-category	f
I have a hard time structuring homeschooling	4
I structure it according to the child's level and objectives	3
I structure it by prioritizing self-care skills	1
I structure it considering the home environment	1
I structure it on the basis of teaching techniques in special education	1

On Table 4, it is seen that the opinions of the participants on how they structure the teaching phase in homeschooling are basically gathered under five sub-categories. It is seen that a significant part of the participants (40%) stated that they have difficulties in structuring homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P10: *"I have difficulties in homeschooling or in structuring and planning teaching…"* It is seen that some participants (30%) consider the level of the student and the characteristics of the objectives while structuring homeschooling. One of the participants expressed his/her opinion on this issue as follows; P7: *"By evaluating the situation of the child I will teach, determining the objectives he/she needs and making the necessary preparations … These preparations include the planning of the teaching, finding the suitable materials and informing the family about the process. In other words, I structure it considering the level of the students and objectives to be accomplished."* One of the participating teachers (10%) stated that he/she focuses on self-care skills while planning the education while another participant stated that he/she structures homeschooling considering the home environment. Moreover, another participant stated that he/she plans homeschooling on the basis of teaching techniques in special education. In these sub-categories, some participants expressed their opinions as follows; P1: *"The skills that I will focus on during the teaching phase are self-care skills because in the school environment, we have difficulty in making students acquire self-care skills. They are difficult to teach in the school environment. Same is true for daily life skills such as washing hands, brushing teeth, dressing up, yet, they are relatively easy to teach in the home environment. I usually prioritize self-care skills when planning homeschooling."* P8: *"I draw attention of the student by saying that we will learn this with you today in order to accomplish the objective I have determined in advance in the teaching phase. I'm trying to find out what he/she knows about the subject with questions ... I find pictures, cards, on the subject or videos from the internet ... techniques such as improvisation, narration, demonstration, question and answer ... it takes a lot of repetition, he/she forgets very quickly, you can't get many answers to the questions, that's the problem ... In short, I structure it on the basis of teaching techniques."*

3.4. Findings regarding the Opinions of the Special Education Teachers on How the Home Environment Affects Their Education

In order to obtain the findings for the fourth research problem, the participants were asked, "Does the home environment affect your education, and if so, how?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 5.

Table 5. Opinions of the special education teachers on how the home environment affects their education

Sub-category	f
It affects education negatively	7
The home environment is an important variable	2
The home environment contains some risks	1

As seen in Table 5, the opinions of the participants about how the home environment affects their education in homeschooling are basically gathered under three sub-categories. The majority of the participants (70%) think that the home environment affects their education negatively in homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P6: *"environment obviously affects education. When it is homeschooling, physical conditions, individuals living at home, our intervention in the child's own area; these all affect negatively."* While some of the participants (20%) stated that the home environment is an important variable, one participant stated that the home environment contains risks. In this regard, some participants expressed their opinions as follows; P5: *"of course it affects. In normal education, there is education five days a week. But in homeschooling, duration of the education varies depending on how long you travel to arrive home and where the house is located, etc. This indicates that the home environment is an important variable."* P2: *"Some students do not have a family atmosphere, do not have a mother or a father or some other issues. Commuting home can be risky for us. It is somehow possible to go after communicating with the parent."*

3.5. Findings Regarding the Opinions of the Special Education Teachers on the Time Allocated to Homeschooling

In order to obtain the findings for the fifth research problem of the study, the participants were asked, "What would you say about the time allocated to homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 6.

Table 6. Opinions of the special education teachers on the time allocated to homeschooling

Sub-category	f
The time allocated to homeschooling is sufficient	6
The time allocated to homeschooling is too long	2
The time allocated to homeschooling is too short	1
It is necessary to make a good planning for the time allocated to homeschooling	1

As seen in Table 6, the opinions of the participants regarding the time allocated to homeschooling are basically gathered under four sub-categories. It is seen that a significant part of the participants (60%) emphasized that the time allocated to homeschooling is sufficient. In this regard, one of the participants expressed his/her opinion as follows; P3: *"I think the time allocated to homeschooling is enough, I even think that 6 hours is too much. I think that it is enough for the children who are educated at home to get 3 or 4 hours of education."* While some participants (20%) stated that the time is too long, one participant stated that the time allocated to homeschooling is very little, and another participant stated that it is necessary to make a good planning for the time allocated to homeschooling. In these sub-categories, some participants expressed their opinions as follows; P10: *"The time allocated to homeschooling is too much in my opinion because studying in the home environment is not like teaching in the classroom environment. In planning the time, it is important to think of the teacher as much as we think of the student and to keep his/her motivation alive."* P5: *"the time is too little in homeschooling. Not enough time to teach the student enough skills"*

3.6. Findings Regarding the Opinions of Special Education Teachers on the Materials Used in Homeschooling

In order to obtain the findings for the sixth research problem of the study, the participants were asked the question, "What would you say about the materials used in homeschooling? What kind of deficiencies do they have, if they have?" The sub-categories containing the opinions of the research participants on this question are presented in Table 7.

Table 7. Opinions of the special education teachers on the materials used in homeschooling

Sub-category	f
There is a great shortage of teaching materials in homeschooling	7
I provide the teaching materials myself in homeschooling	4
In homeschooling, I obtain teaching materials from the school	3
I do not have any problems with teaching materials in homeschooling	1

As seen in Table 7, the opinions of the participants about the materials used in schooling are gathered under four sub-categories. Most of the participants (70%) stated that there is a great shortage of teaching materials in homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P3: *"We usually provide the materials for homeschooling ourselves. Or we get them from the school. There are serious problems in this regard; we have a shortage of materials."* Moreover, it is seen that a significant part of the participants (40%) stated that they themselves provide the teaching materials in homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P8: *"There is no budget provided by the National Education for homeschooling. If the teacher can convince the Principal of the school, then he/she may get some materials. Apart from that, the family can buy materials but this is no very likely. Therefore, we are experiencing a great shortage of materials.* Some of the participants (30%) stated that they obtain the teaching materials from the school for homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P2: *"Families are often not in a position to provide materials. We provide them ourselves, and sometimes we can get them from the school."* It is seen that one participant of the study stated that he/she does not have any problems with teaching materials in homeschooling. In this regard, one participant expressed his/her opinion as follows; P5: *"I do not have any problems with materials in homeschooling. I use almost everything we see at home in education."*

3.7. Findings Regarding the Opinions of the Special Education Teachers on Transportation Required for Homeschooling

In order to obtain the findings for the seventh research problem of the study, the participants were asked "What would you say about transportation required for homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 8.

Table 8.Opinions of the special education teachers on transportation required for homeschooling

Sub-category	f
Transportation is a big problem in homeschooling	4
Transportation is not a big problem	2
The location of the student's home is an important variable in transportation	2
Whether the teacher has a car or not is an important variable in transportation	2

As seen in Table 8, the opinions of the participants on the transportation required for homeschooling are gathered under four sub-categories. A significant part of the participants (40%) stated that transportation is a very big problem in homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P9: *"The cost of the transportation must be met by the teacher himself/herself and I think this is a very big problem and at least some of the transportation fee should be paid to the teacher. Some students live in villages outside the centre."* While some participants (20%) stated that transportation is not a big problem, some others (20%) stated that the location of the student's home is an important variable in transportation. On the other hand, some participants (20%) stated that whether the teacher has a car or not is an important variable in transportation. In these sub-categories, some participants expressed their opinions as follows; P8: *"My student's house was close, I didn't have any problems, but it's okay because I go to school by car, anyway."* P6: *"It is very easy for those who have a car, but it is very difficult for those who do not have a car and have to go to a distant place."*

3.8. Findings Regarding the Opinions of the Special Education Teachers on Student Motivation in Homeschooling

In order to obtain the findings for the eighth research problem of the study, the participants were asked, "What would you like to say about student motivation in homeschooling, what do you do in this regard?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 9.

Table 9. Opinions of the special education teachers on student motivation in homeschooling

Sub-category	f
I motivate them with reinforcers	4
Student motivation in homeschooling is very low	3
I motivate by making a good planning	2
It is difficult to motivate the student in homeschooling	1
I motivate through cooperation with the family	1

As seen in Table 9, the opinions of the participants on student motivation in homeschooling are gathered under five sub-categories. A significant part of the participants (40%) stated that they motivate the student with reinforcers in homeschooling. In this regard, one of the participants expressed his/her opinion as follows; P2: *"We can often use small reinforcers to motivate the student, such as bringing small presents or taking him/her to the park if he/she can leave the house."* While some participants (30%) stated that student motivation is low in homeschooling, some other participants (20%) stated that they make a good planning to motivate students in homeschooling. In these sub-categories, some participants expressed their opinions as follows; P2: *"The motivation of the student is very low. Since education is at home, he/she sees himself/herself as the leader of the home and it is very difficult for him/her to see you as an authority. For example, when there is a problem, he/she tends to go to his/her mother. It is very difficult for us to discipline him/her because he/she* *thinks that he/she can do whatever he/she wants, that he/she can go out and walk around during the lesson. It is easier to set rules for them in the classroom environment. Apart from that, I set rules and clearly explain that he/she will be rewarded if he/she obeys the rules. I pay great attention to using variety of activities. I try to keep the activity period of the child short, especially if he/she is moderately and severely disabled, by changing activities frequently at regular intervals. Then the motivation gets better."* P7: *"…very important. Having the student participate in the lesson also increases the quality of the education provided. I attach great importance to motivation. I am making a good planning."* While one participant stated that it is difficult to motivate the student in homeschooling, another participant stated that he/she cooperates with the family to motivate the student in homeschooling.

3.9. Findings Regarding the Opinions of the Special Education Teachers on the Wage They Receive for Homeschooling

In order to obtain the findings for the ninth research problem of the study, the participants were asked, "What would you like to say about the wage you receive in homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 10.

Table 10. Opinions of the special education teachers on the wage they receive for homeschooling

Sub-category	f
Wage is very low as homeschooling requires extra effort	7
Wage received is the same as the wage received at school	3

As seen in Table 10, the opinions of the participants about the wages they receive in homeschooling are gathered under two sub-categories. The majority of the participants (70%) stated that the wages they receive are very low because homeschooling requires extra intensive labour and effort. In this regard, one of the participants expressed his/her opinion as follows; P7: *"So far, we have talked about the pros and cons of homeschooling. Although I do not say good or bad for the wage, I think that the wage can be increased a bit because of the multitude of negative factors involved in homeschooling; teachers make a serious extra effort. I think the wage is important for teacher motivation and job satisfaction."*

Some of the participants (30%) stated that the wage they receive in homeschooling is the same as the wage they receive at school and that this wage is sufficient. In this regard, one participant stated his/her opinion as follows; *"The wage is enough, I think, our profession is a profession of sacrifice."*

3.10. Findings Regarding the Opinions of the Special Education Teachers on the Physical Conditions of the Setting in which they Provide Homeschooling

In order to obtain the findings for the tenth research problem of the study, the participants were asked, "What would you like to say about the physical conditions of the setting where you provide homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 11.

Table 11. Opinions of the special education teachers on the physical conditions of the setting in which they provide homeschooling

Sub-category	f
Definitely negative.	5
The financial situation of the family is an important variable.	4
The home environment has a great impact on education	1

As seen in Table 11, the opinions of the participants about the physical conditions of the setting in which they provide homeschooling are gathered under three sub-categories. Half of the participants (50%) stated that the physical conditions of the setting in which they provide homeschooling are definitely negative. In this regard, one of the participants expressed his/her opinion as follows; P9: *"They negatively affect. Unfortunately, many families with these children do not even have a separate room because their financial situation is bad. For example, I teach the lessons in the living room. The living room is also used to sleep during the winter months. I run into big problems when I go in the morning."* While a significant part (40%) of the research participants stated that the financial situation of the family of the student they are teaching at home is an important variable, one participant stated that the home environment is very influential on education. In this regard, one of the participants expressed his/her opinion as follows: P7: *"The physical conditions of the environment may not be suitable, but we try to make the environment as unaffected by external factors as possible. Every home and family environment is different, and since their socioeconomic status also differs, I design them in a way that would be closest to the ideal."*

3.11. Findings Regarding the Opinions of the Special Education Teachers on How They Structure the Learning Environment in Homeschooling

In order to obtain the findings for the eleventh research problem of the study, the participants were asked the question, "How do you structure the learning environment during homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 12.

Table 12. Opinions of the special education teachers on how they structure the learning environment in homeschooling

Sub-category	f
I identify an unused room and turn that room into a classroom	4
I teach in a room given to me and I take all the unnecessary items out of the room	3
I do not interfere with the home environment	3
I teach in an environment that the child likes	1

As seen in Table 12, the opinions of the participants of the study on how they structure the learning environment during homeschooling are gathered under four sub-categories. A significant part of the participants (40%) stated that they identify an unused room at home and convert it into a classroom. In this regard, one of the participants expressed his/her opinion as follows; P1: *"When I first go, I usually ask the family which room is their least used room in order to prepare the learning environment. Or, I ask whether the child has his/her own room. Mostly he/she may not have his/her own room, so I want the least used room. I also hang a card on the door stating that there is a lesson to prevent any interference during the lesson. I also set an alarm for the mother and ask her not to enter the room until she hears the sound of the alarm. I take care not to have too many items in the room."* While some of the participants (30%) stated that they take out the unused items in the room allocated to them and structure it as an educational environment, some participants (30%) stated that they do not interfere in the home environment during homeschooling. In these sub-categories, some of the participants expressed their opinions as follows; P3: *"We structure the learning environment according to the characteristics of the learning objective and the physical conditions of the house."* P5: "*I do not interfere too much with the home environment."* One participant stated that he/she teaches in an environment which the student likes.

3.12. Findings Regarding the Opinions of the Special Education Teachers on Teacher-Student-Parent Communication in Homeschooling

In order to obtain the findings for the twelfth research problem of the study, the participants were asked, "What would you say about teacher-student-parent communication in homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 13.

Table 13. Opinions of the special education teachers on teacher-student-parent communication in homeschooling

Sub-category	f
There is a constant interruption of the lesson	5
It is positive in terms of communication and cooperation with the family	4
It is sometimes a problem for male teachers to go to homeschooling.	1
The child stays away from peers	1
The home environment can have its own drawbacks	1
It is difficult to establish authority and class control	1

As seen in Table 13, the opinions of the special education teachers on teacher-student-parent communication in homeschooling are gathered under six sub-categories. Half of the participants (50%) stated that the lesson is constantly interrupted. In this regard, one of the participants expressed his/her opinion as follows; P10: "*I think one of the most important issues in homeschooling is this question you have asked. In homeschooling, the lesson is constantly interrupted. The student's parents, siblings or guests*…" A significant part of the participants (40%) stated that homeschooling is positive in terms of communication and cooperation with the family. Other opinions expressed by participants are that it is sometimes a problem for male teachers to go to homeschooling (10%), that the child stays away from peers (10%), that the home environment has its own drawbacks and that it is difficult to establish authority and class control (10%). In these sub-categories, some participants expressed their opinions as follows; P4: *"The best side of it is that the teacher knows the parent and the student. Of course, it can be more advantageous and better to contact the parent and proceed accordingly."* P9: *"…I have trouble establishing authority and classroom control in homeschooling."*

3.13. Findings Regarding the Opinions of the Special Education Teachers on Their Own Performance in Homeschooling

In order to obtain the findings for the thirteenth research problem of the study, the participants were asked the question, "What would you say when you evaluate your own performance in homeschooling?" The sub-categories containing the opinions of the research participants regarding this question are presented in Table 14.

Table 14. Opinions of the special education teachers on their own performance in homeschooling

Sub-category	f
It is motivating to help a child who can't come to school	6
I think I am good although not as good as in the classroom environment	4
Homeschooling negatively affects my performance	2

As seen in able 14, the opinions of the participants about their own performance in homeschooling are gathered under three sub-categories. The majority of the participants (60%) stated that it is motivating to help a child who cannot come to school. In this regard, one of the participants expressed his/her opinion as follows; P2: *"I can express the following about our own performance: both the child and the family are happy because the child does not come to school. The child is also happy as he/she sees another person and we are happy as we can help someone. Thus, it is a good project…"* Again, a significant part of the participants (40%) stated that their performance is good although not as good as in the classroom environment. In this regard, one of the participants expressed his/her opinion as follows; P8: *"It was my first experience and I think it was good because the family would want me for the next year ... I'm learning too, it's a different feeling, I have learned to be more patient ... I have learned that it is necessary to repeat a lot, when he/she smiles, I become happier..."*. Some of the participants (20%) stated that homeschooling negatively affects their performance. In this regard, one of the participants expressed his/her opinion as follows; P6: *"When I evaluate my own performance, I can say that I am better in the school environment. I feel restricted at home. I think I* *am more challenged here. Working with children is easy for us, but interference from other people negatively affects."*

4. DISCUSSION and CONCLUSION

In the current study, some results were obtained regarding the difficulties experienced by special education teachers who provide homeschooling services. When the results obtained on how special education teachers plan for homeschooling are examined, it is seen that they always make plans just as in the school environment, make plans as daily teaching sessions, do not make any extra planning for homeschooling, make plans according to the conditions of the home environment, make their plans by taking into account the education level of the family and make plans considering all the variables for the target skill. Atbaşı and Pürsün (2021) stated that it is important to make arrangements regarding the individual's needs, environment and materials while planning for individuals who require special education. Otherwise, it is known that the level of effectiveness of the program on the individual will be low. Considering the data obtained as a result of the current study, it is seen that special education teachers do not follow a certain systematic and do not make general arrangements for homeschooling. When the relevant literature is considered, it can be said that it is difficult for existing applications to reach their goals. In addition, the opinion expressed by participants "homeschooling is not very effective" may be related to this.

Another result obtained in the current study is related to what special education teachers think about education in the home environment. The opinions expressed by the special education teachers about education in the home environment revealed that the teachers think that homeschooling services is advantageous for students who cannot come to school, that homeschooling services has more disadvantages, that homeschooling services is not as efficient as the school environment, that there is a discipline problem in homeschooling services and that the education level of the family is an important variable. These findings of the current study are similar to the findings reported by Taşdemir and Bulut (2015). Taşdemir and Bulut (2015) reported that parents find homeschooling activities useful, that homeschooling plays a role in the development of children and that teachers have problems with materials to be used in homeschooling.

Another result of the current study is related to how special education teachers structure the teaching phase in homeschooling. As a result of the study, it was seen that the special education teachers have difficulties in structuring homeschooling that they consider the level of the student and the characteristics of the objectives when structuring homeschooling that they focus on self-care skills when planning homeschooling and that they plan homeschooling considering the home environment. Similarly, when the results obtained from the opinions of the special education teachers about the effects of homeschooling on their education were examined, it was found that they think that the home environment negatively affects their education in homeschooling, that the home environment where the education is given is an important variable and that the home environment has risks. These results of this research coincide with the results of Atbaşı and Pürsün (2021). Atbaşı and Pürsün (2021) also emphasized in their study that home environment is an important variable in homeschooling services.

Another result obtained in the current study is related to the opinions of the special education teachers about the time allocated to homeschooling. When the opinions expressed in this category were examined, it was seen that some teachers think that the time allocated to homeschooling is sufficient; some think that the time is too long and some others think that the time too short. Findings related to the fact that the time allocated for homeschooling service is very small Yıldırım et al. (2015) is consistent with the results of their study. Yıldırım et al. (2015) also comes to the fore in the study of increasing the duration of lessons in homeschooling services.

Another result of the current study is related to the opinions of the special education teachers about the materials used in homeschooling. Based on the opinions expressed in this category, it can be said that there is a great shortage of teaching materials in homeschooling, that teachers themselves provide the teaching materials in homeschooling and that they obtain some of the teaching materials in homeschooling from the school. The results obtained in this part of the study support the results of the studies conducted by Arslan (2015) and Atbaşı and Pürsün (2021). Arslan (2015) stated that one of the important shortcomings that teachers see regarding home education is the inadequacy of materials and the difficulty of accessing materials. Similarly, Atbaşı and Pürsün (2021) stated that among the disadvantages expressed by teachers regarding homeschooling services, there is the difficulty in obtaining materials. In addition, as found in the current study, Atbaşı and Pürsün (2021) found that a significant part of the material supply in homeschooling services is provided by teachers themselves.

Based on what the special education teachers who participated in the study expressed about transportation required for homeschooling, it can be said that the transportation problem in homeschooling is a big problem, that the teachers themselves solve the transportation problem in homeschooling, that the location of the student's house is important for transportation in homeschooling and that the teacher' having his/her own car is important for transportation in homeschooling. The results obtained in this sub-category of the study concur with the results of the study conducted by Susam et al. (2019). Susam et al. (2019) stated that transportation in homeschooling services is an important problem and that solutions should be found for this problem.

The following results were obtained from the statements of the special education teachers about student motivation in homeschooling: teachers try to motivate students with reinforcements in homeschooling, student motivation is low in homeschooling, it is necessary to make a good plan in order to motivate students in homeschooling and it is difficult to motivate students in homeschooling. The results obtained in the study regarding the low level of student motivation in homeschooling services coincide with one of the results emphasized by Berkant and Atılgan (2020). In a finding of Berkant and Atılgan (2020) research, it was seen that homeschooling could not be carried out adequately and effectively, and one of the reasons for this was student reluctance and low motivation.

Another result of the current study is related to the opinions of the special education teachers about the wages they receive in homeschooling. Based on the opinions expressed on wages, it can be said that the majority of the teachers think that the wage they receive are very low because homeschooling requires extra intensive labour and effort. This finding is supported by the study of Atbaşı and Pürsün (2021). On the other hand, some of the participants think that the wage they receive in homeschooling is the same as the wage they receive at school and this wage is sufficient.

The following results were obtained based on the statements of the special education teachers participating in the study about the physical conditions of the environment in which they provide education at home: the physical conditions of the environment in which they provide education at home are definitely negative, the financial situation of the family of the student they teach at home is an important variable and the home environment has a significant influence on education. These results are similar to the results of Peker and Taş, (2017). Peker and Taş (2017) stated that the students remained passive and their motivation was low due to reasons such as the teacher-centred education in homeschooling services and the inability of the student to interact and communicate with his/her peers.

Another result of the current study is related to how special education teachers structure the environment in which lessons are taught during homeschooling. Based on the opinions expressed by the teaches in this category, it was concluded that teachers identify an unused room at home and turn it into a classroom environment, that they remove the unused items in the room allocated to homeschooling and structure it as an educational environment, that they do not interfere with the home environment in homeschooling and that the lessons are taught in an environment that the student likes.

Based on the opinions expressed by the special education teachers about teacher-student-parent communication in homeschooling, the following results were obtained: the lesson in homeschooling is constantly interrupted, it has positive results in terms of communication and cooperation with the family, when male teachers go to homeschooling, this may sometimes cause problems, the home environment can have its own drawbacks and the authority and classroom control cannot be established.

The results obtained on the basis of the opinions expressed by the teachers on their own performance in homeschooling are as follows; it is motivating for them to help students who cannot come to school, their performance at home education is good even though it is not as good as it is in the classroom environment and homeschooling negatively affects their performance. Susam et al. (2019) stated that variables such as transportation, materials, technological infrastructure, strict curriculum etc. affect the motivation of teachers in the homeschooling process and that R&D studies should be carried out to increase teacher motivation in homeschooling.

In light of the findings of the current study, the following suggestions can be made:

a) With the joint work of the Ministry of National Education (MoNE) and Universities, studies on planning for homeschooling services should be carried out and shared with teachers.

b) With the support of organizations such as Ministry of Family and Social Services, MoNE, foundations, NGOs, municipalities, universities, it is necessary to create a classroom in the home environment for individuals who have a report proving that they need homeschooling and have financial problems and the necessary material support should be provided.

c) It is recommended to focus on studies on structuring the teaching phase in homeschooling services in the special education departments of universities.

d) It is recommended to support teachers in transportation to home and to make improvements in their wages.

e) It is recommended to get support from guidance and counselling specialists to inform families about what should they do during the lesson at home.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Kırşehir Ahi Evran University with the decision dated 21/04/2022 and numbered 2022/03/37.

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Appendix-1: Interview Questions

1. How do you plan for homeschooling?
2. What would you like to say about homeschooling, about its advantages and disadvantages?
3. How do you structure the teaching phase in homeschooling, what are the difficulties and conveniences you experience?
4. Does the home environment affect your education, and if so, how?
5. What would you say about the time allocated to homeschooling?
6. What would you say about the materials used in homeschooling? What kind of deficiencies do they have, if they have?
7. What would you say about transportation required for homeschooling?
8. What would you like to say about student motivation in homeschooling, what do you do in this regard?
9. What would you like to say about the wage you receive for homeschooling?
10. What would you like to say about the physical conditions of the setting where you provide homeschooling?
11. How do you structure the learning environment during homeschooling?
12. What would you say about teacher-student-parent communication in homeschooling?
13. What would you say when you evaluate your own performance in homeschooling?

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Abstract

This study was carried out in order to determine how the 3rd grade students of the Department of Elementary Mathematics Education structured their "*if and only if propositions*". The data were obtained by examining the students' answers given to the midterm exam questions and discussing the solutions with the students in the classroom. The study is a case study. As a result of the application, it was found out that the students had difficulty in determining the parts of the hypothesis that are included in "*if and only if*" proposition and therefore dividing the proposition into two "if" proposition. Some students think that the part or parts given as hypothesis should also be proved. When defining propositions, in addition to their "*if and only if* propositions", it is suggested to define new types of proposition in the form of "hypothesis-containing *if and only if* propositions".

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Research Article

An Ontological Study on Proof: If and only If Propositions[*]

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Abstract

This study was carried out in order to determine how the 3rd grade students of the Department of Elementary Mathematics Education structured their "*if and only if propositions*". The data were obtained by examining the students' answers given to the midterm exam questions and discussing the solutions with the students in the classroom. The study is a case study. As a result of the application, it was found out that the students had difficulty in determining the parts of the hypothesis that are included in "*if and only if*" proposition and therefore dividing the proposition into two "if" proposition. Some students think that the part or parts given as hypothesis should also be proved. When defining propositions, in addition to their "*if and only if* propositions", it is suggested to define new types of proposition in the form of "hypothesis-containing *if and only if* propositions".

Keywords: Theorem, if and only if proposition, cognitive structuring, definition, proof

1. INTRODUCTION

People have ideas about what is going on around them. When they claim that these ideas are true, they form a proposition. People will demand the proof from those who put forward proposition. Evidence is necessary for people to accept the correctness of ideas, that is, for the persuasion of the immediate environment. For this purpose, those who make the claim can give examples, model the situation with the help of materials, conduct experiments, benefit from graphics and various representations (Sevgi & Kartalcı, 2021). However, mathematicians will want a formal proof to accept the truth of a proposition (Polster, 2004). In the world of science, the proof is not just about showing the truth of the claim. The proof also shows why the claim is true and convincing (Hanna, 2000). The proof also has some functions as verification (De Villiers, 1999), explanation, verification of definitions, systematization (Barendregt & Wiedijk, 2005), discovery and communication. Therefore proof is an important tool for mathematicians and for the execution of mathematical science (Knuth, 2002). Proof is included in mathematics curricula and the importance of proof is emphasized (Herbst, 2002).

Proof types be defined and classified in different ways in the literature. For example, considering the purpose of proof, there are four proof types: heuristic, descriptive, and exploratory and (Hanna, 2000; Reis & Renkl, 2002). Hemmi (2010) classifies proof approaches as verification /explanation, induction/deductive, intuitive /formal, proof structure open/proof structure not open, while Tall (1999) classifies proof as enactive proof and formal proof. Harel and Sowder (1998) classify students' proof schemes as "externally based", "empirical", and "analytic" proof. These classifications/definitions are an indicator and product of the efforts of mathematicians and mathematics educators to understand proof. These classifications/definitions are also expressions of

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the difficulty of proof and teaching proof. In addition, another subject of interest in proof studies is the processes that students in different age groups go through while proving and their ability to prove (Knuth, 2002). One of the reasons for this increase in studies on proof is that it is very difficult to gain proving competence at every level (Jones, 2000). Even at the undergraduate level, the proof is perhaps one of the most difficult issues to understand (Arsac, 2007). No matter how difficult it is to prove and teach proof, it is impossible to discourage mathematicians from their goal of acquiring these competencies in students. But most mathematicians tend to constantly postpone teaching how to make proof to the next class or level of instruction. Research has shown that students should encounter proof activities as early as possible in order to prove proficiencies (Doruk & Kaplan, 2015; Harel & Sowder, 1998; NCTM, 2000; Tall, 2014). In this sense, proof activities are also could be include in the kindergarten period too. In order to form the basis of the proof, classification, matching and comparison concepts are given in the preschool period. Students are expected to be able to use proof methods and techniques both in primary, secondary and high school (NCTM, 2000). Although it is not easy for students to gain the proficiency of proving at the primary level, it is seen that it is not easy to gain them at advanced levels too. For example, let's consider the level of Van Hiele's Understanding of Geometry called "inference about life (order)".This third level coincides with the last years of the second level of primary education and the high school years. It is known that at this level, students can follow the making of the proof, but they cannot prove the proof themselves (Usiskin, 1982). Another factor that reasons the fact that the proof does not get easier as the stages progress is that the expectations for proof increase continuously as the stages increase. As the levels of education progress, the propositions to be proved quickly become more abstract. The propositions transforms into an abstract structure that requires a formal proof, cannot be modeled, cannot be drawn graph-shape, or cannot be tabulated. Undergraduate students are having a higher level of mathematical knowledge and cognitive competencies. However, theorems at this stage are often more abstract and require even more formal proof. So propositions become much more difficult to prove. It is known that undergraduates had difficulty making proof (Doruk, 2019; Oflaz, Bulut & Akcakin, 2016; Sema & Şenol, 2022). There has also been a lot of research on the views of mathematics teacher candidates and teachers towards making proofs (Doruk & Kaplan, 2015; Doruk, Özdemir & Kaplan, 2015; Knuth, 2002; Yopp, 2011). The literature shows that there are various difficulties in making proofs by students. These difficulties are; thinking they can not prove; fear of proving and dislike of proving (Anapa & Şamkar, 2010; De Villiers, 1999a; Gökkurt, Deniz, Akgün & Soylu, 2014; Jones, 2000; Sevgi & Kartalcı, 2021), not understanding the reasons and benefits of proof (De Villiers, 1999), and not knowing how to use proof (De Villiers, 1999; Moore, 1994), their inability to understand the nature of proof, mathematical rules, proof techniques and strategies (Gibson, 1998); their inability to use mathematical language and logical proofs correctly (Moore, 1994). There are various studies too in the literature that deal with the proving process (Harel & Sowder, 1998; Varghese, 2011). There are other studies in the literature that deal with the proof process from different perspectives.

Examination of the proving process can offer opportunities to overcome many of the difficulties of learning and teaching proving. This study was carried out to examine the proof at the university level. In this study, different from the difficulties mentioned above, a proving difficulty that is not encountered in the literature will be discussed. This difficulty is an ontological difficulty, which arises from not defining the "*if and only if*" proposition, which is perhaps the most abstract of the propositions, in sufficient detail. Because this compound proposition contains the "and, or, if" propositions defined before it. In the scope of the study, the effect of the deficiency resulting from the definition of "*if and only if*" propositions on students' ability to prove will be examined by the case study method. This study is a case study, limited to the students and the course where the researcher is conducting the course. With this study, it will be possible to obtain inferences about the teaching of a subject that is perhaps the most difficult to understand for students in advanced mathematics education. And new definitions and naming have been proposed to make the subject more understandable. In addition, this study is thought to be a study that exemplifies the importance of dealing with pure mathematics subjects by field educators. For this purpose, the third-year students of the Department of Elementary Mathematics Teaching were examined how they structured "*if and only if*" proposition. Namely, how do university third-year students make sense of propositions of type theorem1? question will be tried to be answered with this study. As a result of this review, useful information can be offered obtained for students and teachers about how the proposition can be learn and taught.

1.1. Some Concepts Mentioned in the Study

Definition of "Compound proposition": When two propositions are given, these can be combined with links such as *"and (∧)", "or (v)", "if (=>)"*, and "*if and only if (⇔)* " to obtain new propositions. Such propositions are called compound propositions.

Definition of "if and only if proposition": It is defined as $p \Leftrightarrow q = p \Rightarrow q \wedge q \Rightarrow p$

Each of the propositions is indispensable in terms of mathematics and logic. Perhaps the most complex of propositions is "*if and only if*" proposition among the compound propositions.

An example of a proposition to be examined in the study:

Types of propositions at the university level are defined in the Abstract Mathematics Lesson. No further or more complex form of a proposition than the "*if and only if*" proposition in later years (in later courses) is formally defined.

Within the scope of this study, students' understanding of their "*if and only if*" proposition will be examined. Thus, the ontological (arising from the definition) adequacy of "*if and only if*" propositions will be critical. The prototype of the theorems to be discussed in this study is Theorem1.

Theorem1: *Let G be a group. A necessary and sufficient condition for a non-empty subset H to be a subgroup of G is that* $ab^{-1} \in H$ *for* $\forall a, b \in H$.

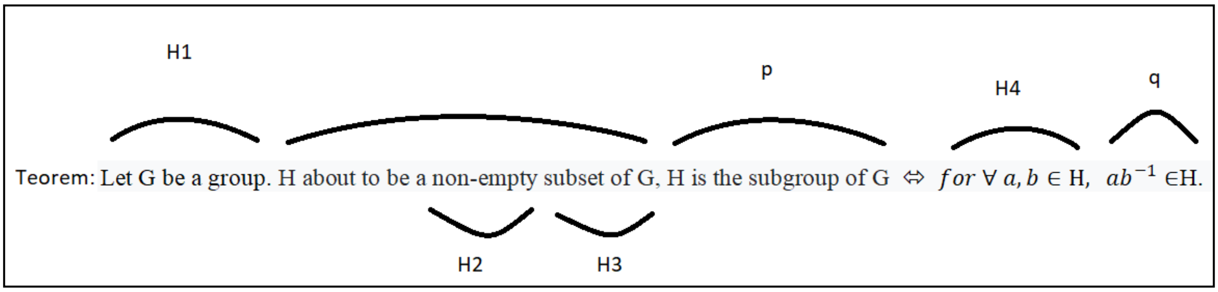

Figure: Theorem1

Explanation of the symbols in Figure:

H1: *It is assumed that G is a group.* This information is given by the authority to the person who will solve the theorem. This information can be used in both directions of proof of the theorem, but it is not wanted to be proved.

H2: It is the assumption that *H is different from the empty set*. This information is a kind of information given by the authority to the person who will solve the theorem. This information can be used in both directions of the theorem's proof, but it is not wanted to be proved.

H3: It is the assumption that *H is a subset of G*. This information is a kind of information given by the authority to the person who will solve the theorem. This information can be used in both directions of the theorem's proof, but it is not wanted to be proved.

H4*:* It denotes that *a and b are given as elements of H*. The authority also provided this information. Although it may seem less powerful than other hypotheses, due to the quantifier "∀" it is actually as important in making proofs as other hypotheses.

***p*:** If taken as *"H is a subgroup of G"* when expressing a hypothesis (during a proof of direction =>); if taken as "*Is H a subgroup of G?"* it means a proposition (during a proof of direction <=).
q: If taken as "ab^{-1} ∈H" when expressing a hypothesis (during a proof of direction <=); if taken as "Is ab^{-1} ∈ H?" it means a proposition (during a proof of direction =>).

The purpose of this study is to examine how students perceive the "*if and only if*" proposition through the example of theorem1.

2. METHOD

2.1. Research Design

The research is a case study. In this case study research, the researcher is also a teacher. In this study, the researcher deals with a situation that he encountered during his own lecture with a group of students and does not aim to generalize. The results obtained may not be valid for students studying at other universities, in this sense, the case study are a suitable method for this research. The teacher is a researcher, teacher and learner in the process. In the process, it is aimed to examine, criticize and change himself, his students, his students' learning products and the learning environment. The data of this study were collected in 4 stages. These stages:

Stage 1: The researcher began his research with the determination that several of the students had misinterpreted especially the right direction (<=) while answering "if and only if" questions on the midterm exam paper an academic year in which he conducted linear II and introduction to Algebra courses. The researcher then more detailed reviewed and analyzed all the students' exam papers for the Introduction to Algebra course. He found that there were significant problems in the proof of "*if and only if*" theorems of the students.

Stage 2: While preparing the lecture notes, the researcher determined theorems of the theorem1 type. And he designed the course in such a way that he can examine how they translate the theorem into "if" statements during the proof of these theorems.

Stage 3: After the researcher has studied the subjects, proved the basic concepts and propositions, he wrote the theorem1 type propositions on the board: (1) asked the students what the type of proposition was. (2) Asked them to convert the theorem into two "if" propositions. (3) He observed how they fragmented the propositions and interviewed 3-4 students about the event. (4) One of the students who thought of breaking down as $p \Leftrightarrow q$ was asked to write their answer on the board. (5) It was discussed whether the answer was correct in the class. (6) the students were asked whether they could prove *H4* acceptance while solving => direction and whether they could prove *H1, H2, H3* acceptance during the proof of the <= direction. (7) The class was asked to interpret the student's answer and other possible answers were written on the board.

Stage 4: The situation was discussed with the students, thus aimed to change the students' understanding.

2.2. Participant Group

The Department of Elementary Mathematics Education, 2012-2013 academic year, third grade students constitute the participant group of the study. In the first phase of the study, the midterm exam papers of 86 students who took the Introduction to Algebra course were examined. These students are students of two classes: the evening class program and the daytime class program. The second and third phase of the study was conducted with 47 students and the fourth phase with 44 students. The difference in the number of students is due to the attendance status of the students at the time the relevant stage of the study was carried out.

The participants of are study is the students to whom the researcher teaches. In the first stage, the exam papers of a total of 86 students in two classes were handled. In the second and third stages, the study was carried out with 47-44 students who attended the class that week.

2.3. Data Collection Tools

The data of the first stage of this study were obtained from the answers given by the students in the midterm exam to the question expressed in figure 1. The data of the first stage of this study were obtained from the answers given by the students in the midterm exam to the question expressed in figure 1. The data from the second and third stages were obtained by asking the students the theorems selected by the researcher, structurally similar to the one in figure 1. That is, in these two stages, the observations, the interview and the answers in the students' notebooks constitute the data of the study. The data of the fourth stage of the study were obtained by solving the same question used in the first stage on the blackboard in the classroom.

The validity of research is closely related to the extent to which the measurement tool reflects the subject to be measured. In this study, the same theorem was used in the 1st and 4th stages. In the 2nd and 3rd stages, structurally identical theorems were used. This is an element that increases the validity of the research.

The reliability of the research is directly related to the ability to get the same results from the measurements again and again. Similar four questions were used in the study. The rapport of the answers in the exam papers on the proof of the theorem with the data obtained from the class indicates the reliability of the study. In other words, data triangulation was provided by document analysis, interview-group interviews and observations.

2.4. Data Analysis

The answers of the students in the midterm exam papers and the answers in the classroom applications were analyzed according to the information in Figure 1, where the theorem1 proposition is explained.

Similarly, the data recorded in the third and fourth stages were analyzed by determining how the students made sense of the expressions H1, H2, H3, H4, p, q.

Problem Status

When we examine theorem1, the proposition is an "*if and only if*" proposition. During the proof, the proposition must be transformed into two "if" propositions. If we write the right direction, (=>) symbolized as to be proved; If we write the right direction, (=>): *If a non-empty subset H of a group of G is a subgroup of G "Is* $ab^{-1} \in H$ *for* $\forall a, b \in H$*?"*

Proof of the right direction of the theorem (=>): before examining the proof, examine fig.1.

In the **right** direction of the theorem, students need to accept that *G is a group (H1), H is a non-empty set (H2), H is a subset of G (H3), H is a subgroup and* $a, b \in H$ (acceptance of *p*' derived from the proposition *p*) and to answer the question *"Is* $ab^{-1} \in H$*?"* by using this information.

Let's answer the question "*Is* $ab^{-1} \in H$ *for* $\forall a, b \in H$*?"*

Let's take the elements *a and b from the set H* (*by the proposition H4*) since *b* is an element of *H*, we know that *H* also contains the element b^{-1}. *If H is a subgroup of G, also, H is a group and in a group*, each element has its opposite (we used the expression *p* when making this inference). Now we have elements *a* and b^{-1}. Moreover, both are elements of *H*. If we process these two elements according to the process of *H*, we get (ab^{-1}). Is this new element *H*'s element? Yes, its element. Because, if *H* is a subgroup of *G*, *H* is a group and has the property of closure so, ab^{-1} is the element of *H*. Then the proof ends.

In fact, in the **right** direction of the theorem (=>), the proposition can be proved without using every given information (*H4* and *p*' statements).

In order to complete the proof, it must be proved in the left direction symbolized as (<=).

Proof of the second direction of the theorem (<=)**:** before examining the proof, examine fig.1.

They need to answer the question "*If a non-empty subset H of a group G provides the condition* $\forall a, b \in H \Rightarrow ab^{-1} \in H$*, is H the subgroup of G?"*

In order for *H* to be a subgroup of *G*, tasks specified in the following stages must be fulfilled:

1: Whether *H* is different from the empty set should be examined. It is given as *H2* information.
2: *H* must be a subset of the *G*. It is given as *H3* information
3: H must have closure property.
4: Elements of *H* must be provided associative property.
5: The identity element must also be an element of the set *H*.
6: Every element in the set *H* must have an inverse.

Proof (<=) : Let's take the elements *a and b* from the set *H* (by the proposition *H4*). The information $ab^{-1} \in H$ for $\forall\, a, b \in H$ is given to us (from proposition *q*). For each element of *H*, this property is provided, so I can take it as $b=a$. Thus, it becomes $aa^{-1} \in H$. So $aa^{-1} = e \in H$ is obtained (The answer to the fifth question was obtained by the proposition *H4* and *q*).

After this stage, if I take $a=e$ and $b=a$ then we get $ea^{-1} \in H$ for $\forall a \in H$. So the inverse of every element will also be in *H* (the answer to the sixth question was obtained by the proposition *q*').

The associative property will be provided since every element of *H* will be an element of *G* (*H3*) and *G* is a group (*H1*).

We have obtained by answering the sixth question that b^{-1} will also be the element of *H* for the element *B*. If we take the elements *a* and b^{-1} instead of *a* and *b* in the expression *q* provided for each element, we get that $a(b^{-1})^{-1}= ab$ is the element of *H*. In other words, closure property will also be provided (by the proposition *q*' and 6th).

As can be seen, the information *H1, H3, H4* and *q*' (hypotheses) must be used to make (<=) the direction of the proof. In other words, students need to know that *G* is a group and that *H* is a different set from the empty set given to them as information. It is also necessary to recognize that *H* is given to them as a subset of *G* and that for $\forall a, b \in H$ the ab^{-1} is the element of *H*, and they examine whether *H* is a subset of *G*.

In light of the above explanations, it is seen that the proposition is not a standard proposition in the form of $p \Leftrightarrow q$ (as defined in abstract mathematics books). Because the proposition is not fragmented in the form of *p=>q* and *q=>p*. Otherwise, the fragmentation would be as follows:

(=>): If a non-empty subset *H* of a group of *G* is a subgroup of *G*, is $ab^{-1} \in H$ for $\forall a, b \in H$?

(<=): If $ab^{-1} \in H$ *for* $\forall a,b \in H$, is a non-empty subset of group *G* a subgroup of *G*?

In fact, this fragmentation of the proposition may not be a problem for a mathematician who specializes in proof. However, for a non-specialized theorem solver (for a student who learns the proof), this can be a big problem. Because we see that there are 4 components within the theorem that we can express as acceptance (see. Fig1). The expressions *H1, H2, H3 and H4* are the acceptance that will be used by the students during the proofs (statements whose accuracy has been given by the authority-to be considered true). Also, there are two other expressions that we will symbolize as *p* and *q*. These two statements are propositions in the theorem (claims in need of proof). But when this "*if and only if*" proposition is fragmented into two "*if*" propositions, *p* turns into an assumption for the direction (=>), we call it *p*' and *q* is a proposition; for the direction (<=), *q* turns into an assumption, we call it *q*' and *p* is a proposition.

But if the students are not aware of what we can call the hypothesis (acceptance) in the fragmentation of the proposition; then the students may also try to prove the propositions given to them. This will cause the propositions to become incomprehensible, difficult and impossible, and there will be no proof.

Let us try to explain again the problem expressed in this paragraph through theorem1.

If students fragment the **right** direction of the theorem (=>) as *if a non-empty subset of H of the group G is a subgroup of G, "Is* $ab^{-1} \in H$ *for* $\forall a, b \in H$*?";* if they fragment the second direction of the theorem (<=) *as if "*$ab^{-1} \in H$ *for* $\forall a,b \in H$*", "Is G a group?", "Is it a subset of non-empty G?",* *“Is it a subgroup of G?"*; or while proving the second direction, instead of asking only “Is *H the subgroup of G*?” question, if they are trying to answer the questions such as *"Is G a group?”,* "*Is G different from the empty set?", "Is H a subset of G?"*, then the students start to solve the second direction of the proposition by asking questions that cannot be answered. As a result, they cannot solve the theorem. In this sense, it is necessary to examine how students make sense of theorems of type theorem1. “How do university third-year students make sense of propositions of type theorem1?" question will be tried to be answered with this study.

3. FINDINGS

The findings of this study are given in 4 titles in accordance with the 4 stages carried out.

Table 1. Findings on stage 1:

		n	**Percent (%)**
No Answer		57	66
Only answer the direction (=>) correctly	No attempt to make the <= direction	5	14
	Tried attempt to make the <= direction but no result	7	
Try attempt to make the both direction		13	15
Solve the theorem correctly		4	5
Total		**86**	**100**

At this stage, the written papers of the 86 students who took the midterm exam were examined. 57 (66%) of the 86 students did not answer the question on the paper. 12 (14%) students were only able to answer the direction (=>) correctly. Of these students, 5 (5.8%) students have never attempted to make the <= direction (there is no wording that has been slandered or deleted on the paper) while 7 (8.1%) students scribbled and (or) tried to delete their answers but did not reach the result. 13 (15%) students tried to do both directions but did not reach the correct results. Only 4 (5%) students were able to solve the theorem correctly.

In other words, while 70 (81%) students could not solve theorem1 at all, 12+4 (18.6%) students were able to solve the direction=>. Only 4 (4.7%) students were able to solve the <= direction. Each student who solved the <= direction (4 people) was able to prove the => direction as well. At this stage, the students ' perceptions of theorem1 could not be determined exactly because they usually devote their time to more familiar-simple questions. However, the researcher found that there were some problems mentioned in the proof of the theorem, especially in the case of the problem in the <= direction. The second stage was designed to understand the prevalence extent and causes of distress. How the students did the proof was examined by handing over the papers many times. In order to see the accuracy of the information obtained in the later stages of the study, the written papers were re-examined many times.

Findings on stage 2:

At this stage, a theorem similar to theorem1 was written on the board and students were asked to say what the type of theorem was. This process took 2 weeks and 6 hours of lessons. The students ' perceptions of 3 similar theorems were examined during the process.

Findings from asking for first similar theorem: First, the theorem was written on the blackboard board. When the students were asked about the type of theorem, all of the students who were in the course at the time (the application was conducted with about 47 students in one class) stated that the proposition was an “*if and only if*” type proposition (students were asked to write the situation in their notebooks). In the sequel, he was asked how to resolve the proposition. Students have written that the proposition should be converted into two “if” propositions. When it is said to break the theorem, a large number of students (more than 30) have written and broken the proposition as the $k \Leftrightarrow r$ proposition. About 10 students suggest;

After writing $H1+H2+H3$ to the first line they break the proposition to the next bottom line as

$p => H4 + q$ and,

$H4 + q=>p$ Let us call this structure the possible structure to be true.

The researcher, who wants to focus on the <= dimension, approached 4 of the students who thought to propose as $p \Leftrightarrow q$ and fragmented the proposition as $H4 + q => H1+H2+H3 + p$. He asked “Are we going to prove *p* while doing this direction of the proof?", "Are we going to prove *H1?"*, “Are we going to prove *H2*?", “Are we going to prove *H3*?". Two of the students answered, “*I don't know*". The third student although stated that the answer to *H2* and *H3* should be sought in the first place, *H1* was already known, but after a few seconds the researcher walked away and said, “*Excuse me, teacher, I couldn't be sure*.” The fourth student said that answers to *H2* and *H3* should be sought, that in order to prove that *H* is a subgroup, it should be examined whether it is different from the empty set and that *H* is a subset. When the researcher asked “*Are you sure?*" he turned his notebook back a few pages, opening the conditions of being subsets and showing the conditions. As the last word, “*teacher, I do not know you wrote like this”* and he smiled.

Findings from asking for second similar theorem: The application was similar to that of the first application. All of the students have said that the type is an "*if and only if*" proposition. They have written the => and <= directions. Similarly, four students were interviewed who thought and fragmented the proposition as $p \Leftrightarrow q$. The researcher asked them “Are we going to prove *p*?”, “Are we going to prove *H1*?”, “Are we going to prove *H2*?”, “Are we going to prove *H3*?”. The first student answered as “*We will prove p, I do not know the others*”. While the second student first said that answers to *H1, H2, and H3* should be sought, after a little hesitation, he said: “I think we would not search answer for *H1*”. Then he has sequenced the questions, “teacher, you asked a similar question in the last lesson, is there a problem? Why did you ask again? What is the truth?”

Another important point here is that although the researcher has solved the theorem correctly after the first application, students generally do not have an increase in awareness about the proof of the theorem, the fragmentation of the theorem and the questions to be answered.

Findings from asking for third similar theorem: The application was similar to that of the first and second application. All of the students have said that the type is an "*if and only if*" proposition. Most of the students have written the => and <= directions. Some of the students (about 10 people) refused to do so. These students’ behavior may have been due to the fact that they did not see a problem with their actions in the second practice. In other words, the students reacted to this application of the researcher, which, according to them, they could not make sense. 5 students have broken down the proposition correctly. At this stage, 4 students were interviewed who fragmented the proposition in the form of $p \Leftrightarrow q$. Three of these students said “*I do not know*” while one of them answered, “*may or may not*".

The researcher thinks that at the end of the second application, the student who reacted as “*why did you ask similar questions again*” was effective in reacting to the other students. As a result, the applications made up to this point indicate that the students have problems in perceiving theorems of the theorem1 type. At this point, Stage 2 has been terminated.

Findings on Stage 3:

After the third similar theorem was asked, theorem1 was written on the board and the students were noted by saying “Shall we solve the exam question again”. Since the exam grade was not announced, the students turned to the theorem in a related way. They were asked to perform the same operations again for theorem1, and a student who broke the theorem in the form $k \Leftrightarrow r$ wrote on the board the => and <= directions of the theorem. When he was asked which questions he would seek while proving his <= direction, "*I don't know*" he answered. Upon this, the proposition was written on the board as in Figure 1 and it was asked which of these statements should be answered during the proof. The answers are as follows:

The proposition p must be answered: 44 students (100%, all of those who were in class that day)

H1 must be answered: 5 students (11.3%)

H2 must be answered: 9 students (20.4%)

H3 must be answered: 8 students (18.1%)

It was observed that some of the students did not raise their hands or declare ideas when answering *H1, H2 and H3*. When the percentages are taken into consideration, it is observed that the percentage of distress that is determined at least 8% in the midterm exam is at least 20.4%. This phase of the study lasted 1 class hour.

Findings on stage 4:

In the course, the students should be informed about the correct breakdown. When students were asked their thoughts about the correct answer, it was observed that some students could not perceive the situation, that is, they did not understand the wrongness of their answers. Although some students used expressions of approval, the researcher had the impression that they did not actually understand the event. Some students have stated that they have never done this conversion before, that they have not encountered a similar situation in the book, and that no similar teaching application has been made by the researcher (despite the examples in Stage 2). A few students with high self-confidence, albeit in a slightly low voice "*teacher, we couldn't do it, but you didn't teach it*" they accused. This phase of the study lasted 1 class hour.

4. DISCUSSION and CONCLUSION

Some "*if and only if*" propositions include acceptance or hypothesis (s) alongside the necessary condition or sufficient condition. This type of propositions should be given a new name and taught to students in Abstract Mathematics course or in Introduction to Algebra-Algebra I course. These propositions can be called "one-sided hypothesized *if and only if* proposition".

Some "*if and only if*" propositions include acceptance or hypothesis (s) alongside the necessary condition and sufficient condition. These propositions should be taught to students in Abstract Mathematics course or in Introduction to Algebra-Algebra I course. This type of proposition can also be called "hypothesized if and only if proposition".

"What is an assumption?" should be explained, defined and exemplified in Abstract Mathematics course. It should also be exemplified and discussed with students how the proposition turns into acceptance when "*if and only if*" propositions are broken down into "if" propositions. It is known that examining and discussing the correctness or falsity of proof by students is effective in students' understanding of proof (Doruk, 2019). Moore (1994) stated that undergraduate mathematics students have difficulties such as being unable to understand and use mathematical language and symbols. In this sense, the idea and the literature agree that theorem1 type propositions proposed in this study should be explained and discussed in more detail.

It is understood that is not sufficient for students to follow only the proofs of the teachers to learn to prove high-level theorems of type theorem1 (especially from Stage 3). For this reason, especially during the course process, students should be provided with the opportunity to make proof with the help of the teacher. The theorem-proving ways of pre-service mathematics teachers in this study show that their perspectives on the nature of proof do immature. This result is compatible with the literature (Güner, 2012).

The situation of these students can also be examined thus the difficulties in learning theorems of type theorem 1 can be determined in more detail. In-class discussions increase students' understanding of the theorem-proof. During the proof of the theorems, students should be asked questions that will improve their understanding by focusing on critical points and discussing differences of opinion by taking the students' opinions.

This study shows us that, although there are some ontological problems with the definition of theorems, solving the theorem is a high-level cognitive competence. Therefore, for the student to reach a level of competence in solving the theorem, it is imperative that the student reveals a consciousness, work and spend labor. It is clear that defining and exemplifying these new types' theorems will not serve as an elixir either. The type of theorem already discussed here is usually theorems of the type encountered in undergraduate courses in the third year. It is also known that students at lower levels have problems with proving the "*if and only if theorems*".

The instructors who carry out the course can repeat the study in the Faculty of Science while the students are studying. It is known that gaining the proficiency of proving is important for graduates of both faculties (Anapa & Şamkar, 2010)

Anapa and Şamkar (2010) suggest that activities that provide students with proving skills should be done more in high school years. They also predict that asking questions about proof in central selection exams will affect the adequacy of proof. In this sense, the effect of the education of students on proof at the high school level on students' ability to prove at the university level can be examined by considering school types.

It is seen that some of the students who realized their mistakes after the 4th stage held the instructors responsibly and made various accusations against them. Actually, the accusations indicate that the instructors who conduct the courses should know pedagogical content knowledge.

It is seen that the steps followed by the students while proving propositions are procedural. It is seen that they do not question the stages of the proof and the reasons for the actions taken. It is known that pre-service teachers choose to memorize while proving (Anapa & Şamkar, 2010).

The level of failure in proving the proposition discussed in this study is high. The failure of undergraduate students to prove is defined as a disappointment by Jones (2000). In other words, it is known that there are studies at the undergraduate level where similar results were obtained with the results obtained in this study conducted at the university level.

Doruk, Özdemir and Kaplan (2015) state that pre-service mathematics teachers lack self-confidence in proving. In this sense, the relationship between pre-service teachers' difficulties in proving their "*if and only if propositions*" and self-confidence can be investigated.

Students' problems regarding the solution of theorems should be resolved as soon as possible by discussing and giving feedback on the exam papers. Although students have the right to object to the exam papers after the exam, they do not have the right to look at the exam paper. However, the researcher thinks that students should have a legal right to look at how their exam papers are scored and where they have mistaken. The instructors should give the student detailed information and feedback about the exam paper. The material and legal infrastructure of this should be established.

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Abstract

The present study investigated the effect of the flipped classroom model, which was practiced in an undergraduate mathematics class, on pre-service primary school teachers' ability to solve problems related to real life and modelling. This study was designed as an action research study exploring the implementation of a new teaching technique. The participants were 16 pre-service teachers who voluntarily took part in the study. The implementation period, which lasted for five weeks, included the following topics: ordered pairs, Cartesian product, relation and its characteristics, the concept of function, types of functions, and linear relation. The data in this study consisted of worksheets that had problem-solving processes, video records of classroom practices, participant journals, and field notes taken by the researcher. The data were analyzed through content analysis. It was observed that the flipped classroom model in the study enabled students to develop their mathematics language, conceptual knowledge, and the use of multiple representations by providing them with an opportunity to work on modelling and real-life problems. This model allowed students to take responsibility for their learning and also provided the teacher with an opportunity to prevent mistakes and misconceptions of students. In addition, it was observed in the data collected from classroom practices and student journals that student–student and student–teacher interactions developed as a result of the classes taught in the flipped classroom model.

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Research Article

Implications from a Modelling based Flipped Mathematics Course *

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Abstract

The present study investigated the effect of the flipped classroom model, which was practiced in an undergraduate mathematics class, on pre-service primary school teachers' ability to solve problems related to real life and modelling. This study was designed as an action research study exploring the implementation of a new teaching technique. The participants were 16 pre-service teachers who voluntarily took part in the study. The implementation period, which lasted for five weeks, included the following topics: ordered pairs, Cartesian product, relation and its characteristics, the concept of function, types of functions, and linear relation. The data in this study consisted of worksheets that had problem-solving processes, video records of classroom practices, participant journals, and field notes taken by the researcher. The data were analyzed through content analysis. It was observed that the flipped classroom model in the study enabled students to develop their mathematics language, conceptual knowledge, and the use of multiple representations by providing them with an opportunity to work on modelling and real-life problems. This model allowed students to take responsibility for their learning and also provided the teacher with an opportunity to prevent mistakes and misconceptions of students. In addition, it was observed in the data collected from classroom practices and student journals that student–student and student–teacher interactions developed as a result of the classes taught in the flipped classroom model.

Keywords: Flipped classroom, real-life problems, modelling problems, relation, function

1. INTRODUCTION

As a result of technological development over the years, mobile devices have become a huge part of our lives, and learning that is independent of time and place has become widespread around the world. The flipped classroom concept is a teaching model that allows this opportunity, and it is considered a technique that enables students to receive course content through electronic devices while they are at home, thus, allowing the classroom time to be used for applied activities (Bergmann & Sams, 2012). The flipped classroom approach does not restrict learning to the classroom environment and enables a range of activities to be conducted in the classroom through tasks and responsibilities undertaken and fulfilled by students.

In flipped classrooms, the time spent out of the classroom should be structured to be able to prepare students for classroom activities in the best way possible, and students should spend their time in the classroom participating in cooperative problem-solving and discussion activities rather than on listening or note-taking (McGivney-Burelle & Xue, 2013). In addition to increasing student–student and student–teacher interaction, flipped classrooms transform traditional teaching environments into student-centered and inquiry-based settings (Bergmann & Sams, 2012). In this model, the teacher

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walks around the classroom and interacts with students who work individually or in small groups and asks questions, answers them, and provides explanations to issues that s/he thinks the class is in need of (McGivney-Burelle & Xue, 2013). Flipped classrooms are considered to be suitable for transforming students' focus on taking notes and encouraging them to engage in sense-making and exploratory activities (Bergmann & Sams, 2012).

Jungić, Kaur, Mulholland, and Xin (2015) consider flipped classrooms as a valuable model because they balance technology and human interaction in the teaching process. This model aids in increasing students' motivation to learn the course content before attending class, providing opportunities for interaction among peers, along with the benefit of receiving immediate feedback from teachers (Zainuddin, 2017). Bhagat, Chang, and Chang (2016), highlighted that low-achieving students receive more attention from teachers in flipped classrooms and have opportunities to discuss their problems in understanding mathematical concepts.

In mathematics education, it has been highlighted that the flipped classroom method eases the transition between conceptual and relational understanding (Bergmann & Sams, 2012). In addition, it was stated that the teachers in flipped classrooms can better identify students who are eager to tackle the problems discussed in the class (Kirvan, Rakes & Zamora, 2015), and this was considered to be critical for the mathematical learning process (Hiebert & Grouws, 2007). In traditional classrooms, while the teachers' attention is on students with high academic performance, the remaining students sit passively. In contrast, the teachers in flipped classrooms are more helpful toward students who struggle with the materials presented to them (Bergmann & Sams, 2012).

Quite a few number of studies were conducted on the use of flipped classrooms for various courses at the undergraduate level in universities (Cronhjort, Filipsson & Weurlander, 2017; McGivney-Burelle & Xue, 2013; Sherrow, Lang & Corbett, 2016; Strayer, 2007). It is especially noteworthy that courses such as Introduction to Statistics (Heuett, 2017; Strayer, 2007); Calculus (Anderson & Brennan, 2015; Cronhjort, et al., 2017; Jungić, et al., 2015; McGivney-Burelle & Xue, 2013; Schroeder, McGivney-Burelle & Xue, 2015); Linear Algebra (Murphy, Chang & Suaray, 2016; Wright, 2015); Algebra (Kirvan, et al., 2015; Lesseig & Krouss, 2017; Van Sickle, 2015); and Finite Mathematics (Guerrero, Beal, Lamb, Sonderegger & Baumgartel, 2011), which are related to mathematics and other disciplines with a link to mathematics, were taught in flipped classrooms. The analysis of relevant studies revealed that McGivney-Burelle and Xue's (2013) study on flipped classrooms showed that students particularly emphasized the roles of videos in achieving better results in homework and tests and classroom time in solving problems. In his study where he compared the use of traditional and flipped classrooms in Introduction to Statistics classes offered at the undergraduate level, Strayer (2007) noted that when students in flipped classrooms were less content with the guidance offered in the classroom, they became more open to cooperative learning and innovative teaching approaches. Similarly, in her research, Van Sickle (2015) emphasized that flipped classrooms was a good method to develop skills in algebra classes. Moreover, she added that it is a convenient model for teaching algebra classes that students were already acquainted with.

Although pre-service classroom teachers are considered to be qualified in mathematics, in terms of using information that is based on operations and rules, especially in arithmetic, it is also known that they experience problems when they are asked to explain why algorithms and/or operations work (Ball, 1990). The starting point of the present study is the fact that when the undergraduate mathematics course was taught to develop pre-service classroom teachers' problem-solving skills and performances, the time given was not sufficient. These circumstances created the need to try out a practice-based teaching model such that theoretical parts are supported with pre-class preparations. Most studies in the literature, while showing that flipped classrooms contribute to students' mathematical performances in quantitative terms (Murphy, et al., 2016; Petrillo, 2016), highlighted the need for in-depth studies to find out whether flipped classrooms are effective in developing certain mathematical skills (Cronhjort, et al., 2017). It is important to conduct an in-depth investigation of both the application of this model and how the model facilitates student learning (Naccarato & Karakok, 2015), just like it is done for any new teaching model.

Prior to conducting this study, it was observed that the classroom time was not enough to teach the content required to solve real-life-related problems in the classroom. This was because of the intensity of the contents of the mathematics course offered at undergraduate level pre-service classroom teacher education programs planned for two hours per week. Therefore, the researchers have designed an action research study based on the flipped classroom model, which they found to be practical in terms of giving more room to practice real-life and modelling problems in the classroom. In this context, the present study aimed to investigate students' performances in solving real-life and modelling problems in the classroom and the learning outcomes of the process. For this reason, the following question makes up the research problem statement in this study: "What are the benefits of flipped classroom model for students, and how did the students' real-life and modelling problem-solving processes develop?"

1.1. Real-Life Problems

It was seen that individuals' needs changed in line with science and advancing technology in the 21st century and that individuals are in need of skills such as decision making, reasoning, and creativity to solve problems (OECD, 2010). However, it is also known that traditional teaching/learning approaches are not sufficient to equip individuals with such and similar skills (English & Watters, 2004; Ministry of National Education Turkey [MoNE], 2016; Zawojewski, Lesh & English, 2003). Although the history of mathematics carries many traces of mathematical subjects being born out of real-life problems, a large number of students' experiences in mathematics courses cause them to consider mathematical subjects to be abstract and irrelevant to real life (Yoon, Dreyfus & Thomas, 2010). At this point, the responsibility of teachers of mathematics classes is to introduce teaching and learning approaches that help set up the link between the mathematics world and the real world in their classes. Model-eliciting activities and application problems are considered to be the two most common ways of setting up the link between the mathematics and the real world (Yoon, Dreyfus & Thomas, 2010). Thanks to such problems, students interpret a case in their real life and mathematize it in a way they are able to understand (Lesh & Doerr, 2003), and thus, mathematical models are structured to seek real-life solutions (Geiger & Kaiser, 2014). These problems also include developing helpful strategies to interpret the nature of the order and patterns, the data that is not clearly seen, aims, and potential solution strategies (Gravemeijer & Doorman, 1999).

The models, which are based on hypotheses developed through mathematical modeling processes, can take the form of mathematical representations in which the relationship between two or more variables is explained (e.g., functions, graphics, tables, equations, inequalities, a system of equations, and geometrical shapes; Bukova-Güzel, 2016). Additionally, a modeling activity generally includes mathematization through various means such as "quantifying, dimensionalizing, coordinatizing, categorizing, algebraizing, and systematizing relevant objects, relationships, actions, and patterns and regularities" (Lesh & Doerr, 2003, p. 5). Model developing activities, which include all these processes, pave the way for students to learn mathematical concepts by relating them to real life (Siller, Çevikbaş, Geiger & Greefrath, 2022). Even though model-eliciting activities are mathematizing the world in a more productive way when compared to application problems, researchers have claimed that model-eliciting activities take more time than other types of problems that are used (Lesh & Doerr, 2003; Lesh, Yoon & Zawojewski; 2007). The need for giving time to real-life problems and mathematical applications in a mathematics course offered at the undergraduate level motivated the researchers to integrate the flipped classroom model into the course and leave the responsibility of learning theoretical mathematics to students.

2. METHOD

The present study adopted an action research design, which is a data-driven research design that teacher-researchers use to make sense of the practices they conduct and to analyse and develop those practices (Cohen, Manion & Morrison, 2007). Action research is defined as a systematic data collection and analysis approach that is directly conducted by the researcher undertaking the practice to overcome process-related problems (Yıldırım & Şimşek, 2016). The present study adopted the scientific action research model, which is a type of action research that is specifically focused on testing and evaluating a certain practice. The study adopted the four-stage procedure described by Lewin (1948), which included planning, acting, observing, and reflecting.

2.1. Participants

The present study was conducted with 16 pre-service classroom teachers registered in an undergraduate mathematics course over five weeks. Around 110 students who were enrolled in an undergraduate elementary teacher education program (Grade 1 to 4) were contacted, and the research process was explained to them. Those who wanted to take the mathematics course among the contacted students were identified, and detailed explanations about what the students were expected to work on within and outside the classroom were provided. Lastly, other responsibilities that they were expected to take on was explained to those students who volunteered to take part in the study.

The participants in the study consisted of individuals who completed their high-school education in various cities, had different socioeconomic backgrounds, were between the ages of 18 and 22, and studied in the same department. The whole group consisted of 16 preservice teachers. There were 11 women and 5 men from a elementary teacher education program (Grade 1 to 4) who agreed to participate voluntarily. They were asked to work in groups of their preference with three to four other students. Further, the students, from the beginning of the first week onward, were asked to work with the same team members in the problem-solving environment during the teaching process to enhance group dynamics by creating a peer learning environment and to enable them to gain the maximum benefit. Participants' real names were not used in the study, and the groups were coded as follows based on the group names the participants chose: Yeni Nesil (YN), Maviş (MVS), Teşkilat-ı Cebir (TC), Son (SON), and Sıralı Dörtlüler (SD).

2.2. Procedures

During the research process, students' learning activities inside and outside of class were designed by the researchers. First, the course materials to be used in out-of-class activities as part of the flipped classroom model were designed. In line with this, the massive open online courses available in the literature were examined by the researchers. Each of the sources accessed was examined by a mathematics expert, two mathematics teaching experts, and an information and education technologies expert in terms of criteria such as their fitness with respect to the learning outcomes of the course, the suitability and structure of the mathematical language used in the videos, the technological characteristics of the videos, and the adequacy of the mathematical content. Following the analysis of the online content, video(s) were edited to align with the learning outcomes of the course, and necessary additions were made. Within the 5-week implementation period, we shared 35 videos (total 158 minutes) with the preservice teachers. The course materials were delivered to the preservice teachers through WhatsApp. During the research period, students were asked to come to the class after watching the videos prepared by the researchers. Thus, students were able to spend more time on real-life and modeling problems during classroom activities. Throughout the study we conducted classroom activities with volunteer students. During the study, there was only one participant could not watch the videos before arriving the in class activities.

The classroom activities that were part of the research study included a number of problem-solving activities that consisted of real-life problems and modeling activities. Each of the problems used in classroom activities was developed by the researchers on the basis of real life. The nature of the problems were directed at developing students' mathematical competence and their use of mathematical language and, at the same time, to help them set up links between real life and mathematics. Topics such as ordered pair, Cartesian product, relation and its characteristics, the concept of function, types of function, and linear relation models, which were part of the undergraduate mathematics course that was the research setting, were included in the study. The topics included in the research study (e.g., relation, functions, and graphics) and their sub-concepts are presented in Table 1. The detailed information regarding the activities designed were given in a drive folder (https://drive.google.com/drive/folders/1IhYE5P-gNugW-KRKQNs6KwcGq8GdtfLa?usp=sharing).

Table 1. The activities in the research study and their content

Week	Activity	Content
Week 1	Cabin Crew	Ordered pair, Cartesian Product & Relation
Week 2	Cabin Control List	Cartesian Product & Relation
	Valentine's Day	Relation, and the characteristics of relation (reflection)
Week 3	Blood Transfusion	The characteristics of relation and the concept of function
Week 4	Yoga Course	Functions & linear relation
Week 5	Call Center	Linear relation, inverse function, graphs of functions and the linear functions

As a part of an action research, after every sessions of in-class activities, researchers conduct a negotiation meeting to evaluate the effectiveness of the activities and to rearrange the forthcoming week's plan. Thus, even if the researchers design all the process before the process, they also rearrange and redesign activities and videos in accordance with group progression and group dynamics.

2.3. Data Collecting Process

The data sources in this study consisted of worksheets that contained problem-solving processes, video records, participant journals, and field notes taken by the researcher. At the beginning of each class, students were given worksheets that explained problems from real life. Those worksheets were the main source to assess groups' performances in a given week. Audio and video recordings relating to groups' problem-solving processes were made in order to understand the strategies and ways of thinking that each group utilized when finding solutions. In addition, field notes were created by recording the feedback given to students and the common mistakes made by them. Triangulation was achieved in the study by using field notes and audio-video records to support the data collected from the worksheets with problems.

2.4. Data Analysis

The analysis of the data took place in two stages: 1) through micro analyses conducted at the end of the class taught each week to analyze the weekly effectiveness of the plans and 2) through macro analyses conducted at the end of the study. Action plans, which were implemented each week, were evaluated by the researchers after implementation. The microanalyses at the end of each week were conducted by two mathematics education experts and a mathematics expert and then, due to the nature of the action research design, new decisions were made to develop action plans to improve the practice.

As for the macro analyses conducted at the end of the study, experts, after coding the data through open coding, met to decide on their agreement with the codes, and they developed themes based on the codes by consensus. Based on the themes that were developed, weekly development in each group was observed procedurally, and similar and different processes between groups were presented through diagrams. After analyzing the whole process, the inter-coder reliability (Miles &

Huberman, 2014) between the coders are found .86. After the codes were negotiated, researchers were constructed the themes and visualize the data as findings.

3. FINDINGS

The results of the present study, which was designed as an action research study, were analyzed in terms of the topics covered and in the context of real-life and modelling problems prepared in relation to those topics.

3.1. First Week: Ordered Pair, Cartesian Product, and Relation

In the cabin crew problem that was presented in the first week of the study, students were asked to use their knowledge on ordered pair, Cartesian product, and relation topics, which they had been learning since high school, in solving real-life problems. In the context presented in the problem, students were, first, asked to identify the convenient seats, then, to match passengers with the dishes they could eat based on their special diet categories, and, finally, identify all the conditions relating to these matchings. The groups showed the solution using various representation forms such as lists and Venn diagrams and by placing the plane in Cartesian coordinates. Additionally, YN, MVS, and TC preferred graphic representation whereas SD, YN, and TC preferred representation through common characteristics in addition to other forms of representation (Figure 1).

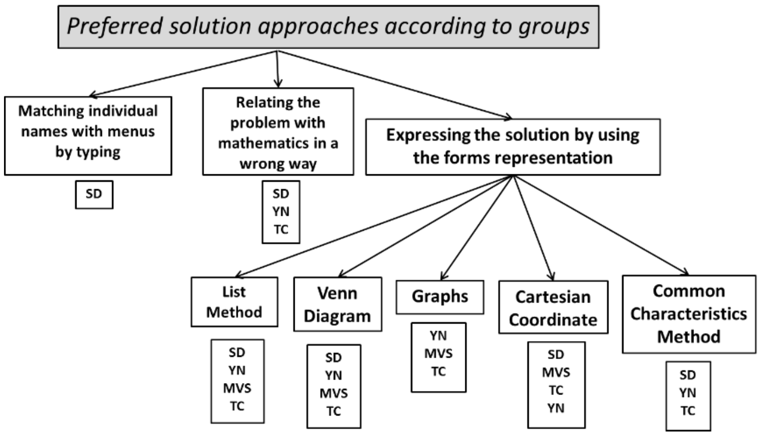
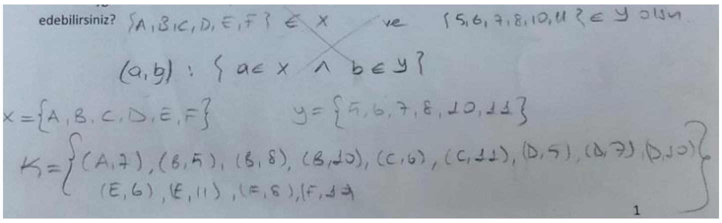


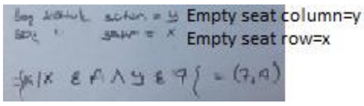
Figure 1. General performances in Week 1

Most of the participants expressed that they encountered such real-life problems for the first time and experienced difficulties in applying their knowledge of ordered pair and Cartesian product, which constitute the basis for the concept of relation, to real-life problems, as shown in researchers' field notes.

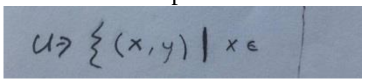
When the preferred solution approaches among the groups were analyzed, it was observed that students tried to express the solution without using the mathematical language appropriately (representations, expressions, notation e.g.). Samples of common characteristics and list methods, which were among the representation forms used by SD, can be found in Figure 2. It has been observed that students were not able to associate the topic with the real-life problems using either one of the representation methods, and they were not able to adequately understand representation using the common characteristics method. It was seen that MVS, like SD, repeated the same mistake in using mathematical language to represent relation with the common characteristics method.



Group SD



Group MVS



Group YN

Figure 2. Samples of mistakes in using mathematical language inadequately in Week 1

When the groups' journals were analyzed, it was found that all the groups liked the videos they watched and perceived teamwork as joyful and educational.

> *"Real-life problems were problems that helped us comprehend the topic. They were questions that were open for reasoning. We found the solutions through discussion and cooperation with our teacher and group members. Classroom environment was quite open for discussion, and it was joyful." (SD)*
>
> *"…Today, watching videos beforehand was extremely helpful in solving the problems our teacher gave us. Our teamwork was joyful and educational. It was an environment suitable for discussion, and we found common ground by listening to each other and transferred it on to paper…" (TC)*

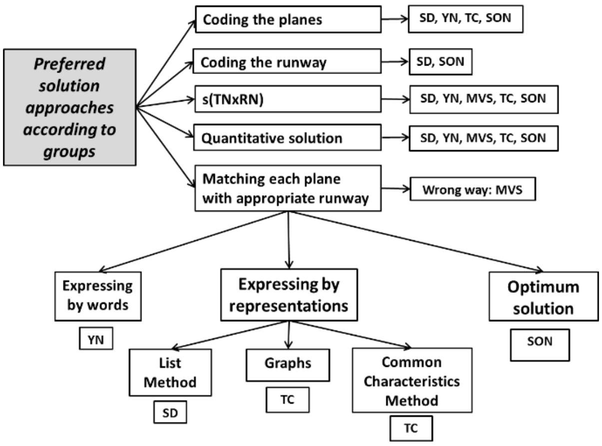
At the end of the first week, although all researchers agreed that relevant concepts were learned based on the worksheets and participant journals, they decided on an action plan for the next classes to provide feedback to students for developing their use of mathematical language.

3.2. Second Week: Cartesian product, Relation, and Characteristics of Relation

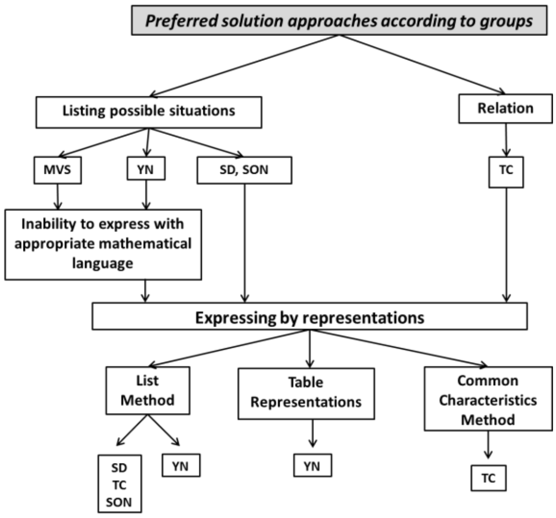
In the second week of the study, students' learning processes regarding the Cartesian product, relation, and the characteristics of relation (reflection) were analyzed through the Cabin Control List and Valentine's Day problems.

The process of solving the first problem touched upon the Cartesian product, which students were considered to have difficulty in explaining through mathematical language. The problem included details of planes' tail numbers (TN) and the smallest runway distance (RD) necessary for takeoff. Students were asked to calculate how many matches there could be without matching TN and runway numbers (RN). This task was assigned to students to assess their knowledge of the Cartesian product. Later, groups were able to match TN and runways on the basis of takeoff-landing RDs for all flights appropriately. This matching task was assigned to students to make them use the concept of relation in real-life problems.

In the Valentine's Day problem, which was the second problem of the week, groups were expected to use relation and its characteristics (reflection) in a real-life problem; the case is that Valentine's Day is being organized in a shopping mall, and the context is a raffle for couples. When the groups' approaches to the solution of the second problem were analyzed, few groups (MVS & YN) were found to have listed all possible conditions without using formal mathematical language related to the characteristics of relation. Figure 3 presents an overview of the groups' performances in the second week.



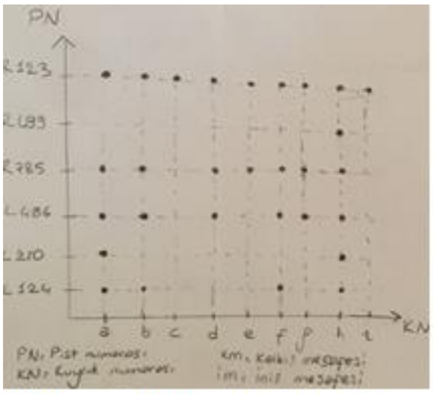
a. Problem 1



b. Problem 2

Figure 3. General performances in Week 2

When the groups' approaches to solving the problems were analyzed (Figure 3a), it was observed that all groups preferred to code the planes; additionally, it was seen that SD and SON groups coded RN as well. All groups were able to find the numerical solution, write the Cartesian product correctly with the help of the feedback they received, and calculate the number of figures in a set without listing all the figures. It was observed that MVS was not able to solve the problem of landing the planes; YN was only able to explain the solution in words and could not explain it mathematically; and SD presented the solution using the list method. However, TC, approached the problem differently from other groups by using graphics (Figure 4) and modeling the solution through the common characteristics method.

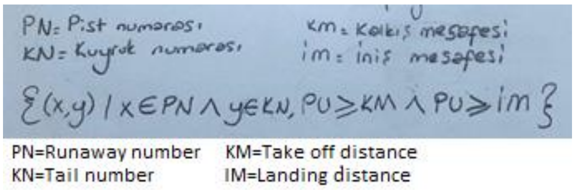


PN=Runway number KM=take-off distance
KN=Tail number IM=Landing distance

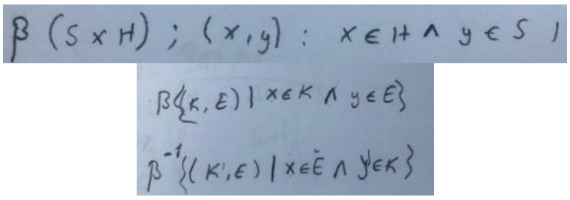
Figure 4. Performance of the TC Group

When the groups' problem-solving approaches for the second problem (Figure 3b) were analyzed, it was found that all groups except TC started the solution by listing all the possible conditions. In this process, TC noted a direct relation; MVS was found to not have used proper mathematical language in this process and did not complete the solution; and YN was found to experience problems in the mathematical representation of domains and codomains. While YN presented the solution using lists and tables, SD and SON used the list method to reach the solution of the problem. Additionally, TC was found to use the list and common characteristics method.

Although students experienced difficulties in using formal mathematical language in expressing the characteristics of relation and, more specifically, domain and codomains in Week 2, it can be understood from the solutions presented in Figure 5 that they were able to develop their mathematical language when compared to the previous week because of the feedback they received regarding mathematical language.



Group TC



Group YN

Figure 5. Samples of the groups' use of mathematical language about the concept of relation

As shown in the participant journals, the researchers' approach in the classroom with regard to the use of mathematical language had an impact on the development of the mathematical language that the students used:

> *"..The questions required more knowledge and thinking skills in terms of content…We have realized that our mathematical language improved due to the nature of the questions' content." (SD)*
>
> *"We have many problems in expressing with mathematical language. We have seen that the research has already been useful. This is because it is now easier to identify our weaknesses." (SON)*
>
> *.".Today… we have developed our thinking skills, we are doing a better job each week…The questions are similar to those we may encounter in real life, and this allows us to solve the problems with pleasure." (TC)*
>
> *These questions allowed us to better express our analytical thinking structure compared to last week…" (MVS)*

Although the researchers had an agreement that the concept of relation was learned at the end of the activities of Week 2, an action plan was made for the next week, which included showing new videos about the characteristics of relation and other videos on the concept of functions for revision.

3.3. Third Week: Characteristics of Relations and the Concept of Functions

The process of learning the characteristics of relation and the concept of function was analyzed in the third week of the research through the Blood Transfusion problem. Details about the blood types of individuals and Rh antigens in their blood were provided, and the students were asked to create a model for blood transfusion. The problem, within a scenario in the context of blood transfusion, aimed to identify the characteristics of relation in the first two questions and the conditions that change a relation into a function as well as the domains and codomains in the following six questions. Figure 6 presents an overview of the group performances in the third week.

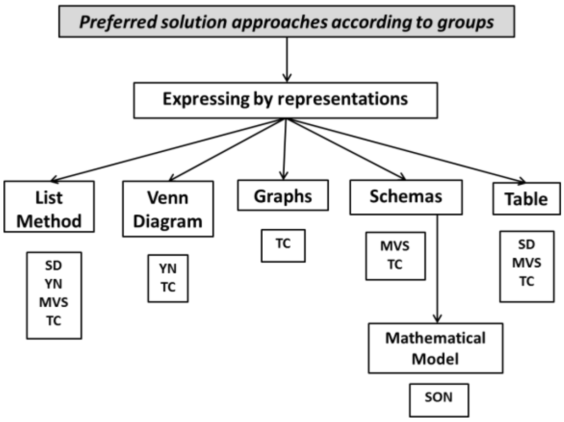
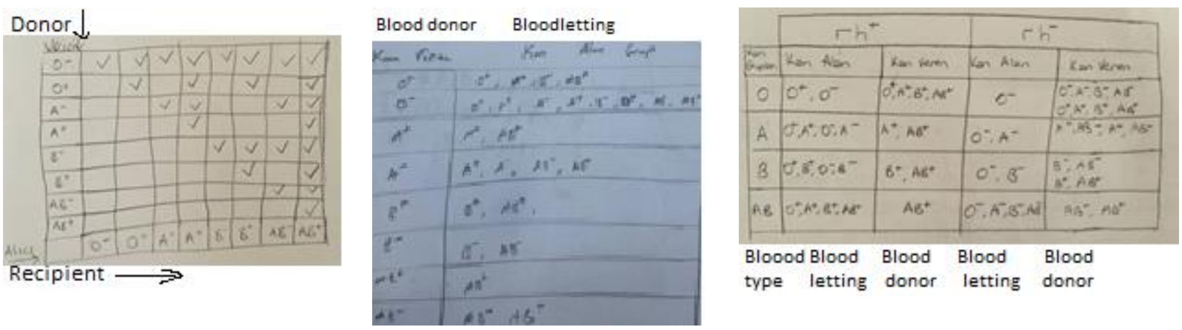


Figure 6. General performances in Week 3

When the solution approaches were analyzed, it was found that almost all groups preferred the list method. It can be seen in Figure 6 that groups presented the solution through multiple forms of representation. All groups except for SON analyzed the characteristics of relation and used proper mathematical language relatively accurately. However, SON focused on identifying the type of relation without referring to the characteristics of relation and wrote all characteristics using proper mathematical language with the guidance of the researchers. All groups except for YN were found to have identified the type of relation (ordered/equivalence) even though it was not requested for in the scenario.

In the next part of the scenario, SD and TC were found to have expressed the characteristics of a relation that meet and that do not meet the criteria of being a function using proper mathematical language. In this part, SD used mathematical representations present in the videos, but TC preferred the use of Venn diagrams. However, YN, MVS, and SON were found not to have linked the solution with the concept of function and to have only identified the condition that was asked for in the scenario. In identifying domains and codomains, SON and TC groups were found to have used proper mathematical language, but the other groups were not able to identify those domains.

In general, tables or diagrams were preferred for presenting solutions. Specifically, SD and YN, as presented in Figure 7, found the solution using tables, and SON put forward two different model proposals as presented in Figure 8. The fact that students tried to develop different models in the subject of blood transfusion, which was a topic they had learned in the past, and that some of them even tried to use models that were non-existent in the literature were noted as striking findings.



a. Group SD **b.** Group YN **c.** Group TC

Figure 7. Tables used by SD, YN, and TC Groups

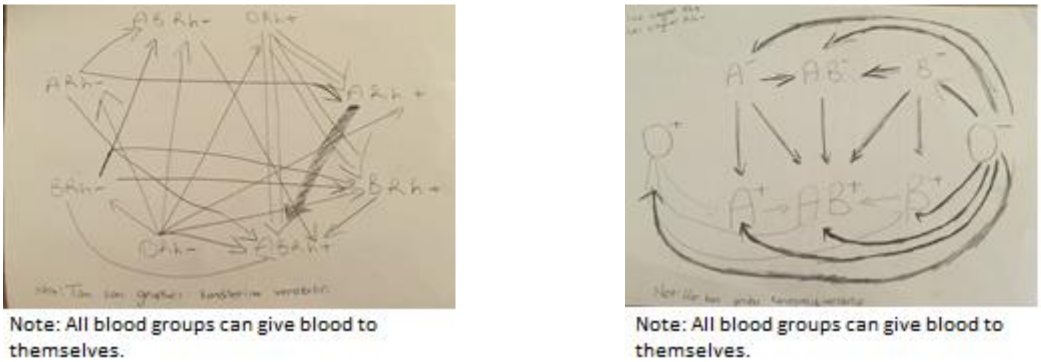
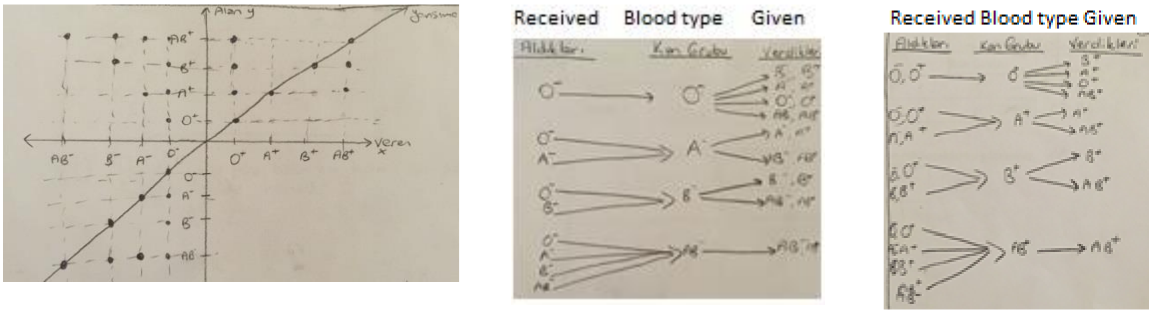


Figure 8. Models developed by the SON Group

While a number of groups preferred the use of more than one form of representation, TC was found to have used all forms of representation, which were used by other groups (Figure 9). Apart from preparing tables and diagrams/schemas, they also presented a solution that was placed on an analytic platform as can be seen in Figure 9.

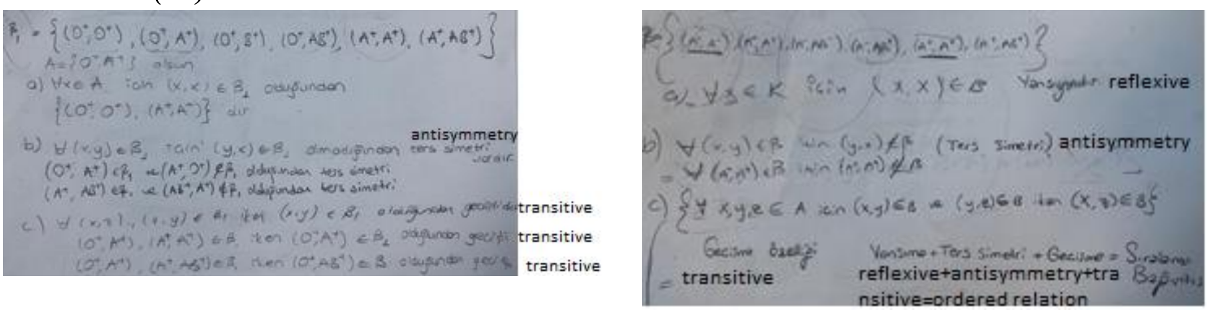


a b

Figure 9. Schemas used by the TC Group

It was observed that students showed progress in the third week in relation to presenting the characteristics of relation using proper mathematical language, which was a topic that students experienced problems with in previous weeks (Figure 10). Moreover, it can be understood from the journals of the groups that real-life problems had positive effects on students' understanding.

"… the fact that the question was related to real life helped us better understand the characteristics of relation. The week was tiring, but we learned while having fun again…" (SD)



a. Group SD **b.** Group TC

Figure 10. Samples of mathematical language use for the characteristics of relation

At the end of the third week, it was decided that the characteristics of relation had been practiced enough, and new decisions were made for the next action plan, such as continuing practice work on the concept of functions in the videos that were to be prepared, decreasing the length of activities considering the volume of the content, and adding credits to the videos.

3.4. Fourth Week: Concepts of Linear Relation and Function

In the fourth week of the study, the process of learning the concept of function and linear relation was analyzed through the Yoga Course problem. The problem included the details of costs for members and non-members in a yoga course, and students were asked to find the most attractive alternative. The first two questions in the scenario focused on linear relation and the last two on whether the relation among variables formed a function. An overview of the problem-solving process is presented in Figure 11.

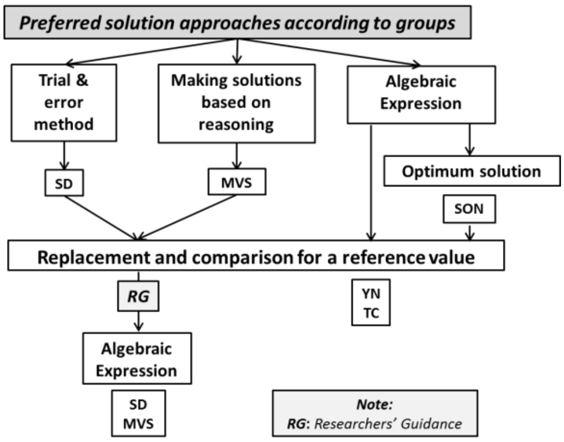


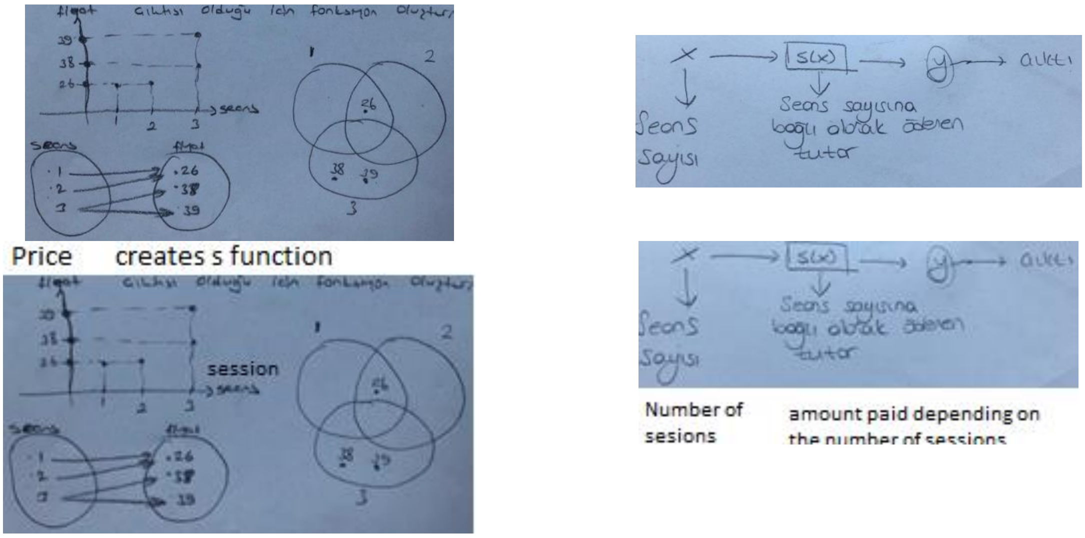
Figure 11. General performances in Week 4

In solving the problem, it was observed that the SD discovered the system that was more attractive by providing numerical examples, and the MVS did so through reasoning. YN, TC, and SON, were observed to, first, prefer writing down the algebraic expression. In the next stage, YN and TC were found to investigate the algebraic expression they wrote for its reference value; they compared it with the results. At this stage, the SON was seen to have reached the best solution by writing the algebraic expression. An important finding was that SD and MVS were able to express the linear relation algebraically only after receiving guidance from the researchers. In the next stage, in comparing membership and non-membership conditions, all groups were found to have correctly interpreted the conditions of whether the relationship among variables indicated a function or not.

The fact that YN, TC, and SON came up with the algebraic expression that they were expected to find in the last stage of solving the problem and that they were able to express it using formal language was considered a finding that indicated that students' mathematical language use had developed. Moreover, the fact that the SD started to diversify their answers by using representations from the videos and that the MVS, which showed low performance in previous weeks when compared to other groups, used multiple representation forms was also considered as a proof of students' development in terms of mathematical language (Figure 12).

When student statements in the journals of the groups during Week 4 were analyzed, the materials prepared in advance for flipped classrooms were found to be effective: *"The videos helped me 100 % in reaching the solution."* (YN)

Since the researchers were in agreement that the identified concepts were taught and students had enough knowledge of linear relation at the end of the fourth week, it was decided that the content of videos would be on the concepts of function and functional relation.



a. Group MVS b. Group SD

Figure 12. Samples of groups' mathematical language use in Week 4

3.5. Fifth Week: Linear relation, Function, and Inverse Function

In the fifth week of the study, the process of discovering linear relation in a real-life problem and expressing this relation in formal mathematical language was analysed through the Call Center problem. The problem included details of customers waiting to be served in a call center and their estimated waiting time, and students were asked to identify the relation between these variables and to calculate the waiting time for customers who were given a sequence number, and similarly, calculate the sequence numbers of customers who were informed of length of the duration they had to stay on the line. In the last part of the problem, students were expected to question whether there was an inverse function for the working principles of the call center. An overview of the problem-solving process is presented in Figure 13.

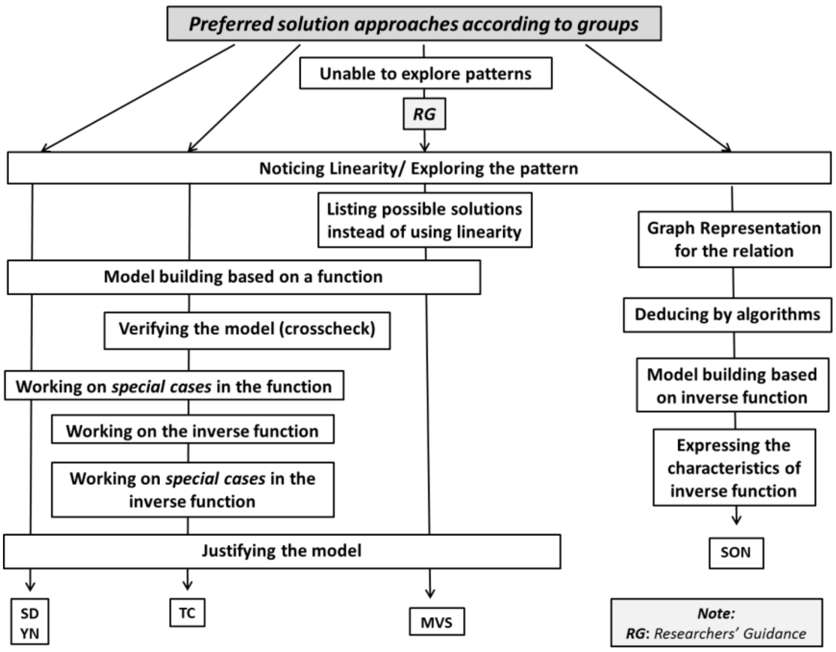
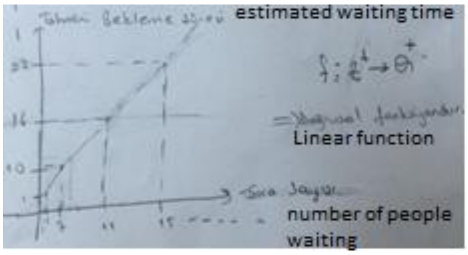


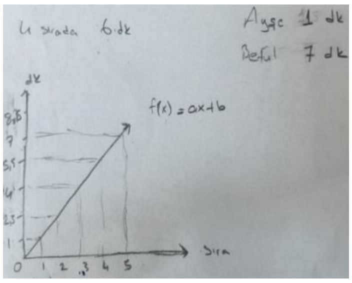
Figure 13. Group performances in Week 5

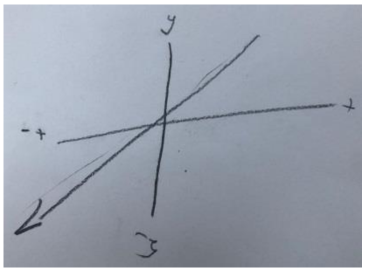
During the fifth week, it was observed that all groups except for one were able to easily identify the linear relation and had started solving the problem. MVS experienced difficulties at the beginning and was then able to realize the linear relation with guidance from the researchers.

MVS, SD, YN, and TC, after realizing the functional relation, were found to continue to the stage of expressing this relation with a model. At this stage, MVS worked persistently on listing potential conditions that exemplify the linear relation, experienced difficulties in developing the model later, and continued with the validation process. TC was found to have worked on special conditions after confirming the model. SD and YN focused on special conditions right after developing the model. In the next stage, although MVS, SD, and YN had defended their models, TC defended their model by working on the inverse function and the special conditions existing in its inverse form. As for SON, after realizing the linear relation, they tried to represent it using graphics, made inferences through algorithmic approaches and, unlike other groups, developed the inverse version of the function and explained its characteristics.

Except for TC, none of the groups mentioned domains or codomains during the process of defining function and inverse function; they paid attention to sets intuitively and did not feel the need to express them through mathematical language. In this process, only TC managed to express the domain correctly, but they made a mistake in writing the codomain. YN, TC, and SON tried to represent the function about the working principle of the call center through a graphic during the solution process. Figure 14 presents the mistakes that the groups made in representing the solution through graphs. Taking domain and range into consideration, it was found that the group TC's graph includes discrete points starting from index number 1; the Group SON's graphed a line starting from 0; and the Group YN graphed a line too, but it includes negative values as well, which was out of the context.







Group TC Group SON Group YN

Figure 14. The graphs drawn by the groups for the problems of Week 5

Considering the groups' performances and because it was the last week in which the concept of function was covered, immediate feedback was provided to the groups to resolve mistakes (e.g., showing domains and codomains in functions, representation of linear functions via graphics, etc.). At the end of the fifth week's practice session, from the groups' worksheets and their statements in the journals, it was clear that concepts related to linear functions were learned.

> *"We have completely understood linear function" (YN)*
> *"…the activity in the classroom allowed the use of the information in the videos…" (SD)*
> *"…it was enjoyable to find the questions' relation to the topic (e.g., developing a formula); the questions are like reinforcements in terms of mastering the topic…" (MVS)*
> *"Today, we had difficulty in graphics; our mathematical language is not as bad as it was when we first started. We have developed ourselves quite a bit. I find this study helpful." (SON)*

4. DISCUSSION and CONCLUSION

The present study evaluated students' problem-solving processes together with their mathematical language, concept development, and the difficulties they experienced in flipped undergraduate mathematics classes. Research indicated that the nature of flipped classroom provide active learning (Novak, Kensington-Miller & Evans, 2017), peer instruction (Novak, Kensington-Miller & Evans, 2017), cooperative learning (Foldnes, 2016), scaffolding (Witt, Trivedi & Aminalroayae, 2021) opportunities for both the learners and the instructors. In this study, by creating opportunities for students to work on real-life problems and model development activities, the learning process was differentiated and enriched with the help of flipped classroom model.

The flipped classroom model used in the study provided the researchers with many opportunities. First, classroom time has become more convenient for cooperative and practice-based activities. As a result, the real-life and modeling problems that were used allowed students to develop various perspectives. Similarly, most of the research (Bukova-Güzel; 2016; Geiger & Kaiser, 2014; Siller, et al., 2022) noted that students who worked on modeling activities learned important mathematical concepts and structures present in complex real-life situations. In our study, the participants stated that they were in such a learning environment for the first time and experienced difficulties in solving the problems since it was the first time that they had encountered real-life problems and model development activities.

According to the conventional perspective regarding the learning and problem-solving process, solving real-life problems, unlike model development and modeling perspectives, are accepted to be more difficult than problems encountered in exams and books (Lesh & Doerr, 2003). In the present study, although the participants stated they had difficulties at the beginning, they were found to consider this method effective later. Therefore, if flipped classrooms are to be applied in a class for the first time, considering the difficulties that both the teacher and the learners may experience, to start with, a subject in which students are less likely to experience problems may be selected. The analysis of the difficulties experienced by students in solving problems indicated that they had the most difficulty in linking the characteristics of function with real life. The students, until they took part in the study, stated that in traditional learning environments throughout their academic life; they were assessed through standardized tests and focused on passing those tests. Likewise, because standardized tests do not allow for satisfactory feedback on students' mathematical skills (Niss, 1999), the use of such activities in assessing students during the learning process is necessitated. Research (Bredow, Roehling, Knorp, & Sweet, 2021) also support that the flipped learning model is more effective than traditional learning setting. Especially, in the field of mathematics education Heuett (2017) and Sen (2021) argued that students' performances in the flipped classroom were better especially in terms of solving mathematical problems when compared to others in traditional learning environments. Strelan, Osborn, and Palmer (2020) state that the most important factor affecting this result is that the flipped classroom model provides opportunities for structured, active learning and problem solving.

An important advantage of practicing the flipped classroom model was the fact that it enhanced the student-teacher and student-student interaction in the classroom. Similar studies in the literature highlighted that flipped classrooms improved student-teacher and student-student interaction (Guerrero, et al., 2011). As Wright (2015) mentioned in her study, one of the reasons why this interaction increased was the fact that students cooperated and helped one another during group work and while learning concepts. Earlier research showed that flipped classrooms equipped students with skills such as cooperative problem-solving, out-of-class study habits, and learning from their peers in both in-class and out-of-class processes (Schroeder, McGivney-Burelle & Xue, 2015). Additionally, Kirvan, et al., (2015) highlighted that while this method saves time for diversifying teaching, it also provides an opportunity to help students who have difficulties and enable them to work both individually and cooperatively.

In this study, another reason why student-student interactions increased was the fact that the teachers were able to pay more attention to students. This situation is underlined in a study conducted by Anderson and Brennan (2015), which showed that the students found the teachers' approach positive and explained that they received more attention. Moreover, a similar situation was evaluated through the perspectives of peer-learning, participation in content, and participation in the learning process in Novak, Kensington-Miller, and Evans' (2016) study. In this context, looking through the perspective of students, it was emphasized that the flipped classrooms model can develop mathematical interaction.

In the present study, the flipped classroom model allowed researchers to focus on preventing student mistakes and misconceptions by decreasing the number of theoretical mathematics topics, with the help of real-life and modeling problems used in classroom activities. Similarly, Heuett (2017) mentioned the advantage of flipped classrooms in responding to students' questions on time and eliminating misconceptions. In our study, the flipped classroom practice provided the opportunity to support students' use of mathematical language as a result of the time it saved. In the present study, it was found that there was generally a tendency among the participant groups to present the solution in words or with any form of representation, and they experienced problems in using mathematical symbols. However, during the weeks of the practice, they were found to have made developments in using mathematical language more effectively. In this process, it was observed that the use of representation forms increased, and students often used multiple forms of representation even if they were not required to do so. Researchers highlighted that flipped classrooms enabled students to develop their mathematical communication skills (Schroeder, McGivney-Burelle & Xue, 2015) and generate more comprehensive and detailed answers to questions requiring the use of complicated mathematical terms, reasoning, and exemplifying (Murphy, et al., 2016).

The structure of flipped classrooms has a number of advantages such as providing students with an opportunity to watch the same video over and over or watching videos at home (Cronhjort, et al., 2017). The videos in the present study guided the students in solving the problems given in the classroom, and they made use of the videos during class without being guided to. Further, they tried to make use of videos that were not presented to them for course preparation. Similarly, in Lesseig and Krouss' (2017) study, the students highlighted the usefulness of watching videos to the learning process. Some students prepared notes while watching the videos to prepare for the classroom and made frequent use of those notes while solving problems as a group in the class. In spite of this, from time to time, students were found to ignore the characteristics of number systems, which provide the input for concepts such as domain, codomain, Cartesian product, relation, and function, which were present in the videos that they watched. Some students ignored this information because they considered it a detail, similar to the attitude in a traditional classroom environment. Therefore, special precautions should be taken to develop students' sensitivity for such concepts. In this sense, Kirvan, et al., (2015) underline the importance of planning classroom activities and videos to be used in flipped classroom practices in a way that would increase students' concentration on conceptual understanding. Although the participants in the study considered the videos to be sufficient, researchers may consider presenting (teaching) concepts in future studies because students can perceive as being more familiar and effective.

Although the study was conducted with volunteer students, the fact that occasionally there were students who could not participate in activities (those who could not join classes on the day of activities) decreased others' motivation. Similarly, that a number of individuals in the group who arrived without watching the videos were included in activities only after they watched the videos negatively affected students' motivation. In Heuett's (2017) study, it was explained that students who arrived in the class without watching the videos had difficulties in adapting to activities because they were not prepared, and this situation prevented them from understanding the concepts well. In the present study, there was only one student who was in a similar situation. Kensington-Miller, Novak, and Evans (2016) stated that the flipped classroom model enabled students to take responsibility for their own learning processes. It is important to develop strategies to get students to undertake this responsibility by planning studies in which the whole classroom takes part for a longer period of time.

In the present study, the students were asked to work in the same group for five weeks to support group dynamics in solving problems. According to Novak, Kensington-Miller, and Evans (2017), active learning and group work are the fundamentals of the flipped learning model. In future studies, groups can be recreated in each class based on the students who are present in the class on a given day.

The analysis of national and international research on flipped classroom are quite relevant to our research. Especially, the research on mathematics education is considered, it is stated in the systematic literature review (Şen, 2022) and meta-analysis study (Sopamena et al., 2023) that mathematics teaching with flipped classroom is more effective than the traditional method. In addition, review studies (meta-analysis, systematic review and thematic analysis) report that this model is also effective on learning outcomes when it is conducted in different disciplines regardless of the course type, both in the Turkish perspective and internationally (Aydın, Ökmen, Şahin & Kılıç, 2021;; Karagöl & Esen, 2019; Strelan, Osborn & Palmer, 2020; Şen, 2022).

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Adnan Menderes University with the decision dated 10/03/2017 and numbered 15428.

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Abstract

The aim of this study is to examine the effect of anxiety level on foreign language success and to examine the level of anxiety in terms of various variables in learning Turkish as a foreign language. Descriptive analysis and measurement by scanning was used. Anxiety levels of students learning Turkish as a foreign language were examined in terms of various variables. "Foreigners' Turkish Learning Anxiety Scale" was applied. In conclusion; Anxiety is an effective factor in learning Turkish as a foreign language. While sufficient level of anxiety facilitates learning, high level of anxiety makes learning difficult. As a new concept, we can call it motivational anxiety. Anxiety levels of students do not differ significantly according to gender, country and time they live. When the anxiety levels of the students learning Turkish as a foreign language are examined according to the variable of the number of languages they know, there is a significant difference in favor of those who speak 4 languages or more. Since the majority of the students are at a moderate level in terms of both academic and self-esteem, it is thought that a moderate level of anxiety will contribute to success.

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Research Article

Examination of Foreign Students' Anxiety in Learning Turkish in Terms of Various Variables [*]

Tuğba ŞİMŞEK [1]

Abstract

The aim of this study is to examine the effect of anxiety level on foreign language success and to examine the level of anxiety in terms of various variables in learning Turkish as a foreign language. Descriptive analysis and measurement by scanning was used. Anxiety levels of students learning Turkish as a foreign language were examined in terms of various variables. "Foreigners' Turkish Learning Anxiety Scale" was applied. In conclusion; Anxiety is an effective factor in learning Turkish as a foreign language. While sufficient level of anxiety facilitates learning, high level of anxiety makes learning difficult. As a new concept, we can call it motivational anxiety. Anxiety levels of students do not differ significantly according to gender, country and time they live. When the anxiety levels of the students learning Turkish as a foreign language are examined according to the variable of the number of languages they know, there is a significant difference in favor of those who speak 4 languages or more. Since the majority of the students are at a moderate level in terms of both academic and self-esteem, it is thought that a moderate level of anxiety will contribute to success.

Keywords: Teaching language, Turkish education, teaching Turkish as a foreign language, anxiety, motivational anxiety

1. INTRODUCTION

With the rapidly changing and developing technology, distances have lost their importance in the globalizing world. Students go to many parts of the world to receive language education. Language schools are established in many countries, especially language teaching centers are opened within universities.

Turkey is also among the preferred countries to learn languages the number of people who prefer to learn Turkish as a foreign language for reasons such as cultural, social, political, educational, etc. The increase in Turkey's commercial and economic relations with other countries and the fact that people from other countries prefer Turkey to receive education have increased the interest in Turkish in the last 20 years (Özdemir, 2019). According to the data of the Higher Education Institution for the 2022-2023 academic years, more than eight million students study in higher education institutions. There are nearly thirty million foreign students; of which nearly nineteen million are males and more than twelve million are females (URL 1). In order for these students to study, they must have a good command of Turkish. In addition, when we consider the people who want to learn Turkish as a second language for various reasons, the number increases considerably.

The number of people who want to learn Turkish, which is among the top five most spoken languages in the world, is increasing day by day (Kılınçarslan & Yavuz, 2014). The importance of the courses opened to learn Turkish increases in direct proportion to this. With the increasing demand, the

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number of Turkish Teaching Centers opened within universities is increasing day by day. Turkish language and culture is taught by the language teaching centers of universities in Turkey, Yunus Emre Institute, Turkish Maarif Foundation and Turcology departments in many foreign universities. (Polatcan, 2019). According to 2021 data, 131 Turkish and Foreign Language Application and Research Centers (TÖMER) are in operation (URL 2).

When the number of people who want to learn Turkish as a foreign language is so high, the importance of the factors that are effective in learning Turkish comes to the fore. There are various factors that affect learning positively and negatively. These include many factors such as mental, cultural and affective factors. One of these factors is anxiety, which has an affective character anxiety is one of the factors that positively or negatively affect learning a foreign language (Baş, 2014). According to Allwright and Bailey (1991) and Horwitz, Horwitz, K. and Cope (1986), foreign language learning anxiety should be considered separately from lesson anxiety experienced in other subjects. (Baş, 2014: 114). As a matter of fact, learning a foreign language is a new and worrying situation.

Anxiety is an unsettling emotion that appears when a strong desire or impulse seems to fail to reach its goal (Enç, 1990). Anxiety, in its broad sense, can also be defined as an emotional state in which a sense of perceived powerlessness is experienced during preparation for a perceived danger (Aydın & Zengin, 2008). The term anxiety is defined by Scovel (1978) as the feeling of uneasiness and anxiety or fear felt by the individual in the face of a threatening situation in general terms. Başaran (1991) states that the main source of anxiety is insecurity and unhealthy self-feeling. If a general definition is made, anxiety is a variety of behavioral and cognitive reactions that affect the person in the face of an unknown situation.

Learning a foreign language is a step into an unknown world. This situation, which creates anxiety and uneasiness, creates the anxiety of learning a foreign language. Language researchers almost agree that one of the main obstacles foreign language learners encounter while learning a foreign language is anxiety arising from the language learning process (Alrabai, 2014; Wu, 2010; cited in Çelik & Kaban, 2022).

In 1986 Horwitz et al. have taken the consuming anxiety literature one step further, by saying special case anxiety which they call "Foreign Language Anxiety" causes negative reactions of students towards language learning. (Tunçel, 2014a). Horwitz, et al. (1986) developed a new concept by revealing foreign language learning anxiety.

Many studies have been conducted on the state of anxiety in learning a foreign language (Djigunovic, 2006; İşcan, 2011; Lucas, Miraflores, & Go, 2011; MacIntyre, Noels, & Clement, 1997; Melanlıoğlu & Demir, 2013; Plotnick, 2009; Tunçel, 2014a). Horwitz, et al. (1986) stated in these studies that foreign language anxiety is a phenomenon specific to foreign language learning. When the results of many studies conducted in Turkey and abroad are examined, it is seen that foreign language anxiety is different from other anxieties and this anxiety is very effective in the foreign language learning process. The existence of studies dealing with anxiety about learning Turkish as a foreign language shows that this problem should be addressed in particular (Batumlu, 2006; Çelik & Kaban, 2022; Erdil, 2016; Özdemir, 2019; Polatcan, 2019; Sarıgül, 2000; Tunçel, 2014b). When the studies are examined, the common result is the finding that anxiety has an effect on foreign language learning. Anxiety also plays an active role in teaching Turkish as a foreign language. Therefore, it is important to examine foreigners' concerns about learning Turkish. Examining the anxieties of students learning Turkish as a foreign language in terms of different variables will lead to the source of their anxieties. This will offer solutions for extreme anxiety or low anxiety.

1.1. The Aim of Study

The aim of this study is to examine the anxiety of learning a foreign language, to reveal the factors affecting the anxiety in learning Turkish as a foreign language and to offer improvement suggestions by comparing them with the studies in the literature. For this purpose, answers to the following questions were sought:

1. What is the state of anxiety in learning Turkish as a foreign language?
2. Does the anxiety of learning a foreign language affect learning positively or negatively?
3. Are there significant differences between the anxiety levels of students learning Turkish as a foreign language and the variable of gender, place of residence, number of known languages, and the variable of duration of residence of foreign students in Turkey?

The answers to these questions were compared with other studies in the literature, and comments were made on the results obtained. The findings between learning Turkish as a foreign language and the level of anxiety were discussed and presented.

2. METHOD

2.1. Research Model

Descriptive analysis, content analysis and measurement by scanning were used in the parts where we discussed the anxiety in learning Turkish as a foreign language and how the anxiety of learning a foreign language affects learning. In the third part, the anxiety levels of the students learning Turkish as a foreign language and the variable of gender, place of residence, the number of known languages, and the variable of the time foreign students lived in Turkey were examined. It is aimed to determine the concerns of people who learn Turkish as a foreign language with a valid and reliable measurement tool.

2.2. Study Group

Foreigners learning Turkish were chosen as the study universe. The sample of the study consists of a total of 145 foreign students, 78 women and 67 men, learning Turkish at Dokuz Eylül University, Language Education Application and Research Center (DEDAM). The application to measure the anxiety levels of foreign students included in the study about learning Turkish was made to the students who volunteered. The results of the study were discussed by supporting the related studies in the literature.

2.3. Data Collection and Analysis

"Foreigners' Turkish Learning Anxiety Scale" developed by Sevim (2019) was used to obtain the findings. This scale, unlike other scales, has been specially prepared for those who learn Turkish as a foreign language. For this reason, this scale was preferred. In the words of Sevim (2019), while developing this scale, after the literature review, a focus group interview was conducted with a group of eight students learning Turkish as a foreign language, and it was tried to determine the expressions of anxiety about learning a foreign language. As a result of this interview, an item pool consisting of 51 questions was created. In order to make the surface validity of the item pool, 18 questions were eliminated by taking the opinions of 4 academicians and a draft scale of 33 questions was obtained. In order to make the content validity of the draft scale, the items were tested with the participation of 10 academicians by applying the Lawshe Technique. In the analysis, it was understood that the content validity rates of the items in the draft scale were at an acceptable level. The draft scale, whose content validity was completed, was applied to a group of 30 students studying at different departments at Atatürk University. Necessary corrections were made by receiving feedback from these students about the intelligibility of the items. After the pilot application was made, the 33-question draft scale was applied to a group of 325 people who spoke Turkish at least at A2 level. In order to apply factor analysis to the draft scale, firstly, Kaiser-Meyer-Olkin Test and Bartlett Sphericity Test were conducted to determine the suitability of the data set for EFA. The data set was found to be suitable for principal components testing ($p<01$).

2.4. Data Analysis

In the research, a 5-interval Likert-type scale consisting of 22 items was developed to measure the anxiety of learning Turkish as a foreign language. This scale, whose validity and reliability has been proven, was used to determine the anxiety levels of foreign students, which constitute the third part of our study, while learning Turkish as a foreign language in terms of various variables. The data of this research were analyzed in the "SPSS 24.00" program. The Man-Whitney U test was used for pairwise comparisons and the Kruskal-Wallis H test for multiple comparisons. The reason for choosing this scale is that it is prepared for those who learn Turkish as a foreign language. In addition, this scale offers the opportunity to measure students' foreign language learning anxiety by comparing them with different variables. While parametric tests provide data only for statistical understanding, this scale we use also takes different variables into account. The application was made to the students who volunteered. It is aimed to discuss the results of the study by supporting the related studies in the literature.

3. FINDINGS

3.1. Anxiety in Learning Turkish as a Foreign Language

Learning a foreign language is not an easy process for many people. Affective, cognitive, cultural etc. Factors such as these can complicate this process. One of the affective factors is anxiety. Fear and anxiety are concepts that are confused with each other in foreign language learning. Actually, the two terms have different meanings (Bacanlı, 2002). Barlow (2002) states that fear is a state of being alert to imminent or imminent dangers. Anxiety is the state of being alarmed for possible situations. Kierkgaard (2013) says that anxiety is completely different from fear and related concepts with a specific object, and therefore anxiety is not found in animals. As Köroğlu (2013) said, feelings of anxiety and fear are normal feelings for human life. Erdil (2016) explained the difference between the concepts of anxiety and fear with the example he gave as follows; A foreign student's hesitation about taking Turkish lessons because he does not like Turkish lessons and does not want to learn Turkish, and his avoidance behavior against this hesitation is an indication of "anxiety". The moment he thinks he has to take a Turkish lesson and enters the classroom, the situation he feels before the Turkish lesson starts is an indicator of "fear". The key difference between fear and anxiety is when the emotion arises. Anxiety is experienced before an event or potential event occurs. Anxiety is a reaction to an emotional state and external danger, that is, to any possible perception of pain (Freud, 2013). Fear is experienced after the event has occurred. While anxiety is in question for many situations, foreign language learning anxiety is specifically addressed in the literature.

Anxiety can be defined as involuntary reactions to possibilities in the face of an unknown situation. The student who learns a foreign language steps into the world of the unknown. A new language is the door to a new world. The anxiety and uncertainty that the foreign student felt before learning a new language reveals some involuntary reactions of the person. These reactions are sweaty hands, dry mouth, etc. It manifests itself cognitively and emotionally as well as having physical reactions such as Studies have shown that anxiety affects the person cognitively and as a result, it also affects the learning process. Kyosti (1992) argues that anxiety is associated with a threatening situation and that anxiety is a complex condition that includes cognitive, emotional, and behavioral dimensions. Although learning a foreign language does not seem like a threatening situation, it is obvious that it affects the person in cognitive, emotional and behavioral dimensions. Ergür (2004) defines anxiety as the feeling of many emotions such as resistance, not feeling safe, and restlessness that occur in the process of learning a foreign language.

In 1986, Horwitz et al. took the anxiety literature one step further by stating that a special situation anxiety, which they named "Foreign Language Anxiety", causes students to react negatively to language learning (Tunçel, 2014a). Horwitz, et al. (1986) first discussed that foreign language anxiety is a phenomenon specific to foreign language learning and formed the conceptual infrastructure of foreign language anxiety. Horwitz, et al. (1986) define foreign language anxiety as a set of self-perception, emotions and behaviors specific to foreign language classes, arising from the uncertainties of the foreign language learning process. The anxiety specific to learning a foreign language is directly related to language learning areas. Foreign language anxiety is defined as a state of tension and fear that is identified with foreign language environments and affects speaking, listening and learning (MacIntyre & Gardner, 1994). This anxiety is not a constant worry. It occurs in certain situations. MacIntyre and Gardner (1991) state that foreign language anxiety is not among the permanent concerns, and it occurs when it creates temporary and special situations or threats, unlike the constant anxiety (Tunçel, 2014a). Of course, there are reasons for this concern. The newly learned language is full of unknowns for a foreigner. However, negative experiences, attitudes towards the learned language, cultural differences, personal characteristics, etc. affects anxiety. Krashen (1985) states that the high level of anxiety of the individual in foreign language environments prevents language acquisition or the realization of the language acquisition process. Horwitz et al., (1986) stated that anxiety is an important factor in language learning, that the foreign language learning process consists of more complex experiences and processes than other courses, and that although some individuals are willing to learn the target language, they cannot succeed in learning the target language due to their anxiety, They state that anxiety should be considered separately from the anxiety experienced in other lessons and that foreign language classes are environments where high-level anxiety is experienced. Horwitz et al., (1986), they found that individuals feel nervous, nervous and stressed in foreign language classes and that these people are mentally inhibited due to their high level of anxiety when they want to learn a foreign language. Although there are many examples of anxiety that makes it difficult to learn a foreign language, there are also different reasons that affect this situation. Horwitz et al., (1986),they found that even individuals who are highly motivated and highly motivated in areas such as music, mathematics, and science lose their motivation in the field of foreign language, and this is due to learning a foreign language in the classroom. The effect of anxiety on performance and success in foreign language learning. Foreign language anxiety can play a role in preventing success in language learning (Tunçel, 2014b). Unlike other courses, foreign language learning anxiety affects the learning process of the individual.

In the process of learning a foreign language, there may be different anxiety states for different skills. There are many studies on the effect of anxiety levels related to speaking skills on learning, especially in the foreign language learning process. In a case study conducted by Koch and Terrell (1991), they found that speaking in front of other students in a foreign language class was a source of anxiety. Contrary to other skills, it is seen that the anxiety of making mistakes is higher in speaking skill. The fear of being criticized for speaking in a foreign language in the community or to another person causes anxiety. Young (1986) states that anxious students fail in verbal production. Making grammatical mistakes, pronunciation mistakes, difficulty remembering words, fear of speaking in class or in front of a different crowd, etc. Possibilities such as increase the level of anxiety in the person. Kleinmann (1977) found that students with high anxiety levels use more difficult grammatical structures in speaking and writing skills. Individuals who do not have difficulty expressing themselves in their mother tongue and understanding others have difficulty in doing these in a foreign language, and they perceive any performance they are expected to perform in a foreign language as a threat to their self-perception. Self-perceptions of being successful communicators can be replaced by shyness, fear, insecurity and even panic in foreign language environments (Horwitz et al., (1986). Anxious students aim to make perfect interpretations (Gregersen & Horwitz, 2002). Avoidance of making mistakes and perfectionism appear as factors that increase the level of anxiety.

Students who are anxious about learning a foreign language resort to various ways to avoid making mistakes. These; These are ways such as participating less in the lesson, avoiding speaking, keeping the texts short, and shortening the expressions. Phillips (1992) found that students with high levels of anxiety displayed their performances using fewer structures. Students use concrete statements using certain patterns rather than interpretation. Steinberg and Horwitz (1986) found that foreign language students with high levels of anxiety tended to use less interpretative power in productive skills than students with low anxiety. There are many studies that have found that anxiety increases the probability of making mistakes. The avoidance of making mistakes, on the other hand, reduces participation in the lesson and hinders creativity. Gregersen (2003) found that anxious students are more prone to making mistakes. However, the level of anxiety is also very important. Studies have revealed that students with high levels of anxiety generally have low achievement levels (Aydın & Zengin, 2008). It shows that students with low or acceptable level of foreign language anxiety are more successful in foreign language learning (Sallabaş, 2012). Based on this information, foreign language learning levels of students with high anxiety levels decrease, while students with low or medium levels of anxiety have higher foreign language learning success.

3.2. Examining the Anxiety of Students Learning Turkish as a Foreign Language in Terms of Various Variables

In this study, in which the anxiety levels of foreign students learning Turkish as a foreign language are examined according to various variables, N refers to the number of people and Mean Rank average score in the tables given. Since the answers are reverse coded, the highest score indicates the least anxiety.

3.2.1. Examining the anxiety of learning Turkish as a foreign language in terms of gender variable

The scale for anxiety in learning Turkish as a foreign language was applied to men and women at the rates shown in the table.

Table 1. Kruskal-Wallis H test results by gender variable

Gender	N	Mean Rank	Asymp. Sig. (2-tailed)
Women	78	69,71	,308*
Men	67	76,84	
Total	145		

* *p<.05*

Of the 145 people in Table 1 who learn Turkish as a foreign language, 78 are women and 67 are men. Although there is a 7-point difference in favor of women, there is no significant difference in terms of gender variable in foreigners' anxiety about learning Turkish. This 7-point difference may be the result of women being more emotionally sensitive. For this reason, the anxiety felt while learning Turkish as a foreign language may have been higher than that of men, although not at a significant level.

3.2.2. Learning Turkish as a foreign language investigation of anxiety in terms of place of residence variable

The scale for anxiety in learning Turkish as a foreign language was applied to students living in different countries who came to Turkey for education. Anxiety statuses are listed in the table according to the place where they live.

Table 2. Kruskal-Wallis H test results by country of residence variable

Country	N	Mean Rank	Asymp. Sig. (2-tailed)
Turkish republics	76	89,95	
Arabic countries	13	55,46	,000*
Persian	21	52,52	
Russia - Ukraine	10	65,45	
Far East	26	54,46	
Total	146		

* *p<.05*

Anxiety levels of students learning Turkish as a foreign language according to the country of residence variable are given in Table 2. When this table is examined, it is seen that there is no significant difference in anxiety according to the country of residence variable. However, it is thought that the significant number of students living in the Turkish Republics may cause this result. Foreigners learning Turkish are concentrated in the Turkish Republics. And when the table is examined, it is seen that the anxiety levels of the students living here are lower, although it is not at a significant level. The reason for this may be that the languages spoken in the Turkic Republics are generally dialects of Turkish. The decrease in anxiety levels of students living in Turkic Republics where these languages, which are distantly or closely related to Turkey Turkish, are spoken can be considered normal.

3.2.3. Learning Turkish as a foreign language investigation of anxiety in terms of number of known languages variable

The scale for anxiety in learning Turkish as a foreign language was applied to foreign students who speak more than one language, and it was seen that bilinguals generally stated Turkish as a second language.

Table 3. Kruskal-Wallis H test results according to how many languages speak variable

Number of Languages Known	N	Mean Rank	Asymp. Sig. (2-tailed)
2	27	66,50	
3	53	65,01	,042*
4 and more	66	83,18	
Total	146		

* *p<.05*

When Table 3 is examined, it is seen that there is a significant difference in the anxiety about learning Turkish as a foreign language in favor of those who speak 4 or more languages. This result is an expected result. As a matter of fact, foreign students who have learned four or more foreign languages before are experienced. Since they know the process, it is expected that they do not have to worry about what will happen or have a low level of anxiety.

3.2.4. Learning Turkish as a foreign language investigation of anxiety in terms of the variable of time living in Turkey

The scale for anxiety in learning Turkish as a foreign language was applied to foreign students who came to Turkey from different countries to learn Turkish. The distribution of students according to the time they have lived in Turkey is shown in the table.

Table 4. Kruskal-Wallis H test results according to the variable of length of living in Turkey

How Long Has İt Been Lived in Turkey	N	Mean Rank	Asymp. Sig. (2-tailed)
0-6 ay	129	74,38	
6 months and more	17	66,82	,488*
Total	146		

* *p<.05*

Table 4 shows the anxiety levels of foreign students learning Turkish as a foreign language according to the time they lived in Turkey. There is no significant difference according to this table. It is seen that the duration of foreign students living in Turkey is concentrated between 0-6 months. This strengthens the possibility that they came to Turkey for language education.

4. DISCUSSION and CONCLUSION

Although the word anxiety has negative connotations, this is not entirely true. As a matter of fact, it is very difficult for us to be motivated about a subject that we are not worried about. It would be very difficult to provide our inner motivation to move us if we did not have the anxiety of success. Anxiety prompts us to learn and gives us energy to work. Anxiety doesn't just express negative emotions. The level of anxiety is very important for it to be beneficial. In the literature review, it is seen that anxiety is handled at three different levels in foreign language teaching. These levels are:

High level of anxiety. Krashen (1985) states that the high level of anxiety of the individual in foreign language environments prevents the individual from acquiring the language or performing the language acquisition process. Andrade and Williams (2009) concluded that students with high anxiety are afraid to speak in a foreign language class. There are many studies that show that high anxiety negatively affects the process of learning a foreign language.

Medium anxiety level. According to the Yerkes-Dodson law, moderate anxiety affects the student's performance most positively and facilitates learning (Yerkes & Dodson, 1908). A moderate level of foreign language learning anxiety contributes positively to the learning process of the student.

Low level of anxiety. In addition to having a high level of anxiety, having a low level of anxiety can negatively affect the learning of the individual (Baş, 2013). Matsumoto (1989) found that the subject who had problems in listening and speaking had a low level of anxiety. The low level of foreign language learning anxiety makes the learning process of the student inefficient.

Being too anxious or carefree negatively affects learning. However, studies showing that a moderate anxiety in learning a foreign language facilitates learning are important. While anxiety was considered as a factor preventing foreign language learning in the 1960s, it was concluded that 'moderate' anxiety could play a role in increasing foreign language success in studies conducted in later years (Tunçel, 2014b). The fact that the student's level of anxiety while learning a foreign language is at a moderate level affects the learning process positively. The negative effects of high levels of anxiety on learning success and student performance have been demonstrated by many studies. The fact that the effect of anxiety on the success level of the student in the foreign language learning process has been proven by many studies emphasizes the importance of the level of anxiety. While a high or low level of foreign language anxiety affects learning negatively, moderate anxiety positively affects the success of the student in learning a foreign language.

Foreign language learning anxiety level affects learning. However, anxiety is not a situation that directly prevents learning. While a moderate level of anxiety affects learning positively, being excessively anxious or carefree does not prevent learning. Bacanlı (2002) likens the effect of anxiety on learning to general arousal level and states that it differs from person to person. Features such as academic ability and self-esteem can differentiate the effect of anxiety on learning. While students with low and high academic ability are not affected by the level of anxiety, students with a medium academic level can learn less when they are overly anxious (Bacanlı, 2002). These students can learn even if they have anxiety levels that negatively affect the learning of other students. A similar study was conducted by Spielberger (1962). In the study, the school achievements of students with three different anxiety states and three different academic abilities were compared. According to the research results; The relationship between anxiety and learning depends on academic ability. Anxiety has little effect on the success of students with low and high academic ability. The main factor affecting the success of students is low academic ability. Students with high academic ability find learning so easy that anxiety does not affect them. Anxiety is very important for students with intermediate abilities. The reason for the low achievement levels of students with moderate academic ability and high anxiety level is that they worry too much about academic or non-academic subjects and do not pay enough attention to the subject. Since high anxiety also negatively affects attention, these students may not be able to focus their attention on the details of the subject they are studying, so they may be insufficient in what they need to learn, that is, incomplete learning. In addition, because of their high anxiety, they may not be able to show their real success in exams. Low and high anxiety do not make a difference in terms of success in students with low and high academic ability (intelligence score). However, high anxiety affects success negatively in students with moderate academic ability (Arı, 2009). Accordingly, the level of academic success of the student directly affects the effect of anxiety level on success.

There are many types of anxiety in foreign language learning. Although the types of anxiety that researchers present by categorizing differ, they are generally divided into three:

Personal anxiety. In some individuals, anxiety appears as a constant state. Anxiety is part of the human personality.

Situational anxiety. Anxiety is a reaction to a particular situation in a given time.

Event-related anxiety. It is the anxiety felt in the face of certain events (Ellis, 1994).

There are three types of foreign language learning anxiety. These types of anxiety are:

Communication anxiety: It is experienced by individuals who have immature views and thoughts but have immature communication skills in the target language.

Exam anxiety: It arises during the academic evaluation process. It is defined as the fear of failing in exams.

Fear of negative evaluation: It is a fear of foreign language learners who fail to make a decent social impression, arising from the evaluations made by others (Young, 1991).

Although these anxieties are common for every course, Young (1991) found in their research that there are six different types that affect foreign language anxiety. These types are:

1. Personal and interpersonal causes.
2. Individual differences in language learning.
3. Instructor beliefs about language learning.
4. Instructor - student interactions.
5. Classroom environments.
6. Language tests.

The causes of anxiety in foreign language learning were also defined by Aydın and Zengin (2008), and they obtained results similar to Young (1991). According to the results of the studies, the factors that cause anxiety are as follows:

Proficiency levels of foreign language students. Bailey (1983) found that those who find themselves inadequate compared to other foreign language learners tend to be anxious.

Exam applications. Bailey (1983) determined that mistakes and mistakes in exam applications and the behaviors exhibited by teachers are also sources of anxiety.

Teachers' behavior. Bailey (1983) emphasized their findings on exam practices as Ellis and Rathbone (1987) stated that students felt anxious because of teachers' threatening questions.

Difficulty level of foreign language lessons. As a result of two separate studies conducted by Young (1990) and Price (1991), they determined that the level of foreign language anxiety is related to the difficulty level of language lessons.

Language ability levels of students. Sparks and Ganschow (1991), in three separate studies, found that language skill level, which is one of the individual differences that directly affect language learning, is closely related to anxiety.

Cultural differences. The target culture causes some affective effects on foreign language learners and the affective situations experienced in the process of acquaintance with the target culture; emotional decline, panic, anger, self-pity, sadness and alienation Cultural differences. The target culture causes some affective effects on foreign language learners and the affective situations experienced in the process of acquaintance with the target culture; emotional regression, panic, anger, self-pity, sadness and alienation. Being lost in the target culture is a cause for anxiety is a natural consequence of intercultural differences (Ellis, 1994).

When the types of anxiety are examined, there are unknown or unpredictable situations, events, etc. in accordance with the definition. appears as a response to it. Anxiety occurs due to personality traits, language intelligence or language ability, adaptation skills, language learning environment, student's level, learning environment, test anxiety, fear of criticism. The level of foreign language learning anxiety also varies according to the size of the reactions given to such situations and events and personality traits.

We talked about the types of foreign language learning anxiety, since foreign language learning anxiety has different effects on students at different academic levels, and in some studies, low or high levels of anxiety have an effect on the level of foreign language learning. So, how to deal with anxiety in order to eliminate the negative situations caused by this foreign language learning anxiety?

Various types of anxiety give clues about coping with anxiety in foreign language learning. Horwtizt et al. (1986) identified two methods to cope with anxiety. The first method is to teach students how to deal with anxiety-provoking situations. The second method is to make the learning environment less stressful.

Ellis and Sinclair (1989) argued that teachers should be trained in ways that students can learn better, focusing on how to teach rather than what should be taught. Another suggestion made by Campbell and Ortiz (1991) to reduce the level of anxiety is that students talk to their teachers or friends about their worries or keep a diary about this issue (Aydın & Zengin, 2008). Reviewing and reorganizing factors such as student, teacher, learning environment and learning path will be effective in bringing the level of anxiety to the desired level.

By examining the types of foreign language learning anxieties, improving the situations, events and emotions that cause anxiety will eliminate the negative effect on learning caused by anxiety. Foreigners' language learning or Turkish learning anxiety has been the subject of many studies. When anxiety researches as a foreign language are examined in the world, it is seen that anxiety researches generally concentrate on learning English as a foreign language. Horwitz et al., (1986) conducted a study on 75 university students, 39 men and 36 women, who were learning Spanish as a foreign language. As a result of this research, it was determined that students with high anxiety were afraid to speak in a foreign language class. The importance of this research is that they found the scale called "Foreign Language Classroom Anxiety", which has been used by many anxiety researchers since 1986. Many studies conducted in Turkey are also carried out with the Turkish version of this scale.

Sevim (2019) Foreigners' Turkish Learning Anxiety Scale, on the other hand, was preferred in our study because it is a special scale prepared for Turkish.

In the studies conducted, the anxiety status of students who learn foreign languages through language skills such as reading, writing and speaking were examined, the results of the anxiety felt while learning Turkish were investigated, and the effects of anxiety on learning a foreign language were discussed. Academic studies on anxiety; it has gravitated towards more specific areas such as speaking anxiety and writing skills (Tunçel, 2014b). İşcan (2015), in his study on 100 students studying at the Turkish department of Jordan University, found that Jordanian students had high levels of somatic and social anxiety regarding their Turkish writing skills, while cognitive anxiety levels were low. The reason for this is that students feel under pressure due to the fear that their composition will be negatively evaluated by the teachers, lack of self-confidence, and time constraints. The fact that the anxiety levels of students who speak four languages or more were lower in our study shows that the students can overcome the lack of self-confidence and the fear of being under pressure with the experiences gained while learning other languages. As a matter of fact, the emphasis given to an unknown situation in the definition of anxiety may have revealed a decrease in the reaction to a known situation, that is, a decrease in anxiety. Again, Aytan and Tunçel (2015) conducted a study on a total of 422 foreign students, 183 women and 239 men, studying at Süleyman Demirel and International Antalya University in the first semester of the 2014-2015 academic year. At the end of the study, the "Turkish as a Foreign Language Writing Anxiety Scale" was found to be a valid and reliable measurement tool and it was stated that it would be useful for researchers who want to study the writing anxiety of foreign students learning Turkish. When the studies are examined, it is seen that writing and speaking anxiety are the most common types of anxiety in foreign language learning. Lucas, Miraflores, and Go (2011) conducted a study on 250 students enrolled in foreign language courses at De La Salle University. As a result of the research, they found that foreign students are generally anxious while learning English. When the studies are examined in general, anxiety emerges as an inevitable situation in foreign language learning. MacIntyre, Noels, and Clement (1997) conducted a study of 37 volunteer adolescent Canadian (29 women and 8 men) English-speaking students. As a result of the research, it was determined that students with high anxiety got lower scores than students with low anxiety in speaking proficiency, while anxious students underestimated their own capacity, while students with low anxiety tended to overestimate their own capacity. A low level of anxiety contributes positively to students' foreign language speaking skills. Sallabaş (2012), in his research titled "Assessment of Speech Anxiety of Learners of Turkish as a Foreign Language", found that students have a certain amount of anxiety when speaking Turkish, but this anxiety is not high. Sevim (2014), in his research titled "Examination of Foreign Students' Turkish Speaking Anxiety in terms of Some Variables", concluded that foreign students' Turkish speaking anxiety levels are low. While there are studies in which the level of anxiety in speaking skills is low in learning a foreign language, there are also studies in which it is determined at a medium level. For example, Özdemir (2013), in his master's thesis titled "Sources of Speech Anxiety of Learners of Turkish as a Foreign Language", concluded that the students who answered the scale had moderate anxiety in line with the average scores of the dimensions of speaking anxiety of the students learning Turkish as a foreign language when the scale was examined in general. When the studies dealing with the speaking skills anxiety of the students learning Turkish as a foreign language are examined, it is seen that the anxiety levels are generally low.

Foreign students' perspective on the foreign language they learn is also important. Positive feelings and thoughts about the learned language affect the level of anxiety and indirectly make learning easier or harder. Sallabaş (2012) conducted a research on 68 foreign students studying at C level at Ankara University Turkish Teaching Center Taksim branch. As a result of the research, it was determined that those who think Turkish is not a difficult language have significantly lower levels of anxiety than those who think it is difficult, and that other variables do not make a significant difference. Bacanlı (2002) states that since the majority of the students are at a moderate level in terms of both academic and self-esteem, by following the middle path, the effect of worrying on learning is positive. When the studies conducted to keep the anxiety level at medium levels are examined, it will contribute to academic success.

There are many studies in the literature examining foreign language learning anxiety in terms of various variables. As a result of the literature research in foreign language learning, it was determined that the relationship between anxiety and gender had three different effects on language learning. While there are science researchers who found that the relationship between anxiety and gender in foreign language learning does not affect the language learning process, there are also science researchers who found that women students are more anxious than men students or that men students are more anxious than women students. In our study, there was no significant difference in the level of anxiety about learning Turkish as a foreign language in terms of gender variable. When we look at the studies examining the correlation between anxiety and gender in foreign language learning, it is seen that most of them have similar results with our study. Apart from foreign language anxiety, on writing anxiety, İşeri and Ünal (2012) concluded that there was no significant difference according to gender in their study titled "Examination of Turkish Teacher Candidates' Writing Anxiety in Terms of Various Variables". Tunçel (2014a), in his research titled "Anxiety Regarding Turkish as a Foreign Language and the Effect of Anxiety on Foreign Language Success", determined that there was no significant difference between the participants' end-of-course final achievement exam levels depending on the gender variable. Sevim (2014), in his research titled "Examination of Foreign Students' Turkish Speaking Anxiety in terms of Some Variables", concluded that there was no significant effect of gender on the Turkish speaking anxiety levels of foreign students, and that the Turkish speaking levels of women and men students were the same. Sarıgül (2000) and Batumlu (2006) found that foreign language anxiety did not show any difference according to gender. Tiryaki (2011) concluded that writing anxiety did not differ according to gender in his master's thesis titled "University Students' Argumentative Text Writing Skills and Writing Anxiety and Critical Thinking Skills". Lucas, Miraflores, and Go (2011) concluded in their study, "English Learning Anxiety Among Foreign Students Learning English in the Philippines," that test-exam thinking is a factor that increases anxiety among all groupings of boys and girls. These results are consistent with the findings of our study.

Although not many, there are also studies in which women's anxiety levels are higher in foreign language learning. Aida (1994) and Dalkılıç (2001) concluded that foreign language anxiety levels differ between men and women students. Andrade and Williams (2009) conducted a study on 253 students (132 men and 111 women) taught English by native English speakers from 6 different 4-year Japanese universities. As a result of this research, it was determined that women generally have more intense anxiety than men. Plotnick (2009) found that women have more anxiety than men. Aydın, Yavuz and Yeşilyurt (2006), in their research titled "Test Anxiety in Foreign Language Learning", found that women students feel less confident and relieved than men students when they know that they will be tested; women students are more afraid than men students even if they are well prepared for the test; women students found that they studied more than men students if they had previously received low test scores. In this regard, although no significant difference was found in our study, it is seen that women have a higher level of anxiety than men, with a difference of 7 points. It is similar to the results of these studies in this respect. Na (2007), on the other hand, conducted a study on 115 Chinese students learning English as a foreign language and concluded that men students have higher levels of anxiety than women students.

When the relationship between the variable of permanent residence of foreign language learners and the level of foreign language learning anxiety was examined, it was concluded that there was no significant difference in our study. Melanlıoğlu and Demir (2013) conducted a study on foreign students studying at Gazi University TÖMER. As a result of the research, "The Second Language Speech Anxiety Scale" was found to be valid and reliable. In addition, in the study, it was determined that the speaking anxiety of the students learning Turkish as a second language did not make a statistically significant difference according to the gender, country variable and age variable. The fact that there is no significant difference between the place of residence of foreign students and their foreign language learning anxiety is similar to the findings of our study.

When the relationship between the variable of how many languages the foreign language learners know and the level of foreign language learning anxiety, it was concluded in our study that there was a significant decrease in the level of anxiety in favor of those who knew four languages or more. Tunçel (2014a) conducted a research on 108 Greek students (82 women and 26 men) who attended the Turkish as a foreign language introductory (A1) level course opened within the Department of Modern Greek Languages at the Aristotle University of Thessaloniki. As a result of the research, it has been determined that anxiety plays a role in increasing success in foreign language learning up to a certain level and there is a positive correlation between foreign language success and foreign language proficiency rate. This result is consistent with the findings of our study. Sevim (2014), on the other hand, conducted a research on 74 foreign graduate and doctorate students studying at Atatürk University. As a result of the research, it was determined that foreign students had a low level of Turkish speaking anxiety. In addition, it was concluded that the anxiety levels of the students did not show a significant difference in terms of gender, field of study, educational status, knowing a language other than Turkish and the type of school they graduated from. Although the findings obtained by Sevim (2014) are mostly similar to the findings of our study, they differ in terms of the languages spoken by the students.

When the relationship between the variable of duration of foreign language learning students lived in Turkey and the level of foreign language learning anxiety was examined, it was concluded that there was no significant difference in our study. It is thought that the reason for this may be due to the fact that the duration of foreign students in the sample of our study is concentrated in the option 0-6 months (129 people). Chiang (2009) conducted a study on 327 interpreter students at 9 different institutes in Taiwan. 327 students have studied at schools that provide official English education for at least 6 years. As a result of the research, Chiang (2009) determined that foreign language anxiety in Taiwanese interpreter students is much less anxious than students learning different languages in different nationalities. This result is important in terms of showing that foreign language learning differs in countries and this affects the level of anxiety. İşcan (2011) conducted a research on the fear of learning Turkish among Indian students learning Turkish as an optional foreign language at Jawaharlal Nehru University, India. As a result of the research, İşcan (2011) determined that Indian students who learn Turkish as a foreign language have low Turkish learning anxiety and high Turkish learning success levels. The low level of anxiety of students learning a foreign language in their own country indicates that students feel more comfortable.

In this study, it is aimed to reveal the factors affecting the anxiety in learning Turkish as a foreign language and to offer improvement suggestions by comparing them with the studies in the literature. For this purpose, the study consists of three parts.

In the first part, anxiety in learning Turkish as a foreign language is discussed by comparing it with other studies in the literature. As a result, anxiety and fear are concepts that differ from each other in terms of timing. Anxiety is a reaction before an uncertain situation occurs. Foreign language learning anxiety has a different place in the literature. Research shows that; the anxiety felt while learning a foreign language is different from the anxiety felt in other lessons. Foreign language anxiety can be defined as a set of self-perception, academic abilities, emotions and behaviors specific to foreign language classes, arising from the uncertainties of the foreign language learning process.

Foreign language classrooms are environments with high levels of anxiety. The foreign language learning process consists of more complex experiences and processes than other courses. Even anxiety about different language skills gained while learning a foreign language varies. Anxiety can also vary for reading, speaking, writing, and listening skills. In particular, it is seen that the levels of anxiety towards speaking skills have increased significantly compared to other skills. This suggests that in addition to speaking in a newly learned foreign language, which affects the level of anxiety, speaking in public, establishing a dialogue, being afraid of making mistakes, and similar possibilities increase the level of anxiety by including social and individual anxiety situations. There are many internal and environmental factors that affect the level of anxiety. Therefore, the state of anxiety is not stable. The students found that they felt nervous, nervous and stressed in foreign language lessons, unlike other lessons, and that these people were mentally inhibited due to their high level of anxiety when they wanted to learn a foreign language. Again, no matter how eager the student is to learn the foreign language, he may not be successful in learning the target language because of his anxiety.

Foreign language learning anxiety is an affective reaction to a newly learned language. However, this response is a complex situation that includes cognitive, behavioral and physical dimensions.

Physically, anxiety about learning a foreign language, sweating of the hand, dry mouth, etc. manifests itself with symptoms such as: Behaviorally, foreign language learning anxiety determines the student's reactions while learning a foreign language. The student, who shows avoidance behavior uses formulaic sentences to avoid making mistakes, gives short answers and shows avoidance behaviors as much as possible. Cognitively, the anxiety of learning a foreign language affects the student's level of learning that foreign language. This is a controversial issue. As a matter of fact, although the results of many studies show that there is a negative correlation between anxiety level and foreign language learning success, there are studies showing that different factors also affect this success.

In the second part, an answer was sought to the question of whether foreign language learning anxiety affects learning positively or negatively. In addition to many studies that reveal the effect of high level of anxiety in foreign language learning that makes learning difficult, there are studies that prove and prove that it is far from being a factor that reduces success on its own. In conclusion; In order to determine the effect of foreign language learning anxiety on academic success, two questions are important: According to whom? According to what? It has been shown that foreign language anxiety, which was said to have a negative effect on academic achievement until the 1960s, is directly related to self-perception and academic ability level in later studies. This situation reveals that the level of foreign language anxiety alone cannot have an effect on academic achievement. As a matter of fact, anxiety is not the only factor affecting success.

There are factors that cause anxiety For example; reviewing and rearranging factors such as student, teacher, learning environment and learning path will be effective in bringing the level of anxiety to the desired level. By examining the types of foreign language learning anxiety, improving the situations, events and emotions that cause anxiety will eliminate the negative effect on learning caused by anxiety. Again, the level of anxiety does not have the same effect on every individual. For a student with a good self-perception and moderate academic ability, anxiety is a factor that increases academic success.

In the third part, the anxiety levels of students learning Turkish as a foreign language were examined in terms of variables such as gender, place of residence, number of known languages, and time lived in Turkey. In conclusion; there is no significant difference in anxiety level in terms of gender variable. However, it was determined that there was a 7-point difference in favor of women.

In terms of the place of residence variable, it has been determined that the students in the sample of our study constantly live in the Turkic Republics, Arab countries, Persian, Russia-Ukraine and the

Far East. There is no significant difference in terms of the variable of place where foreign language anxieties constantly live. However, when looking at the results, it is seen that foreign students mostly live in Turkish Republics. It is thought that this situation may have affected the result.

When the anxiety levels of the students learning Turkish as a foreign language are examined according to the variable of the number of languages they know, there is a significant difference in favor of those who speak 4 languages or more. The reason for the low level of anxiety of foreign students who speak 4 languages or more may be the effect of their previous experience on their anxiety levels. As a matter of fact, the experience of learning a foreign language and having achieved it four or more times may increase their self-perception and may suggest that their academic abilities are high.

When the anxiety levels are examined according to the variable of the time they have lived in Turkey, there is no significant difference. However, the fact that the density is in favor of foreign students living in Turkey between 0-6 months can significantly affect this result. Again, these foreign students living in Turkey between 0-6 months suggest that they live in the country for the purpose of learning a language.

In conclusion; although there are studies that show the effect of high anxiety level on the success of learning a foreign language, it has been concluded that looking at the anxiety level unilaterally will affect the reliability and reality of the results. There are many factors that affect the level of anxiety. Revealing these factors will help to find the real reasons for their effect on academic achievement. Academic success and self-perception anxiety level affect the student's learning of a foreign language. Students with low self-perception and students with very high self-esteem are not affected by the level of anxiety. Again, while the effect of anxiety level is limited on individuals with very low or very high academic ability; A medium level of anxiety positively affects the success of a student with a medium level of academic ability. There is no significant gender difference in foreign students learning Turkish. Research shows that the gender factor is not effective in learning a foreign language in other countries. Although there is no significant difference in terms of living space, the gathering of the majority in the Turkish Republics must have affected the result. The low level of anxiety of those who know four languages or more is an example of the effect of a previously experienced situation on the anxiety level. There is no significant difference in terms of the variable of duration of living in Turkey. However, the concentration of foreign students between 0-6 months may have affected the result.

As a result, although there are many factors affecting the level of anxiety in foreign language learning, the effect of anxiety level on foreign language learning success is clearly seen. While sufficient level of anxiety facilitates learning, high level of anxiety makes learning difficult. This anxiety, which is at a sufficient level, can be called motivational anxiety. Using motivational anxiety in education has a positive effect on success. It is important to consider anxiety levels together with different variables, not alone, and to develop new scales in which self-perception and academic ability variables can be measured with a multi-faceted research in order to make the results meaningful. In-depth investigation of the factors affecting the anxiety level of students learning Turkish as a foreign language will increase the quality of education. Again, the importance of anxiety in education, its positive and negative aspects should be investigated in depth.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Dokuz Eylül University with the decision dated 18/12/2022 and numbered 457404.

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Abstract

Individuals can encounter non-governmental organizations (NGOs), one of the most significant experiences of citizenship, during the early stages of their education. Individuals with foundational experiences at the primary school level, as they reach the middle school level, gain the opportunity to better understand the meaning and importance of NGOs through social studies and equivalent courses. Determining how students perceive NGOs at the end of this educational period is crucial in shaping education about NGOs and citizenship education. This study aimed to reveal the middle school 7th-grade students' point of view on the NGO and NGO-citizen relationship. The study was carried out as a qualitative study. The qualitative study sample consisted of 39 (20 females, 19 males) 7th-grade students selected with purposive sampling methods. The data collected with open-ended questions were analyzed with content analysis. As a result of the study, it was determined that the students considered NGOs in terms of helping people and volunteerism. On the other hand, it was also seen that the students did not mention the political characteristics of the NGOs. It was found that students have a perspective of looking out for mutual benefit in the relationship between the NGO and the citizenship. In addition, all the students emphasized the responsibility to support the NGOs. Nevertheless, this mentioned support was more financial, and there was not enough emphasis on the support provided by social and political participation.

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Research Article

Seventh-Grade Students' Perspective on Non-Governmental Organization*

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Abstract

Individuals can encounter non-governmental organizations (NGOs), one of the most significant experiences of citizenship, during the early stages of their education. Individuals with foundational experiences at the primary school level, as they reach the middle school level, gain the opportunity to better understand the meaning and importance of NGOs through social studies and equivalent courses. Determining how students perceive NGOs at the end of this educational period is crucial in shaping education about NGOs and citizenship education. This study aimed to reveal the middle school 7th-grade students' point of view on the NGO and NGO-citizen relationship. The study was carried out as a qualitative study. The qualitative study sample consisted of 39 (20 females, 19 males) 7th-grade students selected with purposive sampling methods. The data collected with open-ended questions were analyzed with content analysis. As a result of the study, it was determined that the students considered NGOs in terms of helping people and volunteerism. On the other hand, it was also seen that the students did not mention the political characteristics of the NGOs. It was found that students have a perspective of looking out for mutual benefit in the relationship between the NGO and the citizenship. In addition, all the students emphasized the responsibility to support the NGOs. Nevertheless, this mentioned support was more financial, and there was not enough emphasis on the support provided by social and political participation.

Keywords: Citizenship education, social studies education, students' perspective, NGO

1. INTRODUCTION

A non-governmental organization (NGO) is any association that independently addresses various social issues, takes on the duty of training and informing the public, and recommends numerous topics (TDK, 2022). With their organizational structures and emergence goals, non-governmental organizations carry out a variety of tasks. They are accountable for a wide range of things, including social welfare, environmental values, health and safety, and education (Willetts, 2002). In this sense, NGOs link the government and civil society in various areas, such as natural disasters, violence, environment, education, and violation of individual rights and freedoms.

Although NGOs are made up of a wide variety of structures, their common goal is to focus on long-term issues (climate change, human rights and democracy, etc.) (Hall-Jones, 2006). They provide this through services (such as aid and shelter), education, raising awareness, and defending the public interest (Stromquist, 2002). They promote social participation by assisting interest groups and facilitating participant involvement (Abiddin, Ibrahim & Abdul Aziz, 2022).

In this section, education from general to specific, social studies education and in this context, the relationship between social participation and NGO will be summarized first. Then, justifications for the study's relevance and significance will be provided in light of the literature, and the study's aim will be outlined.

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1.1. Education and NGO

Education is one of the areas where the impact of NGOs can be seen concretely. Social forces, NGOs and focus groups have always greatly influenced education, and even these significant influences have played a decisive role in creating and organizing education programs (Taylor, 2019). In addition to the official economic support for education, NGOs play an important and increasing role in financing basic education (Naylor & Ndaruhutse, 2015). Ribeiro, Rodrigues, Caetano, Pais and Menezes (2012) suggest that many countries still dominate compliance models in citizenship education and emphasize that a robust civil society should be encouraged for citizenship education. The way to a strong civil society is to consider the current and future needs of the society. These needs establish the objectives of NGOs, and individuals are trained in conformity with these objectives in schools, which are essential to NGOs (Park, 2006). One of the fundamental objectives of the school is, without a doubt, to train active citizens. In this respect, NGOs help schools and students understand the power of citizenship (Xiong & Li, 2017) and provide them with information and materials about the field they work in (Ersoy, 2014). In summary, education is indispensable for NGOs and NGOs to fulfil their function in transforming society into a more livable form.

Undoubtedly, the social studies course comes first among the courses that can be benefited from NGOs at primary and middle school levels. The social studies course aims to prepare students for social life with the knowledge, skills, and value dimensions it entails and to acquire the skills and qualifications needed to be an active citizen. One of the objectives of social studies education is “to train young people as active and responsible citizens in democratic societies” (NCSS, 2016). The critical thing in active citizenship education is to enable students to become action-oriented participatory individuals in society. Therefore, fostering active citizenship involves real-world, long-term experience gained through a direct link between the school and the real world.

An active citizen is a person who believes that every individual in the society should participate in political and social life and has specific roles and responsibilities. The characteristics of an active citizen are creating awareness in society, changing society, contributing to society, and fighting against injustice (Khandpekar, 2016). What is expected from an active citizen is to contribute both to personal development by taking individual responsibility and to social development by taking social responsibility. The society mentioned here can be extended to all humanity, starting from his/her immediate environment.

The active citizenship learning area included in the social studies curriculum, which started to be implemented in Türkiye in 2018, directly serves to raise individuals as active citizens. In this curriculum, NGOs are mentioned when creating active citizens; explicit content about NGOs is presented in this context. In this context, the social studies course is one of the most crucial courses at the primary and middle school level that provides the relationship between education-NGO in general and citizenship education-NGO in particular. Therefore, NGOs should be open to cooperation with schools in raising active citizens, create units that work with students, and make activity plans for students regarding active citizenship education (Kallioniemi, Zaleskiené, Lalor & Misiejuk, 2010). Raising people as active citizens who support and participate in NGOs is of great importance in developing democracy at local, national and global levels (Ersoy, 2014; Ribeiro, Caetano & Menezes, 2016). Thus, active citizenship education from primary school to higher education is important.

1.2. Social Participation and NGO

Students need to learn a variety of abilities in order to comprehend and contribute to the growth of democracies. One of these skills is social participation, a significant feature of active citizenship. With social participation skills, students are expected to participate in scientific, social, cultural, arts and sports activities in and out of school. By this means, it aims to develop students’ sense of success, motivation, self-confidence and responsibility. Since students’ tendencies and knowledge shape their actions, schools play an important role in developing social participation skills (Kallioniemi et al., 2010). NGOs offer students social participation opportunities through voluntary service activities (Dere & Akdeniz, 2021). The values and skills gained by the students participating in the activities within the social studies course also contribute to citizenship education (Bengiç-Çolak, 2015). For this purpose, it is aimed to provide students with attitudes, behaviors and skills such as taking responsibility with social participation skills, being able to deal with the social problems around them individually or in cooperation with others and developing and implementing projects that will contribute to their solution, working willingly to complete the group tasks and feeling responsibility towards the group (MoNE, 2018).

1.3. Research Problem and Literature Review

It was reported that in Eurostat in 2019 and Youth Wellbeing in 2017 that the participation of the young is low in active citizenship and participatory activities due to their lack of time and interest (Görgün-Baran, 2019). This data clearly shows that the relationship between the young and the non-governmental organizations, which is the primary option of participatory activities, is weak. One of the reasons of the young's indifference is undoubted because of their limited or even lack of non-governmental organization experiences. Considering that the young spend a substantial part of their time in school, it can be clearly seen that it is indispensable for the young to gain non-governmental organization experience within the education process. It is possible to say that the frequency and quality of the active citizenship experiences of the young will increase as the education level increases. Even though these experiences start from the first stages of education, it would not be wrong to state that meaningful experiences for NGOs start especially at the middle school level, considering the developmental characteristics of the students. Therefore, cooperation between non-governmental organizations and education is extremely important in order to raise active and engaged citizens.

Most of the research on non-governmental organizations in the field of education is related to the educational activities of non-governmental organizations (Akatay, 2019; Kallioniemi et al., 2010; Karataş, 2013; Naylor & Ndaruhutse, 2015; Park, 2006; Ribeiro et al., 2012; Ribeiro et al., 2016; Selanik-Ay, 2016; Taylor, 2019; Xiong & Li, 2017). There are also studies conducted with teachers and mostly preservice teachers for active citizenship (Değirmenci & Eskici, 2019; Dere & Akdeniz, 2021; Egüz & Kafadar, 2020; Ersoy, 2014; Faiz, 2020). In addition, there are also studies directly on students related to active citizenship (Akar & Keser-Aschenberger, 2016; Bengiç-Çolak, 2015; Demirhan-Işık, 2018; Finley, 2011; Kızılay, 2015). In the literature, there is not enough study that directly examines the perceptions and thoughts of middle school students about NGOs and the relationship between NGOs and citizenship.

Today, countries worldwide are concerned about their futures due to issues such as young people's apathy about the political and social difficulties facing the society in which they live. It is of the utmost importance to shed light on how the connection between active citizenship and NGOs is typically construed, given that the utilization of NGOs in teaching is a critical factor in the formation and modification of students' perceptions of active citizenship. In this direction, determining the perspective and knowledge level of the students will also contribute to the determination of the relationship between NGOs, educational institutions and citizenship education. On the other hand, it is thought that it will help the studies about NGOs and educational institutions and guide similar research to be carried out with students. It will contribute to the visibility/recognition of NGOs' political, social and economic duties, especially by children and young people. It is thought that this study will contribute to the literature in terms of changing or improving the perceptions of students, the adults of the future, regarding the contribution of NGOs to the existence of democracy in the society in which they live and to their development as active citizens.

This study aims to determine the perspectives of middle school 7th-grade students about NGOs and the NGO-citizenship relationship. For this purpose, the research questions are determined as follows:

What is the students' perspective on non-governmental organizations?

What is the students' perspective on the relationship between non-governmental organizations and citizenship?

2. METHOD

Qualitative inquiry is a research approach in which research and findings are presented non-numerically, the research is conducted in a natural setting, and the number of individuals or situations examined is limited (Robson, 2015). In this study, a qualitative research approach was chosen, as the aim is to uncover the impressions of participants who have experience with the situation that needs to be investigated without worrying about generalization (Creswell, 2013; Patton, 2002). Additionally, it was tried to obtain in-depth and detailed information about students' perspectives on NGOs and NGO-citizen relations.

2.1. Participants

Since the study is based on a qualitative approach, the purposive sampling method was used to obtain in-depth data on the researched subject by providing information-rich environments (Patton, 2002). In the criterion sampling method, which is one of the purposeful sampling methods, there are several predetermined criteria and these criteria can be prepared by the researcher, or a pre-created criteria list can be used (Patton, 2002). In this direction, points such as the fact that the subjects within the scope of active citizenship learning area were covered in the 4th, 5th, and 6th grades of the students in the 7th grade which is the last year social studies course is taught in Türkiye, that the selected school has worked with at least one NGO per year, that the participants are familiar with the NGOs were chosen as criteria. With these criteria, the study was carried out with 39 (20 f, 19 m) 7th-grade students studying in two different middle schools in the central district of Trabzon province. The participants consist of students who have attended at least once to informing or activities about NGOs given in their schools. Social studies is a course taught between the 4th and 7th grades in Türkiye, and students are expected to reach all the acquisitions of this course at the 7th grade level. This study was carried out with the 7th grade students since it was expected that the students would have obtained all the information about the NGOs, which they could encounter directly, at the middle school level.

2.2. Instruments

An open-ended question protocol prepared by the researchers was used as a data collection tool in the study. Open-ended questions, preferred if the participants are to respond freely, provide in-depth answers about people's experiences, perceptions, ideas, feelings and knowledge (Patton, 2002). In this study, the open-ended question protocol, which is one of the qualitative data collection tools, was preferred to reveal the perspectives of the participants in a more comprehensive and detailed way (Creswell, 2013). It is possible to collect more detailed data, particularly from elementary and secondary middle school students, if they express their opinions in writing instead of verbally. While creating the questions used in the study, a draft form including a total of 11 open-ended questions was prepared in line with the research problem. The draft form was rearranged according to the feedback of two faculty members and three postgraduates who have studied citizenship education in social studies education. A pilot study was conducted with 15 students from the 7th grade of a middle school located in the district center to ensure the validity and reliability of the form, and as a result, the open-ended question protocol was finalized. In the open-ended question protocol, characteristics and functions of NGOs, the views of students on how the relationship between citizenship and NGOs should be, and how citizens can contribute to NGOs were tried to be revealed in addition to their perspectives on the definition.

2.3. Data Analysis

Content analysis, a data analysis method among qualitative approaches (Schreier, 2014), is generally utilized for interview transcripts, diaries, and similar documents (Patton, 2002). In this research, the content analysis method was chosen to reveal the relational network within the qualitative data obtained from the participants and the meanings hidden among the data (Patton, 2002). Thus, in line with the data obtained, it was tried to understand the students' views clearly. In this context, each response was directly transferred to the computer environment to facilitate the analysis. Then, all the responses to the open-ended questions were carefully read and coded. Different methods can be opted for attributing importance to the codes through numerical values as a result of the content analysis (Schreier, 2014). In this study, the codes were digitized and given the idea that they could reveal the participant's views more clearly. During the data coding, the first researcher initially determined the codes; then, the second evaluated the developed codes. After this two-stage process, the researchers met and reviewed the entire coding process. After this stage, the different coding suggested by the researchers were reconsidered and a consensus was reached for each conflicting code. The finalized codes and the frequencies of these are presented with graphics. Also, to ensure the confidentiality of the participants included in the study voluntarily, their names were coded as P1, P2, …, and P39.

Some strategies were used to ensure credibility, transferability and consistency, and confirmability in the current study:

Two experts with qualitative research experience were consulted about the entire study. Both researchers contributed to the research process holistically. Before the data collection was started, a pilot study was conducted, and the data collection tool was updated by taking expert opinions. The data collection was carried out with voluntary participants selected from two schools using the purposive sampling method. In addition, the data obtained from the study were coded in a general framework by the researchers and reported directly without including the researchers' comments. The codes developed with the raw data were checked by continuous comparison. Results related to the developed codes are presented through direct quotations.

3. FINDINGS

In this section, the data were presented in graphics with direct quotations after being analyzed. Students' views on the definition, characteristics, functions, citizen-NGO relationship and the contribution of citizens to NGOs were presented under headings.

3.1. Definition of Non-Governmental Organization

The students' views on how they define the concept of NGO are presented in Figure 1 by coding.

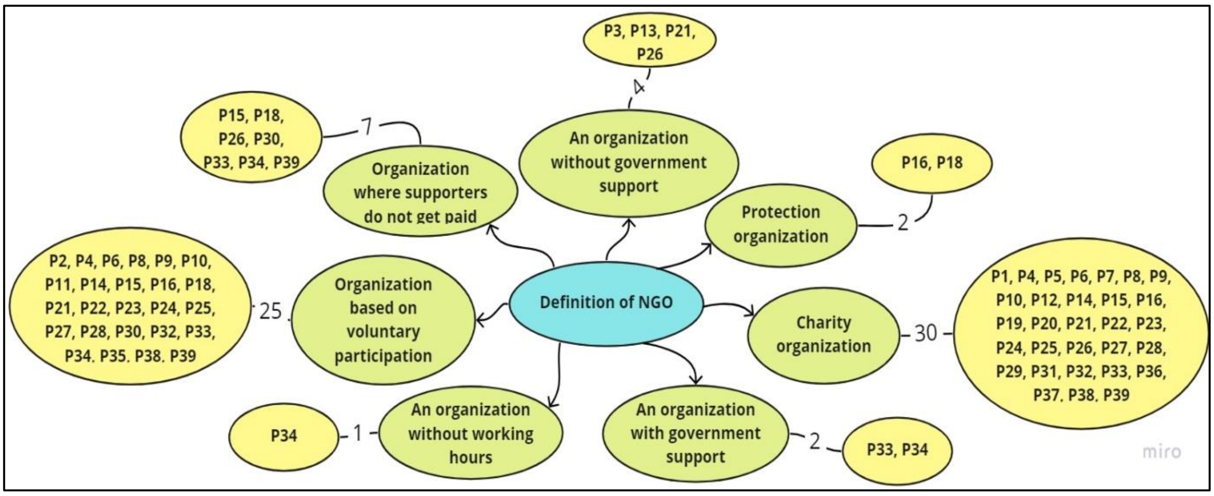

Figure 1. Definition of non-governmental organization

As seen in Figure 1, the concept of NGO is predominantly considered by students as a 'Charity organization' and 'Organization based on voluntary participation.' P3 stated the following regarding the definition that includes many of the mentioned codes: 'It is an organization where volunteers contribute or help without demanding a wage or expecting something in return. They are established with the support of the state and individuals with better financial status and aim to meet all kinds of needs.' Similarly, P18 also stated, 'Organizations created by people who help people and do this work voluntarily and do not receive a salary in return are called non-governmental organizations.'

It is noteworthy that the students especially emphasized the participation of charity organizations and volunteers while describing the NGOs. Another underlined issue is the emphasis that individuals do not receive money in return for their support. In addition, some students expressed the NGO as a state-supported organization and an organization not supported by the state. Here, two opposing views emerged as whether the NGO has state support. Even in small numbers, organizations for protection purposes and organizations that do not have working hours are among the definitions made.

3.2. Characteristics of Non-Governmental Organizations

The students' views on the characteristics of NGOs are presented in Figure 2 through codes.

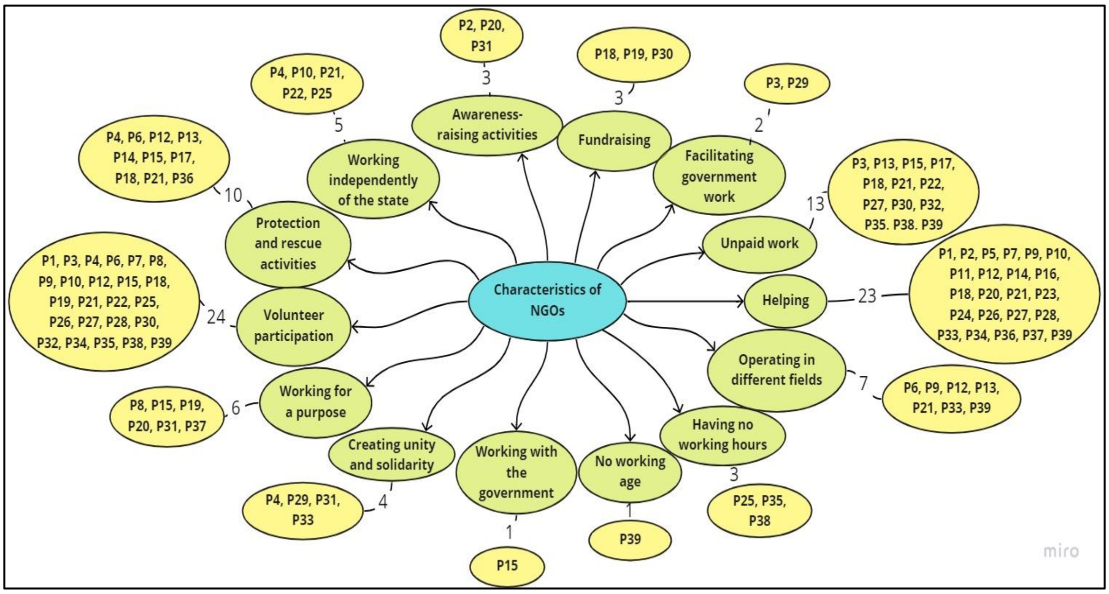

Figure 2. Characteristics of non-governmental organizations

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As seen in Figure 2, 'Volunteer participation' was emphasized the most in the codes developed for the characteristics of NGOs, followed by 'Helping' and 'Unpaid work' codes. In addition to these, different characteristics of NGOs such as 'Protection and rescue activities,' 'Working for a purpose,' 'Creating unity and solidarity,' 'Awareness-raising activities' and 'Fundraising' are emphasized. P18 made the following statement referring to codes such as 'Volunteer participation, helping, unpaid work, fundraising,' including many of the characteristics of the NGOs: '*NGOs help people for free. Their employees are volunteers and are not paid for it. Non-governmental organizations keep afloat with donations.*' As emphasized in the definition of NGOs, P11 stated that '*Helping people for free and doing favors is their most important characteristic*' with regard to 'Helping' in terms of their characteristics. Among other important characteristics not mentioned by the participants, P2 stated, '*They carry out activities to help people and raise awareness in some areas*' regarding the code of 'Awareness raising activities.' P3 stated, '*They do not receive a salary, they are volunteers, and in this way, they help the affairs of the state*' regarding the code of 'facilitating government work,' P4 on the code of 'creating unity-togetherness' stated, '*They have volunteers. They provide unity. They operate* *independently of the state. They save lives.*' and P25 stated on the code 'Having no working hours' that '*It is voluntary, they do not have working hours, they do not receive money from the state.*' Another characteristic of the NGOs, which only one participant focused on, was expressed by P39 as '*They have no working-age...*'.

3.3. Functions of Non-Governmental Organizations

The students' views on what NGOs do are presented in Figure 3 through codes.

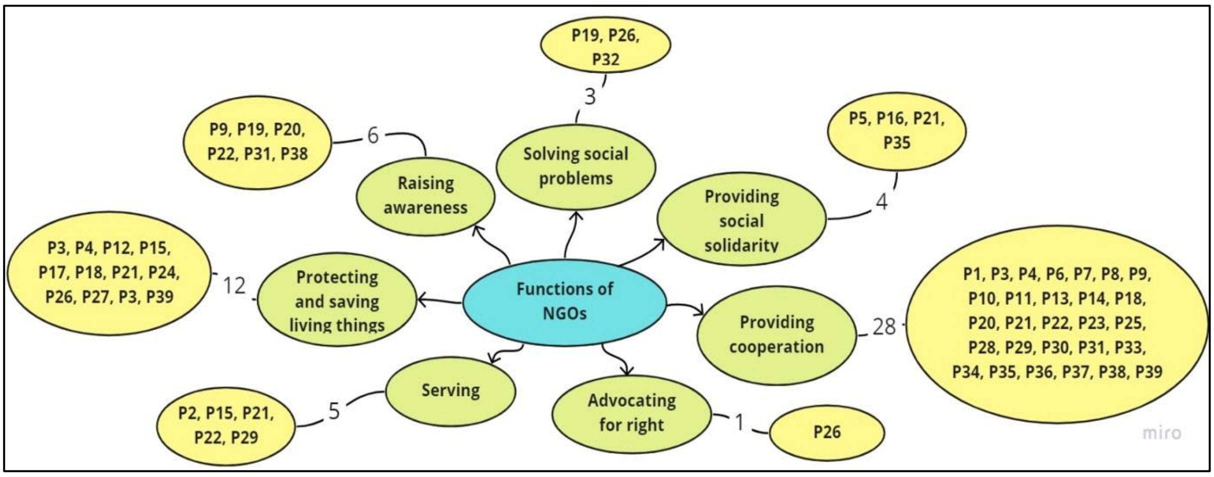

Figure 3. Functions of non-governmental organizations

As can be seen in Figure 3, the emphasis is placed on 'Providing cooperation,' followed by the codes of 'Protecting and saving living things' and 'Raising awareness' follow it most. Different benefits of NGOs are also emphasized, such as 'Serving,' 'Providing social solidarity' and 'Solving social problems.' In their response, which includes many characteristics as well as the two most emphasized codes, Regarding NGOs, P21 stated that they provided food, shelter and clothing aid to people who lost their homes in natural disasters (avalanche, landslide, flood, etc.) and increased solidarity by collecting donations from the surrounding provinces. He also stated that they provide assistance to developing countries in terms of health, money and shelter, and that they support health and protection of living life in difficult situations such as wars. Students underlined the benefits of NGOs, such as providing cooperation and protecting and saving living life. Related to the code of 'Awareness raising and awareness raising,' one of the other benefits stated by the participants P31 said, 'It has benefits such as making people sensitive to the environment, planting trees in the environment, and raising awareness.' P2 stated, 'They enable volunteers to serve people without receiving or giving money' on 'Serving.' P16 expressed, 'They make people sitting idly in their homes engaged citizens for their nation' related to 'Providing social solidarity,' and P32 stated, 'They play a great role in solving the problems of the people, that is, in solving the problems of the society' related to 'Solving social problems.' Lastly, P26 said, 'They are organizations that do not allow all living things in the world to be harmed, protect and defend the rights of all, and try to make the world better' with regard to 'Advocating for rights,' which was included in one's views.

3.4. The Relationship between Citizenship and Non-Governmental Organizations

The students' views on the relationship between citizenship and NGOs are presented in Figure 4 through codes.

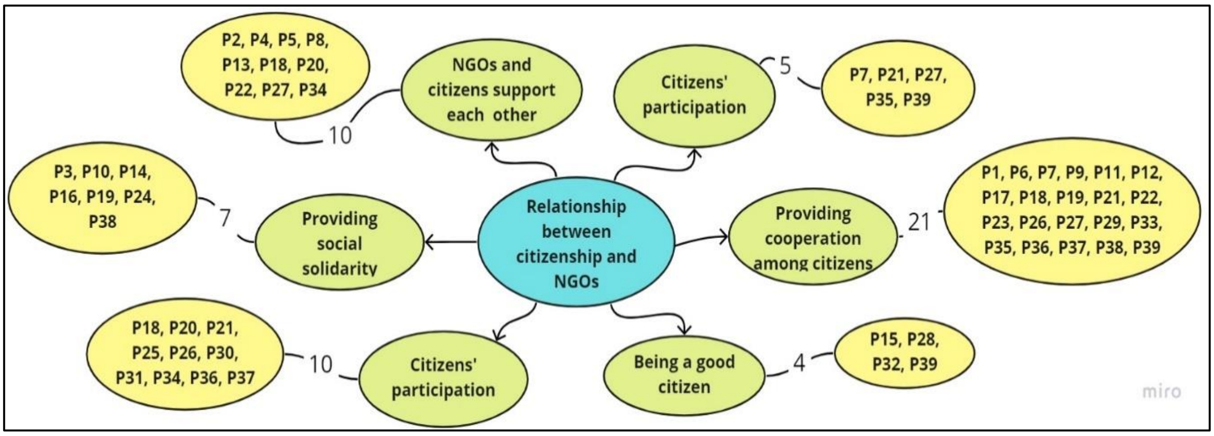

Figure 4. Relationship between citizenship and non-governmental organizations

As seen in Figure 4, the most emphasized code is 'Providing cooperation among citizens' among the codes related to how the students perceive the relationship between NGOs and citizenship. It is followed by the codes 'NGOs and citizens support each other,' 'Citizens' participation' and 'Providing social solidarity.' In addition, some students expressed this relationship as 'Helping become citizens' and 'Being a good citizen.' Cooperation stands out in this question as in the others. Regarding 'providing cooperation among citizens' student P21 stated 'non-governmental organizations fulfill their duties duly, free of charge and voluntarily. Citizens also donate to these organizations to help people, providing mutual aid. They also fulfill their civic duties.' On the same subject, P38 said 'It allows citizens to ask for a little help as they want other citizens in their own country to be comfortable.'

P18 also emphasized the 'Citizens' participation' with their statement, 'non-governmental organizations help where needed, thanks to responsible citizens. Because if citizens do not donate to non-governmental organizations, they cannot help people, there is such a relationship.' regarding 'NGOs and citizens support each other.' In addition, P26 expressed, 'Citizens donate to NGOs and join them voluntarily. Moreover, NGOs help citizens.' The view of 'Providing social solidarity' was expressed by P10 as follows: 'We, as citizens, do not expect everything from NGOs, and we can strengthen solidarity as a society by helping them.' P35 and P7 emphasized 'Helping become citizens.' P35 said, 'As citizens of that country, we have a responsibility to help and contribute to non-governmental organizations,' and P7 said, 'I think it is a civic duty to help non-governmental organizations.' Lastly, the relationship between NGO and citizenship was expressed as 'Being a good citizen.' Regarding this, P28 and P32 stated, 'Joining and supporting non-governmental organizations shows that we are good citizens'.

3.5. Citizens' Contribution to Non-Governmental Organizations

Through codes, students' views on whether and how citizens contribute to NGOs are presented in Figure 5

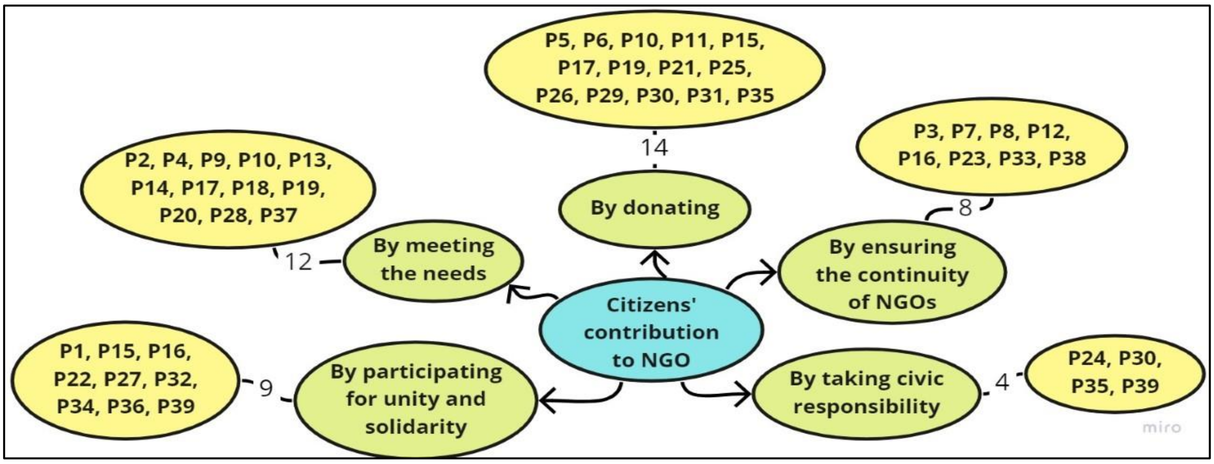

Figure 5. Citizens' contribution to non-governmental organizations

As seen in Figure 5, all the participants first stated, ‘Yes, they should contribute,’ regarding the codes on the contribution of citizens to NGOs and what contributions they can make. The code most emphasized by students regarding the contribution of citizens to NGOs was 'by donating'. Regarding this code, P31 stated that people who want to donate should participate in NGO activities to carry out projects such as environmental protection and organizing the NGOs. The second most emphasized view by the students is the participation of the citizens ‘by meeting the needs’. Considering that everyone may need NGOs one day, P18 emphasized that everyone should help in line with the needs of NGOs and this is a good thing. The students expressed another contribution as ‘by participating for unity and solidarity.’ Regarding this, P1 said, ‘Yes, we should contribute as citizens. After all, we are Türkiye, and no one can be left behind in our country. There has to be unity.’ Some of the student's responses to the view ‘by ensuring the continuity of NGOs’ are as follows: P8 ‘Yes, they should, because non-governmental organizations can survive with these contributions,’ and P16 ‘They should contribute. Because non-governmental organizations work for them. If citizens do not help, how can non-governmental organizations help them? Otherwise, there would be no non-governmental organizations.’ Lastly, the students emphasized the necessity of contributing by ‘taking civic responsibility.’ Regarding this, P30 said, ‘They should contribute because it is a responsibility for citizenship,’ and P35 said, ‘Yes, because it is their responsibility; they should give material and moral support.’

4. DISCUSSION and CONCLUSION

The conclusions reached within the titles specified in the study's results are presented in this section.

In the results regarding the definition of NGO, most students defined NGOs as charity organizations or organizations based on voluntary participation. This result coincides with the conclusion in Demirhan-Işık's (2018) study that students characterize NGOs with their volunteering and helping values. It is also seen that NGOs are emphasized as aid agencies regarding their definitions in the study with preservice teachers by Selanik-Ay (2016) and with school administrators by Karataş (2013). Although these studies were not conducted with students, teachers' views should also be considered since they can influence student perception. In this study, it has been determined that very few students have misconceptions about separating NGOs from state-affiliated public institutions, as they describe them as state-supported organizations. This misconception reveals that students have a limited definition of NGOs. Considering the studies on teachers and the preservice teachers mentioned here, it can be said that teachers also play a role in this limited definition of students. Therefore, it can be claimed that teachers as well as students have a limited knowledge-based conceptualization of civil society.

In the results on the characteristics of NGOs, voluntary participation and helping features were emphasized in parallel with the definition-related results. Unpaid work, protection and recovery activities are the second-level important characteristics. A small number of students also mentioned essential characteristics such as working for a purpose, working independently of the state, providing unity, awareness-raising activities, and facilitating the work of the state. This result is similar to the characteristics of working independently from the state, volunteering and facilitating the work of the state put forward by Aslan and Alkış (2013). It also coincides with the characteristics of volunteering and unity stated by Bayram (2015). This result also shows that students can express the characteristics of NGOs at a limited level, as in the definitions of NGOs, and they have very general and inadequate knowledge. The reason can be shown as students do not encounter NGOs enough in their daily lives, and NGOs are not included in detail, even at school. As a matter of fact, the emphasis on NGOs in the social studies curriculum in Türkiye (MoNE, 2018) is made directly with an acquisition associated with official institutions only at the 7th grade level. In the information in the 7th grade textbook, it is seen that non-governmental organizations are limited to issues related to aid, health and environment (MoNE, 2019). This shows the reason for students' inadequate NGO conceptualization is because of the limitation in the content of the social studies course.

Regarding the function of NGOs, it was concluded that about half of the students focused on helping each other and about one-third on protecting life. On the other hand, very few students expressed the other benefits of NGOs, such as raising awareness, advocating for rights, and solving problems. In the results regarding the function of NGOs, a conceptualization is. seen to focus on aid and health areas within their general fields of activity. This reveals that NGOs are recognized by the participants from a narrower perspective, not all their aspects. Similarly, Demirhan-Işık (2018) found that students do not have adequate knowledge of the diversity of NGOs' scope. Non-governmental organizations are also active in areas such as social work, science and sports, apart from health, environment and education (Akatay, 2019). In addition, the political functions of NGOs, which is one of the reasons for their existence, have never been addressed. It can be said that student awareness of the different functions of NGOs, such as directing politics in the country or directing the ruling power to the development and dissemination of human rights, cannot be achieved. In fact, in democratic (or at least claiming to be) countries, the fact that NGOs are a political control mechanism is one of the most important functions for the existence of democracy.

It has been concluded that the students perceive the relationship between citizenship and NGOs as the citizens taking responsibility to participate in and support non-governmental organizations. Non-governmental organizations are perceived as providing the most cooperation and social solidarity among citizens. In other words, it has been found that both parties perceive it as a relationship based on mutual gain. In parallel with the result here, some participants emphasized the importance of non-governmental organizations in benevolence in the studies conducted by Kızılay (2015) with 7th-grade students and by Faiz (2020) with teachers. In the studies by Egüz and Kafadar (2020) and Dere and Akdeniz (2021), they suggested that citizens should know their responsibilities effectively and that they are individuals who fulfil them according to preservice teachers, which supports the result of the current study. Likewise, Değirmenci and Eskici (2019) revealed in their study that active citizens are people who are sensitive to social problems and know and take responsibility in society. In the current study, it has been revealed that students perceive the relationship between NGOs and citizens to be more about providing cooperation. The results regarding NGO's function are consistent with these.

In terms of supporting non-governmental organizations, all the students stated that citizens should contribute to non-governmental organizations. The studies of Demirhan-Işık (2018) and Kara (2022) also emphasize the responsibility of citizens to support NGOs. Some studies in the literature have revealed that students are willing to participate in the activities of NGOs (Demirhan-Işık, 2018; Kara, 2022). In some other studies, an increase in the voluntary participation behavior of students at different education levels has also been observed after the interactions such as receiving training or cooperation with the NGO (Kallioniemi et al, 2010; Keser, Akar & Yıldırım, 2011). In the current study, it has been concluded that students mostly perceive the contribution of citizens to NGOs as making donations and meeting the needs of NGOs. This shows that students generally prefer the easy way of providing financial aid. However, when evaluated within the scope of citizenship consciousness, more opinions on contributing by participating are expected. Students should undergo training on this subject at an early age to positively increase their views on it and actively participate in NGOs (Finley, 2011). As the participants of this study, it can be interpreted that the students are willing to support non-governmental organizations by showing sensitivity to problems as active citizens, taking responsibility and actively participating. Thus, it is emphasized in the literature that it is necessary not only to fulfill the rights and duties, but also to show sensitivity to the problems of society and act with a sense of unity since active citizenship is a kind of volunteer activity (Pecnikova, 2016).

Considering the results of the study, it can be said that the student's knowledge about non-governmental organizations is inadequate, and they need more information and experience about NGOs. However, it has not been directly measured by a test. Although the sample was selected from the schools where an NGO carried out a task, it is understood from the study results that this experience is insufficient for the students. Therefore, it can be said that students' NGO experiences should not be limited to their school experience, and they should gain long-term real-life experiences.

Some recommendations can be made considering these results:

Students should be allowed to learn more about NGOs' types, qualifications, and fields of activity and participate in practices, particularly in social studies and other appropriate courses.

Students willing to help and support NGOs should be directed to cooperate with NGOs by organizing activities such as visiting NGOs and hosting NGO officials in the 5th and 6th grades.

With the encouragement of the Ministry of National Education, cooperation between schools and NGOs should be developed, and more promotion and implementation activities should be carried out in schools with NGOs.

This study was limited to two schools in the province. The regional situation and needs can be revealed by conducting more extensive research in different regions or provinces throughout the country.

Projects can be carried out to create a more accurate and comprehensive perception of NGOs in the minds of students and to encourage them to participate, in order to highlight all functions of NGOs -apart from their humanitarian aspect- especially their political function.

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Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Trabzon University with the decision dated 08/01/2020 and numbered 81614018-E.14.

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Methodology, data collection, data analysis, review and editing

Abstract

The purpose of this research is the longitudinal examination of the change in learning motivation (LM) and attention level (AL) of students continuing formal education at secondary school in the pre-pandemic period (PreP), in the pandemic period (PP) during the process of online education, and in the post-pandemic period (PostP) during the new school year of face-to-face education. The data for the research was collected through the Persona 360 software, which is used to support guidance and psychological counseling services in K-12 and follows the development of students. It is known that the students' psycho-social and educational developments are followed at school by the psychological counselors. The data for the research was collected through the Persona 360 school guidance software used for this purpose from 1,183 students continuing education in 9th and 10th grades at private and state schools in Azerbaijan and Turkey. Within the longitudinal research model, the data was collected three years in a row by the Burdon Attention Test, Learning Motivation Scale, and Temperament-Enneagram 9-Factor Personality Test (MEM-9). The analyses were performed using SPSS 23.0/Windows software pack and ANOVA, two-way ANOVA, and MANOVA tests. Pursuant to the findings obtained, it was found that the students' learning motivations and attention levels changed negatively in the COVID-19 period for the three different time frames. The findings were discussed in the context of temperament and traumatic stress experiences affecting the students' learning motivations and attention levels.

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Research Article

Change in the Learning Motivations and Attention Orientations of Students in the Pre- and Post-COVID-19 Periods: A Longitudinal Study [*]

Mehmet PALANCI [1]

Abstract

The purpose of this research is the longitudinal examination of the change in learning motivation (LM) and attention level (AL) of students continuing formal education at secondary school in the pre-pandemic period (PreP), in the pandemic period (PP) during the process of online education, and in the post-pandemic period (PostP) during the new school year of face-to-face education. The data for the research was collected through the Persona 360 software, which is used to support guidance and psychological counseling services in K-12 and follows the development of students. It is known that the students' psycho-social and educational developments are followed at school by the psychological counselors. The data for the research was collected through the Persona 360 school guidance software used for this purpose from 1,183 students continuing education in 9th and 10th grades at private and state schools in Azerbaijan and Turkey. Within the longitudinal research model, the data was collected three years in a row by the Burdon Attention Test, Learning Motivation Scale, and Temperament-Enneagram 9-Factor Personality Test (MEM-9). The analyses were performed using SPSS 23.0/Windows software pack and ANOVA, two-way ANOVA, and MANOVA tests. Pursuant to the findings obtained, it was found that the students' learning motivations and attention levels changed negatively in the COVID-19 period for the three different time frames. The findings were discussed in the context of temperament and traumatic stress experiences affecting the students' learning motivations and attention levels.

Keywords: Learning motivation, attention deficit, temperament, COVID-19, psychological well-being

1. INTRODUCTION

Schools and students may be indicated as being among the parties affected the most by the measures taken due to the COVID-19 pandemic. The pandemic constituted a new social order in statuses requiring face-to-face contact and in nearly all the domains of the ordinary course of life. The prerequisite of social distance that manifested itself with the COVID-19 pandemic caused the closure of educational institutions for a long period (Telavi at al., 2020). Until that period, the traditional schools used to work under a design in which teachers, students, and families were nearly always coming together in person and in which the events were being carried out face-to-face. But during the pandemic period, the foresight that the number of people infected with COVID-19 would rapidly increase if the current practice continued caused the physical closure of schools in nearly the whole world. Even if different preferences were observed among the countries regarding the closure, Azerbaijan and Turkey ranked at the top among the world's countries in terms of both total closure duration and uninterrupted closure duration at a single time (OECD, 2021). In the new order of life that began with long-term lockdown, the students' online education without the theme of peers caused significant educational and behavioral problems (Lupas et al., 2021). The lack of foresight regarding when the pandemic would end and how much the problems might grow initiated discussions at

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different levels among the educators regarding the preparation they were required to do and the scope of online education. For that reason, the schools became obliged to continuously redetermine their educational priorities and their approaches regarding the students at specific intervals in the online education process. Especially the problems resulting from online education for the small age groups and for the students with individual differences caused additional discussion (Kumar & Nayar, 2021). Because, in a pedagogic sense, the limitations of online education generated problems regarding the consideration of individual differences and the determination of the curriculum's priorities. Preparing a proper infrastructure generating contents conforming to the status, determining the measurement processes, and keeping the students' motivation high caused distress for the educators. Along with the lockdown, the problems observed in the students' adaptation to the new status and especially their decreasing learning motivation and attention level, in addition to the arising new habits, caused negative effects on the students' success. The students' motivations that were waning before the screen and the teachers' decreasing active management skills began to become more complex especially for the small age groups and for students showing developmental individual differences (Merzon et al., 2021)

Additional problems also occurred for children experiencing distractibility and having difficulty adapting to the new education model due to their temperament, as well as for children with limited domestic physical conditions and means of technology usage. One of the most significant problems observed in the COVID-19 period in terms of students and the learning process was what the status of students who experienced problems even during face-to-face education and who developed differently despite being normal would be. The students' attention levels (Ando, Takeda, & Kumagai, 2021), internal motivation levels (Capone & Lepore, 2022; Hatip & Nurkamilah, 2023), and temperament types (Fiske, Scerif, & Holmboe, 2022) have a significant place among the individual differences affecting learning. The uncertainties brought by the process for children in whom problems and differences are observed in their mental, attentional, and emotional development, including those with dynamic temperaments and personality traits, increased incrementally. In normally developing children, factors such as rate of learning, difference of perception, adaptability to school, concerns and fears, participation behaviors, and introversion define individual differences that would affect the quality of general education. The intensity of these factors and the conditions affecting their increase or decrease also have a direct or indirect effect on the children's sense of belonging to school and their passion for educational purposes. Numerous scientific studies on the effects of online education on children are known to have been conducted. In the researches within this scope, concern, depression, behavioral problems, loss of motivation, distractibility, domestic communication conflicts, anger, technology addiction, malnutrition and extensive problems affecting the learning quality (Hernández-Peña, Gea-García, García-Fuentes, Martínez-Aranda, & Menayo, 2023; Kumar & Nayar, 2021) were emphasized. The students' attention deficit and low motivation quite increased depending on the students' ages, grades, and developmental characteristics in the online education process. As being exposed to screens extended, problems especially regarding some courses became more apparent. Ultimately, excessive contact with technology, domestic physical conditions, and the children's individual differences and talents made the inequality of opportunity in education more apparent (Kumar & Nayar, 2021).

It can be assumed that this process progressed more negatively for some children due to personality traits and emotional development characteristics. In children, there is a close relationship between temperament and learning. Temperament expresses the individual's innate personality traits and plays a significant role in the learning process. Temperament affects the children's learning styles and preferences. While some children are eager and curious about events and new experiences, others may be more shy and prudent. These characteristics may affect the child's learning style. While curious and eager children may adopt a learning approach based on exploring, shy and prudent children may prefer a directional learning approach. The status may be analyzed additionally for children who are more dynamic, who are distracted more easily, who already have continuing problems on this issue within the scope of temperament characteristics, and for children who can be emotionally motivated more easily within the group. The Nine-Factor Temperament Model suggests an extensive model examining the children's learning and behavioral tendencies as per individual differences (Palancı et al., 2015). For instance, attention deficit and impulsivity, as neurodevelopmental problems, may be defined as problems making the educational and behavioral adaptations observed in numerous settings, including school, difficult. It is known that the problem in question increases as per the students' temperament characteristics (Palancı, 2017), and it is possible for it to increase the learning problems that came to light in the pandemic period. Students with low AL frequently experience difficulties in intragroup relationships and academic and professional problems. It is known that the students and individuals in this group get low social support due to their impulsive behaviors and improper emotional expressions and experience more conflict with others including their family members and friends. In addition, such children's possibility of experiencing difficulties such as depression, anxiety, and fear is higher, and their self-esteem is significantly low. Moreover, they tend to experience academic difficulty more as they typically use less efficient learning strategies during this process, and their academic success decreases significantly (Li, Luo, Lei, Xu, & Chen, 2022). In the research performed by, the psychological effects of COVID-19 on the students were examined. The findings of the research revealed that 27.3% of the participants had experienced slight or more traumatic ache, and 34.2% of them had experienced a slight or more depressive symptoms (Anglim & Horwood, 2021). It was determined that such emotional difficulties differ as per temperament and personality traits and that personal variables such as learning motivation, gender, and psychological well-being level affect the students' learning behaviors, online learning satisfaction, and perception of success. The students' temperament differences affect their behavioral tendencies. The temperament may positively or negatively affect the children's learning process. For instance, while a careful and disciplined child may be more successful in learning activities, and an angry and anxious child may not direct his attention to learning. For this reason, teachers and parents may develop suitable strategies to support the learning process in the best manner by recognizing the children's temperamental characteristics. For instance, a shy child may be included in learning activities slowly, or a hyperactive may be assisted in gathering his attention by including physical activities in his learning process (Palancı, 2015). Examination within the scope of the pandemic of individual differences among children, who are more emotional and dynamic and who have lower attention and competition skills, is deemed significant within this scope (Buthmann, Miller & Gotlib, 2022). The psychological characteristics and adaptations of mainly adults in the pandemic period were examined according to the 5-factor personality model (Krupić, Žuro & Krupić, 2021). The number of researches about personality differences in children and adolescents is very limited. The temperament characteristics will assist in understanding the children's resistance behaviors that they will exhibit in the face of educational problems as well as clarifying the children's learning motivations and participation behaviors. In this research, the temperament construct was addressed as a 9-factor as per the Temperament-Enneagram theory. In order to form a more typical sampling, the temperament construct was addressed as the comparison of M1 and M6 (Buthmann, Miller & Gotlib, 2022; Fiske, Scerif, & Holmboe, 2022) children, who are deemed to be more advantageous, and M2 and M7 children (Palancı at al., 2015; Palancı, 2017), who are known to be more disadvantageous.

1.1. Purpose of the Research

The purpose of this research is to comparatively examine the students' changing AL and LM levels in the pre-pandemic period, in the pandemic period, and in the post-pandemic period. It is known that individual differences affect educational motivation and sustainable attention levels. In the research, it was also tried to understand the possible effects of temperament characteristics, which are known to affect psychological resistance and well-being, regarding the students' attention levels and learning motivations. Even if the pandemic ended, it is also important to understand whether it had left some lasting effects on the students or not. Consequently, it was observed that the COVID-19 pandemic affected the students' psychological health, learning motivations, attention levels, and social developments. It has been known that the students develop in a versatile manner in school life, both directly and indirectly, by keeping up with norms and face-to-face interaction. It is considered that being face-to-face assists in exhibiting a higher struggle for attaining life's purposes due to motivation and socio-psychological factors on human psychology. It is evident that online education will make more distinct some disadvantageous issues resulting from the children's individual differences. The conflicts increased by technology addiction and concerns of the parents and the difficulties that the children experienced in understanding the requirements of the pandemic have been reflected more in the children's individual differences. And understanding the change in the pandemic's effects that it longitudinally revealed on this issue as per the personality traits and attention levels will be able to contribute to understanding child development and psychological well-being levels. The research carried out for this purpose was intended to understand the effect of individual differences on learning motivation and sustainable attention skills. Understanding how the pandemic, sudden losses, earthquake, and other possible traumatic experiences are being perceived as per the children's individual differences is considered important. Because of this, more consistent approaches and priorities based on individual differences that may assist the children's development and learning in traumatic cases will be able to be determined. Four hypotheses formed for attaining these purposes are given below.

Hypothesis 1. In PP and PostP periods, the students' attention levels significantly decreased compared to PreP period.

Hypothesis 2. In PP and PostP periods, the students' learning motivations significantly decreased compared to PreP period.

Hypothesis 3. In PP and PostP periods, the students' attention levels decreased by differing as per their genders.

Hypothesis 4. The students' learning motivations and attention levels undergo change as per their temperaments and personality types.

2. METHOD

2.1 Research Design

The research was carried out by taking repeated measurements of secondary school students in the pre-pandemic period, in the pandemic period, and in the post-pandemic period. This approach corresponds to the longitudinal research method type (Lynn, 2009), which is data collection from the same research group at different time frames using the same variables.

2.2. Participants

The research group was selected randomly from among 17,824 students studying at schools using the Persona 360 school guidance program. The data was collected within the scope of the variables from the students in the pre-pandemic period, in the pandemic period, and in the post-pandemic period. 1,200 ninth and tenth grade students, calculated as per cutoff scores as having low and high attention levels according to the results of the attention test, were selected randomly from the universe. During the selection of the sample, it was considered necessary for the students to have been studying for three years at a school included in the system and to have completed their measurements in full. While the participants were determined through the computer method as per their AL, the gender and temperament distributions came out through random method. The participants consisted of students studying at private and state schools providing Turkish education in the cities of Baku, Antalya, Diyarbakır, Istanbul, Hatay, Samsun, and Van.

2.3. Instruments

2.3.1. Persona 360

It is a web-based software application used in order to provide support for school psychological counseling and guidance practices. Persona 360 is software that assists the faultless completion of the psychological and educational tests by the students under the supervision of teachers and psychological counselors. Within the scope of educational, personal, and career development, 283 development parameters of the students were measured. The program is used with the support of parents and teachers until the 3rd grade. The construct and usage interface were designed in a manner that will allow the children to complete the tests by themselves after the referred grade. 9th and 10th grade students, constituting the research group, complete the tests by themselves via computer. Persona 360 statistically monitors each year the change in student scores and tries to predict the arising change. By the tests that are increased or decreased as per the developmental expectations of each grade level, the students' learning, psychological well-being, and adaptation developments. Numerous variables such as AL, LM, impulsivity, fear, anxiety, depression, anger, success purposefulness, academic procrastination, and technology addiction are continuously monitored within the scope of school psychological counseling services for each educational level.

2.3.2. Burdon Attention Test

The Burdon Attention Test (BAT), developed by Benjamin Burdon (1955), was used in order to determine the attention levels of the participants in the research. Today, it is extensively used in education, psychology, neurology, and psychiatry researches. The test is applied by marking specific letters among mixed letters. These letters are organized in a specific order on the page, and 660 letters are available on each page. On a page prepared for testing purposes, there are 31 units of the letter "a", 29 units of the letter "g", 30 units of the letter "b", and 29 units of the letter "d". In the test, 5 minutes are provided to the participants for each section. It is asked for the participants to mark under the letters a, b, d, and g on a page and not to mark a single letter while examining a row. But the participants should underline all the letters a, b, d, and g on the page. This status is notified to the participants prior to the test. After completion of the test, the marks are counted, and the test is evaluated. In the evaluation of the test, the correct answers of the participants are considered, and each correct answer is recorded as a score. The time spent on the completion of the test and the number of correct answers constitute the individual's score. In the study performed by Karaduman (2004), the correlation coefficient of validity and reliability of the Burdon Attention Test was found to be .78. During the calculation of the attention scores in the research, the correctly and incorrectly marked letters were determined, and they were arranged in such a manner that each incorrectly marked letter would delete a correctly marked letter.

2.3.3. Temperament-Enneagram 9-Factor Personality Test (MEM-9)

It is a Likert-type scale with ratings of tenfold, developed by Palancı (2018). The responses have ratings of tenfold (0-10-20-30-40-50-60-70-80-90-100) varying between 0% (this article doesn't represent me at all) and 100% (this article represents me completely). During the first stage of the development of the test, a question pool of 134 articles was prepared by the researcher in the first stage. In the direction of the feedback of six specialists, who have knowledge about Temperament-Enneagram and who are serving as active scholars in the domain of psychology and psychiatry, the articles of the scale in the pool were reduced or revised, and a pilot scheme form of 111 articles was applied to the participants. Its final form of 106 articles, which was revised by the use of preadministration data from 150 individuals, was applied to the participants in order to carry out the validity and reliability research. The data analyses were performed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). In the first stage, the two articles that disrupted the latent relationship assumption and total correlation calculations of the article with excessively low and high calculation values were eliminated. EFA and CFA were carried out with the remaining 104 articles. Then the scale form of 90 articles, which ensures validity and reliability at the most optimum level and that is practicable, was obtained. The data for the validation study of the scale was obtained from 4,774 participants. To be subjected to the test, one must be at least 15 years old. The average age of the participants was calculated as 25.12 (Sd: 11.02). The participant with the lowest age was 15, and the participant with the highest age was 51. The distribution of the participants as per gender was 3,110 women and 1,664 men. It was determined that factor load values for MEM-9 were changing between 0.47 and 0.71, that the articles of the scale were being gathered under 9 factors, and that they were defining 68.6% of the total variance. Fit index values obtained as the result of confirmatory factor analysis (CFA) performed for MEM-9 were calculated as $\chi 2=116.09$ ($p=.000$), $\chi 2/sd=5.82$, RMSEA=.09, GFI= 0.82, AGFI=0.88, CFI=0.89, and NNFI=0.93. The results obtained from the confirmatory factor analysis indicated that the 9-type Temperament – Enneagram construct of the hypothetical construct anticipated for the measured construct statistically matched. In the reliability study, it was calculated with the Cronbach's alpha coefficient. The values obtained varied between .82 and .90 for the sub-factors.

2.3.4. Scale of Learning Motivation

It was developed by Kandemir and Palancı (2017). It's a means of measurement focused on measuring the holistic motivation strength of the students as per their self-consciousness, self-regulation skills, and external attributions. The measurement instrument with 5-point Likert-type grading has a single factor construct with 12 articles. The scale was applied with the participation of 1,610 high school students. It was obtained from volunteering students studying at schools which participated in school seminars organized in the provinces of Trabzon, Bayburt, Antalya, Aydın, Ankara, Istanbul, and Ordu. Under a single factor, the scale defined .66 of the total variance. Internal consistency reliability was .86, and the test-retest reliability coefficient (according to data collected from 270 students after 4 online weeks) was .80. Some sample scale articles are "my desire for learning increases as I learn new subjects", "my belief in being successful is high", "I like learning new information while preparing assignments", and "I don't quit studying until reaching the solution". The increase in scores indicated an increase in the learning motivations of the students.

2.4. Procedure

Persona 360 is a special software prepared for bringing into the open the individual differences of the students and providing personal psychological support. The software used for K-12 monitors and measures the students' educational, personal, and career development characteristics through 283 different parameters. Persona 360 is an application that assists in collecting data from students under the supervision of psychological counselors and classroom teachers. The measurements taken at four different times in the school year are obtained under the control of school specialists. In the pandemic period, the data was obtained for each classroom in groups of 10 through the online participation of classroom teachers. While responding to the online tests, the students got support from teachers and PCG specialists for statuses and questions for which they had to get information. Each application was constructed by the specialists in a manner that could be completed in at least 40 minutes and at most in 60 minutes. The families and schools using the application monitor the students' holistic developments each year. The presence of such software provided an opportunity for the use of an unplanned dataset in the COVID-19 period that had been compiled in advance in order to contribute to science. As anticipating the pandemic wouldn't be possible, measuring the effects occurring before and after the pandemic became possible by this means. In this sense, the AL and LM data collected in the PreP period are deemed valuable. Along with the declaration of the pandemic, the researches performed on AL and LM naturally mostly belongs to the acute period. It has been observed that some researchers tried to calculate the possible effects through follow-up studies. There were 17,824 students whose data was regularly being collected through Persona 360 in the period before the pandemic. In the PP, it was decided to make a longitudinal study on this subject, and the research was carried out by monitoring 1,200 students with determined levels of low (600) and high (600). The selection of students according to low and high values was performed as per the random computer method and attention test cutoff scores. And the LM and temperament types of these students came out within the random distribution as per the selection results. After the elimination of deficient data and data disrupting homogeneity, the final analyses were carried out on 1,183 students.

2.5. Data Analysis

Data analyses were performed by the SPSS/Windows 22.0 software pack. The homogeneity and distribution adequacy of the data were analyzed by SPSS/Explore. After the elimination of extreme and deficient data, analyses were carried out on 1,183 students. The data was analyzed by ANOVA for longitudinal comparisons, by two-way ANOVA for the time * AL/LM interaction effect, and by MAVOVA for examining the interaction of temperament types and AL/LM. Before proceeding with the analyses, it was checked whether the dataset met the assumptions or not in order to perform ANOVA, two-way ANOVA, and MANOVA. The skewness value was calculated as -.15, and the kurtosis value was calculated as .22. The values being between -1 and +1 indicate that there is a distribution suitable for analysis. The variance homogeneity of the data was also examined, with the Levene's test being a prerequisite. As the F value calculated for each dependent variable is at the significance level of p>.05, it was deemed that the intergroup initial equality values were met. It was observed that the covariance matrix among variables along the groups was Box's M: 30.1 in MANOVA, and that this prerequisite was met as the calculated p value was bigger than .05. As per these results, it was deemed that the obligation to use an additional correction and calculation type withered. As per the convenience presented by the listed current analyses, only the Wilks' lambda value was examined in the analyses for MANOVA. The data was analyzed in such a manner as to be at the significance level of p<.05 the lowest.

3. FINDINGS

Table 1. Distribution values regarding the data

Scale	N	$\bar{X}$	S.d.	Skewness	Kurtosis	Min	Max	Power
AL	1200	15.03	6.74	.687	-.458	12.00	186.00	.933
LM	1200	6.21	7.03	.457	-.567	2.00	102.00	.979

Table 2. ANOVA analysis of the change of AL and LM in the PreP, PP, and PostP periods

Source	Var	Kt	Ko	F	p	Var	Kt	Ko	F	p
Between Group	AL	160.01	9.33	11.06	.01	LM	107.03	6.70	5.12	.05
Within Group		3035.5	3.04				2111.7	2.14		

Hypothesis 1: It is understood by the findings in Tables 3 and 4 that the students' AL changed significantly in the PreP, PP, and PostP periods. A significant difference was found among groups at the F=11.60, p<.01 level. In the group difference analysis after Tukey's comparison, it was observed that the change in AL was significant for all the groups, including the PreP, PP, and PostP periods.

Hypothesis 2: It is understood by the findings in Tables 3 and 4 that the students' LM changed significantly in the PreP, PP, and PostP periods. A significant difference was found among groups at F=5.12, p<.01 level. In the group difference analysis after Tukey's comparison, it was observed that the change in LM was between the PreP and PP periods. In terms of LM, the difference between the

PreP and PostP periods was not significant. Even if the PostP period exhibited lower LM results compared to the PreP period, the difference was not statistically significant.

Hypothesis 3: As per the findings of the two-way ANOVA performed in order to analyze the time-gender interaction effect of AL in PreP, PP, and PostP periods, a significant difference (F=11.49, p<.01) was found. As the main effect analysis was similar to the ANOVA analysis, it is not given again as a finding. But when the averages of the change of AL ($X_{(Male)} =$ 3.11 males $X_{(Female)}$ = 4.59) was examined for gender * PreP, PP, and PostP period, it is understood that the change of AL is mostly to the detriment of males.

Table 3. Means and standard deviations of total and two-way ANOVA results of students with low and high AL in the PreP, PP, and PostP periods

	PreP	PP	PostP
AL (Negative)	4.10 (.72)	2.80 (.98)	3.04 (.42)
AL (Positive)	4.79 (.91)	3.61 (.57)	4.20 (.62)
Total	4.27 (.88)	3.17 (.74)	3.99 (.47)
F (Group: AL, High, Low)	F=47.07***, (η^2) =.04)		
F (Sample: PreP, PP, PostP)	F=45.12***, (η^2) =.05)		
F Group X sample (Gender)	F=11.49** , (η^2 =.03)		

Hypothesis 4: As observed in Table 4, the AL and LM levels significantly changed as per temperament types in the PP. Through the MANOVA analysis, M7 and M2 students, who were assumed to be affected the most by concern, fear, and online education, were subjected to comparison with M1 and M6 students, who were assumed to have more resistant characteristics. LM differs significantly as per four different temperament types (λ: .64, F: 8.18, p<.001). According to the Tukey’s test used for the post-comparison range calculations of data exhibiting homogenous distribution, it was understood that the significant difference for LM resulted from the M7 and M2 students, respectively, as per effect degree. The difference between these two groups was also calculated to be significant. The group experiencing the highest loss for LM was the M7 students, and a significant change difference was not calculated for the M1 and M6 students.

AL differs significantly as per four different temperament types (λ: 0.78, F: 11.17, p<.001). According to the Tukey’s test used for the post-comparison range calculations of data exhibiting homogenous distribution, it was understood that the significant difference for AL resulted from the M7, M2, and M1 students, respectively, as per effect degree. The difference between these three groups was also calculated to be significant. The group experiencing the highest loss for AL was the M7 students, and a significant change difference was not calculated for the M6 students.

Table 4. MANOVA results of AG and ADHD personality traits by groups during COVID-19

		Type1	**Type7**	**Type2**	**Type6**	**F**	**(η^2)**
LM	Mean	3.10	1.85	2.93	3.32	8.18***	(.05)
	SD	.70	.77	.60	1.00		
AL	Mean	2.79	0.63	2.02	2.14	11.17***	(.07)
	SD	.76	.09	.80	.82		
Multivariate /\ F (df=13.80)						5.07***	

4. DISCUSSION and CONCLUSION

4.1. Discussion

Hypothesis 1: The hypothesis that the students’ AL will decrease longitudinally in the PP and PostP period compared to the PreP period was verified as per the current findings. The most remarkable finding of the research was that AL in PostP period couldn’t reach again the level of the PreP period. The average difference between these two periods preserves its statistical significance. The period in which AL was measured the lowest was PP. It is known that the pandemic, which caused a traumatic lifestyle, resulted in significant health, economic, educational, social, sociologic, psychological, and political consequences. But it was observed that the highest discussion came out as per the concerns and expectations (Werner & Woessmann, 2023) in the domains of health (Billing, 2023; Caesar, Layer, & Barasi, 2023) and education. It is known that the cessation of face-to-face education in a period in which educational population and mobilization are very high in the world caused depression, anxiety (Lakhan, Agrawal, & Sharma, 2020), hopelessness, trauma, and concern for the future (Harper, Satchell, Fido, & Latzman, 2021) among the families and education professionals as the students being in the first place in terms of time management and child development. But as it is possible for numerous educational themes or concepts for children to be open for discussion, it is observed that the problems of motivation loss (Yu, 2022; Faridah, Sari, Wahyuningsih, Oganda, & Rahardja, 2022; Naciri, Radid, Kharbach, & Chemsi, 2021) and attention deficit experienced especially due to online education are encountered more as the focus discussion domain (Advokat, Lane, & Luo, 2011; Ando, Takeda, & Kumagai, 2021; Bailie & Linden, 2023; Behrmann et al., 2023; Bruni et al., 2023; Helsin, Shuai, Wang, Qiu, M, & Wilson, 2023). The studies carried out within this scope often use university students as references. Moreover, in nearly all the current researches accessed, there is no comparative data regarding the PreP period. For this reason, it may be deemed important for the data obtained to address the AL of high school students in three different periods of the pandemic.

Consequently, it was observed that the AL of high school students decreased at a statistically significant level in the PP and PostP period compared to the PreP period. As the main finding, it can be said that the quality of attention in the PreP period couldn't be attained again by the children. Moreover, the findings of the research indicated that the AL of all the students decreased, irrespective of their low or high attention levels in the PreP period. As low AL in the PreP period was a disadvantage, PD increased that risk more considering the style of education. In PP, the AL of students, who are eager for education with high motivation, success, and attention levels, also decreased. In addition, the continuation in the PostP period of the problems of students with low or high AL revealed that all the students were negatively affected by this process, independent of their current attention levels. This finding revealed the conclusion that the pandemic caused negative and permanent effects on the adolescents' skills of gathering and maintaining attention and their skills of using the same for educational purposes. Most of the researches performed within this scope indicated that the attention of the students was negatively affected by the process (Altszuler et al., 2012; Dvorsky et al., 2022; Lupas et al., 2021; Merzon et al., 2021). Another reason for the decrease in attention is the decrease in in-class education interaction, which mediates peer learning and the development of social skills. Loneliness and being in front of the screen caused the students to be more nervous and inattentive (Bailie & Linden, 2023). The findings of the current research and the data obtained in the post-COVID period indicate that the attention levels of the students decreased in the COVID-19 process and that such effects are still continuing due to the changing and disrupted development of the children. The problems of being attached to the screen more and of increasing game addiction occurred in children with ADHD. Unsuccess, negative feedback, academic procrastination, problems due to time management, and loss of motivation had also been effective on AL. Other significant causes of the decrease in AL in children and adolescents are decreasing personal learning skills and disruption of personal studying, reading and understanding strategies (Capone & Lepore, 2022). Both the lack of knowledge of the children and families in terms of what they would do for personal transformation in such a case and the limitedness of the interference of the professionals increased the problems observed (Shuai et al., 2021). Consequently, it can be assumed that the sudden change in face-to-face education standards and applications forming the basis of competences and education of children that used to occur through personal learning strategies and attendance at school negatively affected the sustainable AL of the children. Moreover, along with the addition of uncertainty, concern, stress, and physical restrictions, multidimensional educational and behavioral problems came out, including the decrease in AL for the children.

Hypothesis 2:

The hypothesis that the students' LM would decrease in the PP and PostP period compared to the PreP period was verified as per the findings. The PP, during which only online education continued, was the period during which the LM of the high school students was the lowest. As different from the AL variable, LM changed more rapidly in the PostP period, and got close to its general level in the PreP period. Along with the continuation of a partial decrease, this difference is not statistically significant. This finding reveals that the learning variables examined as characteristics (status) for the COVID-19 period improved in time, but that the time (improving conditions of the pandemic) couldn't eliminate the disruption in competences (in gradual developmental characteristics) such as attention. Even if similar researches don't include a longitudinal comparison for the three periods, they indicated that learning motivations had decreased in the pandemic period and in the subsequent new normal period (Shuai et al., 2021). It is known that the students' success and motivation positively change depending on the size and quality of the group they are in and on the content of the course (Moliner & Alegre, 2022). In the process of pandemic, the variable that decreases the students' motivation levels the most is the decrease in in-group motivation interaction, which contributes to cognitive stress and psychological well-being. The reflection on the children of parents' concerns and stress related to the future of schools and exams is also effective in decreasing LM (Martin, Ginns, & Collie, 2023). The decrease of socialization skills, boredom of the children from online education, losses in teacher performance, and insufficiency of some practices as per content or age level may be indicated among the most significant causes of motivation loss (Jhawar, El-Ghandour, Ezzat, & Gonzalez-Lopez, 2023). Education strategies developed as peculiar to the status, cooperation of teachers and students, gamification, and computer practices are able to increase learning success (Yu, 2022), but it may be difficult to achieve this for each course, age level, and student. On the other hand, it can be said that the impossibility for the educational institutions to be ready in advance against such a process, rapidly making the curriculum suitable for online education, the difficulty of the control of student events and of the assistance processes to be provided (Lupas et al., 2021), and the limitation of other students' participation, listening, and understanding skills during the feedback in the process of online education also negatively affect the motivation of participation (Sibley et al., 2021). In addition, the decrease in readiness and self-regulation skills associated with online education is among the causes of motivation loss (Li et al., 2022). It can be assumed that face-to-face education may decrease academic procrastination with the power of decisiveness and exposure due to the observation of group synergy, ease of feedback, and educational performance (Capone &Lepore, 2022). Loss of motivation came out due to a decrease in self-efficacy level, a loss of interest, and a decrease in sense of reasoning. The stress caused by adaptation to the new status also impeded the students' motivation level (Martin et al, 2023). Moreover, subjects such as increasing academic procrastination, missing critical learning details, uncertainty experiences, difficulty in learning (Xhakolli &Hamzallari, 2023), loss of interest, observed benefit, and assignment of priority also caused motivation loss due to the performance of students and teachers (Hatip & Nurkamilah, 2023). Not being familiar with online education and the requirement of making more effort for success are also other causes of motivation loss. The decrease in external motivation resources revealed more risk for the students whose internal motivation remained low (He et al., 2021). The decrease experienced in subjects such as emotional bonding, watching peers, and being a leader in the classroom may be listed among the causes of deeming online education boring (Sibley et al., 2012). The mixture of weekday and weekend concepts, the limitation of natural entertainment, and the shortening or change of performance periods caused attention and motivation losses (Korpa et al., 2021), and the process generated worse conditions for children who were already unwilling for learning and school and who were already experiencing learning difficulty (Becker et al., 2020). The decrease in extra activities performed at school, in sports and travel events within and outside the school, in relationships outside the school, in behaviors requiring social association and in reading level may be listed among the cause of the decrease in LM (Relyea, Rich, Kim, & Gilbert, 2022).

Hypothesis 3: The hypothesis that the students' attention levels differ as decreasing as per gender in the PP and PostP period compared to the PreP period was accepted as per the findings of the research. It was observed that AL was more problematic especially among male students. Within the scope of getting the diagnosis of ADHD, it is known that males are more disadvantageous (Bauermeister et al., 2007). It is possible for AL to change as per gender due to physical restrictions and the online nature of educational events. The data verifies the assumption that the AL decreases more to the detriment of males in the pandemic period. As the difference occurring in the AL in terms of female students being significant, this difference is only limited with the PP for females. The decrease in AL in the PreP and PostP periods for male students was higher compared to female students, and such losses continue despite the new normal school process. The relationship between AL and pandemic is also related to different variables including the number of siblings, age, parent attitudes, medication usage, and gender (Takeda, Tsuji, Akatsu, & Nomura, 2023). It was observed that SES, culture, educational perception of the mother and father, and behavior and management skills caused more problems for disadvantageous groups regarding AL, depending on the quality of societies and education systems (Xhakolli & Hamzallari, 2023). It was found that the negative effect of online education regarding attention level in the pandemic period was higher among women. It was found that attention deficits at different SES levels decreased success and that this affected whole student groups, whether a diagnosis of disorder exists or not. It was observed that low self-efficacy, including anxiety, depression, learning difficulties, and other conditions requiring special education, caused negative pressure on the quality of attention and learning skills. There had been periods and groups in which the losses experienced on this subject reached very high average values (Hoofman & Secord, 2021). In the context of culture and SES, it can be said that ADHD affects males and black, Latino, and Middle Eastern children more (Breaux et al., 2022). The results indicated that the AL in a longitudinal sense decreased for females and males, but that more problems occurred for males within the scope of time*level and that the problems continued also in the PostP period as different from the LM.

Hypothesis 4: The hypothesis that the learning motivation and attention level change as per the students' temperaments and personality types was verified as per the current findings. Within the scope of this hypothesis, it was found that the students' AL and LM levels changed in the PP depending on their temperament characteristics and personality traits. M7 and M2 students were the ones who were in the personality group experiencing the highest AL and LM decreases. In terms of AL, it was understood that only the M1 students experienced problems in PP, which was different from LM. It was found that all the personality types got affected by the pandemic, but especially the M7 male students were the sub-group experiencing the problem the most in the context of time*loss (AL-LM). It was observed that loss of motivation was experienced most among the M2 female students. These findings are consistent with the Temperament-Enneagram Theory's definition of behavior tendencies frequently observed in these personality types. But in the PP, a significant level of decrease was observed in the LM and AL of the children of all temperament types. In terms of AL, the M7 children are the sub-group who experienced the highest loss in the PP. For M7, this loss continued significantly also in the PreP and PostP periods. In terms of LM, the M2 children are the sub-group who experienced the highest loss in the PP. As different from the other findings, a statistically significant decrease in LM level continued in the PostP period only for the M2 children. The current finding indicated that the interaction effect of the high vulnerability level of the M2 children continued, depending on the trauma.

Consequently, it was indicated that the interaction of personality type and pandemic focused on the Big Five Theory and on adults in the COVID-19 period (Anglim & Horwood, 2021; Krupić, Žuro, & Krupić 2021). The main reason for this is the complex construct of personality measurement and the relative difficulty of measuring the children or adolescents. There are studies addressing the relationship between temperament characteristics and psychological well-being, attention, and motivation. In the studies in which the pandemic period was addressed for different personality traits, it was observed that the status often caused problems for the neurotic personality types. It was observed that extroversion and openness to experience provide more resistance, and that the responsibility (Hernández-Peña et al., 2023) tendencies carry the individuals' psychological well-being levels to varying levels depending on age, profession, and other disorders (Liang et al., 2021). Moreover, it was revealed that the adaptation levels of the individuals change as per the social norms and personal values they adopt and as per their coping skills (Buthmann, Miller & Gotlib, 2022; Hipp et al., 2020; Kim et al., 2013). The results indicated that neuroticism and scrupulosity cause more anxiety (Xu et al., 2023) and that extroversion causes less anxiety (Anglim & Horwood, 2021). The findings of the research revealed a similar finding for the M2 and more introverted sensitive temperament characteristics (Fiske, Scerif, & Holmboe, 2022). It was understood from the findings that the M1, who are relatively more perfectionist, neat, and controller, and the M6, who have a high perception of responsibility, generate higher resistance. Emotional regulation problems and feelings of anxiety, which change depending on personality traits, affected both the motivation and AL of the students. It was observed that the temperament characteristics, being the source of personality, had an effect on the online LM and AL of the students in the pandemic period by affecting the resources determining personal motivation, including coping skills.

4.2. Conclusion and Recommendations

In the COVID-19 period, the high school students' LM and AL decreased significantly. Moreover, this decrease became more distinct to the detriment of impulsive and anxious children, depending on temperament type. According to the data obtained in the 3-year monitoring process of the students covering the periods of PreP, PP, and PostP, it was observed that the students couldn't completely reach their motivation and attention levels that they had prior to the pandemic despite the resumption of face-to-face education. The active pandemic period, when education was completely online and general social life was restricted, was the period in which the worst values in terms of LM and AL were obtained by the measurements.

- Health care professionals and teachers should be aware of the overall impact of COVID-19 on the health and well-being of children and young people with low AL.
- Educators and clinicians should be aware of the long-term consequences of individual differences during the COVID-19 pandemic and should implement pro-active strategies to support children and young people with low attention levels, low motivation, and poor temperament.
- Children and young people with poor AL and LM may suffer greatly from reduced access to sports and leisure facilities.
- Time management and appropriate web designs should be made for students who have online education periods and attention deficit.
- Policymakers should be aware of the potential negative consequences of COVID-19. In particular, in order to support individual differences and make this sustainable under all conditions, personal education should be supported more.
- In online education applications, it can be suggested that school psychological counselors increase group motivation by increasing e-guidance and motivation group studies.

- There is a mediating relationship between attention deficit, learning strength and loss of motivation. For this reason, the possible causality of this relationship should be adequately analyzed while approaching possible problems.

By monitoring the change observed in the PostP period through intermediary and predictor variability analyses, more indicators and means of interference on the subject should be brought to the attention of educators and psychology professionals.

Ethics Committee Decision

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Abstract

The need for constructivist classroom environments in mathematics teaching cannot be ignored in order for sustainable development to continue. One of the most important applications of constructivist classroom environments in mathematics education all over the world is mathematical activities. The proficiency of pre-service mathematics teachers in developing activities will support constructivist classroom environments. In this study, it was aimed to reveal pre-service mathematics teachers' thoughts about what points they consider while they develop activities for mathematics courses. With this aim, an open-ended question was addressed to 23 pre-service teachers taking education at Elementary Mathematics Teaching program of a state university and having received the elective course of *Activity Development in Mathematics Teaching*. The obtained data was analyzed via the content analysis method. As a result of the study, it was determined that the participant elementary pre-service mathematics teachers expressed the points which they considered while developing activities with a total of 161 sentences or words. The statements obtained as a result of the analysis of the answers which the pre-service teachers gave to the research problem were gathered and examined under five sub-themes, namely *general*, *purpose*, *scope*, *planning* and *the role of the teacher in practice*. In respect of the points which elementary pre-service mathematics teachers considered while developing activities for mathematics courses, participants considered while developing activities for mathematics courses, they were observed to use statements which were mostly related to the sub-theme of *the role of the teacher in practice*. When it was evaluated in general, it has been observed that the participant elementary pre-service mathematics teachers are generally aware of the points to be emphasized. However, due to the low number of pre-service teachers who emphasized some points, it was concluded that they did not have enough knowledge about developing activities

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Research Article

The Points to be Considered while Developing the Activities for the Mathematics Course [*]

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Abstract

The need for constructivist classroom environments in mathematics teaching cannot be ignored in order for sustainable development to continue. One of the most important applications of constructivist classroom environments in mathematics education all over the world is mathematical activities. The proficiency of pre-service mathematics teachers in developing activities will support constructivist classroom environments. In this study, it was aimed to reveal pre-service mathematics teachers' thoughts about what points they consider while they develop activities for mathematics courses. With this aim, an open-ended question was addressed to 23 pre-service teachers taking education at Elementary Mathematics Teaching program of a state university and having received the elective course of *Activity Development in Mathematics Teaching*. The obtained data was analyzed via the content analysis method. As a result of the study, it was determined that the participant elementary pre-service mathematics teachers expressed the points which they considered while developing activities with a total of 161 sentences or words. The statements obtained as a result of the analysis of the answers which the pre-service teachers gave to the research problem were gathered and examined under five sub-themes, namely *general, purpose, scope, planning* and *the role of the teacher in practice*. In respect of the points which elementary pre-service mathematics teachers considered while developing activities for mathematics courses, participants considered while developing activities for mathematics courses, they were observed to use statements which were mostly related to the sub-theme of *the role of the teacher in practice*. When it was evaluated in general, it has been observed that the participant elementary pre-service mathematics teachers are generally aware of the points to be emphasized. However, due to the low number of pre-service teachers who emphasized some points, it was concluded that they did not have enough knowledge about developing activities.

Keywords: Activity development, mathematical activity, mathematics course, pre-service mathematics teacher

1. INTRODUCTION

The global changes lived in today's world make it necessary for countries to follow science and technology closely and perceive and use the changes. Stoblein (2009) states that students who attend a traditional class have a low level of understanding, because teachers do not provide opportunities to support students' thinking and learning process. In this context, countries have needed to revise their educational policies. As in the international in our country, too, from 2004 on, the Ministry of National Education (MoNE) has renewed the teaching programs according to the constructivist approach. İlhan and Aslaner (2022) emphasize that the majority of mathematical and geometric objects contain abstract concepts that require mental activity. Considering these abstract concepts and taking into account the changing educational philosophies, students are not expected to memorize formulas in mathematics teaching, but to reach the information actively in the process themselves. Together with this change, the learning-teaching processes of the programs, the tools used, the structures of classes and the teacher and student roles have also changed. The teacher has been taken from the position of giving students knowledge directly and brought into the position of supporting their learning and

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helping them learn (Saylan & Yurdakul, 2005). Student, however, have come into the position of being active in the process, being responsible of their own learning and constituting their new knowledge by starting from their previous knowledge (Umay, Duatepe, & Akkus-Cikla, 2005). Although knowledge is easily accessible, it is more important that the reached knowledge should be interpreted and used in problem situations. According to the constructivist approach, knowledge is not transferred literally from one individual to another, but an individual can be guided in his/her constructing the knowledge by choosing appropriate tasks (Dede, Dogan, & Aslan-Tutak, 2020). Within the mathematics teaching program based on constructivist approach, activities are attracting attention as the most important learning-teaching tool. In order to realize environment, teachers should design learning environments using mathematical activities to create efficient classrooms (Ayalon, Naftaliev, Levenson & Levy, 2021). It is emphasized by many scientists that mathematical activities have a very important place in the mathematics' teaching and learning (Crespo, 2003). In this context, the importance of activity-based learning should be emphasized It can be stated that this situation is also valid for courses other than mathematics. At this point Karatas and Cerci (2023) emphasize that activities are very necessary for language teaching in their studies.

In activity-based learning, it is thought that students will be held responsible for their own learning and their personal development will be supported (Festus, 2013). Placing the activities frequently mentioned in the program in the center of the learning-teaching process has put forward the importance of the activities and there has appeared a need for explaining this concept (Toprak, 2014). When the mathematics education literature is examined, it is seen that the English words "task" and "activity" are used in place of the Turkish word "etkinlik". The word "görev" can be used as the Turkish equivalent of the English word "task" and the word "aktivite" can be used as the Turkish equivalent of the English word "activity". When the meanings of these words within the mathematics learning and teaching environments are examined, it is seen that Doyle (1983; 1988) defines the word "task" as a mathematical situation on which students work without always participating actively and the word "activity" as a situation in which students work actively on a subject about which they have no information. However, Sullivan, Clarke and Clarke, (2013) define the term "task" both as a starting point for a student to learn and a process composed of context-based questions, situations and instructions and where a student's knowledge is required and the term "activity" as the thoughts, physical, written, verbal statements which students produce to answer the process included in the statement of a task. Yeo (2017) in the study, helped teachers select types of mathematical tasks that could help them design or select more appropriate tasks that would appeal to students with different abilities to develop different types of mathematical thinking processes. These tasks initiate activities, which provide the basis for learning to take place. In their study, Henningsen and Stein (1997) state that mathematical tasks included in activities will teach students mathematics and do mathematics. Many studies have been conducted on designing or modifying activities in mathematics education, as they draw attention to the important role of tasks in activities in students' mathematics learning. Lee, Lee and Park (2019) in their studies, he focuses on developing the skills of pre-service middle school teachers to change mathematical tasks through activities for noticing. Consequently, it can be stated that the development of pre-service teachers' noticing skills and this development affect their task changes. At the same time, it can be stated that they will develop a student's mathematical thinking and association skills.

Although there is a wide range of meanings for the concept of activity, there isn't a shared definition of it (Ozmantar, Bozkurt, Demir, Bingolbali & Anil, 2010; Ugurel & Bukova-Guzel, 2010). In traditional approaches, activity is expressed as a work created by students and prepared by the teacher following a certain path (Margolinas, 2013). According to Dede et al. (2020), activity is defined as learning activities which are in line with pedagogical approaches enabling students to focus on thoughts via various mathematical tasks. However, Bozkurt (2012) defines mathematical activity as the generation of a product by activating a problem given for learning a piece of mathematical knowledge with the help of some materials and tasks given to students. Stein, Grover and Henningsen (1996) said that, activity is given as the classroom activities drawing students' attention to a certain mathematical thought. In addition to this an activity as the activities supporting students' learning and enhancing their learning levels (MacDonald, 2008). As pointed out by the definitions, in order to do an effective and qualified mathematical teaching enhancing students' learning levels, well-structured activities to activate students' meta-cognitive skills such as problem solving, search for a pattern, arriving at generalizations and develop their mathematical thinking should be taken into consideration. Each of the mathematical activities has a critical role for mathematical learning (NCTM, 2000). Simon and Tzur (2004) emphasizes that activities are attached importance with the aim of developing the teaching of a concept and increasing the quality of mathematical education in the USA. In order to realize the learning by understanding, it is important to teach students mathematical concepts and procedures and the relationships between these (Soylu & Soylu, 2006). Mathematical signs like terms, equations are either tool or objects in mathematical activities. For this reason, Wille (2020) emphasizes that sign activities are a part of mathematical activities.

In his study, Baki (2008) points to the importance of mathematical activities' giving concepts and relationships between concepts in a planned way. While Swan (2008) emphasizes students must be active participation in the process through activities, Doyle (1988) states that students should take responsibility in activities. Activities do not only have students be occupied with a task intensively, but they are also important in teachers' arranging the teaching environment effectively (Johnson & Clarke, 2017). According to this, it can be stated that an activity is a process achieving students' active participation in a teaching environment. This requires setting activities, which are to have students acquire new knowledge and take them in the center to work by starting from students' previous knowledge. Henningsen and Stein (1997) emphasizes that the activities allow students to develop their mathematical thinking and reasoning skills. Hence, it is inevitable that students should be provided with different learning ways (Stylianides & Stylianides, 2008). It can be said that students' learning mathematics with the help of activities is the basic building block of the learning process. For, students are expected to be mentally and physically active and go into an occupation in the learning process via learning activities. According to Stein et al. (1996), activities give students what they learn, their knowledge of mathematics and their perception of mathematics. If the fact that an activity is a very important phenomenon is taken into consideration, the importance of an activity design should also be emphasized in order to create the desired effect in teaching and the fact that an activity design is a process requiring care and attention should not be ignored. A well-designed, well-structured activities offer significant benefits to the learning-teaching process.

Although there are different viewpoints about activity development, there are also some common principles. Lappan and Biars (1995) mentioned the necessity of considering what students work on, what mathematical knowledge expected to appear as a result of the activity, what mathematical thoughts reveled by students and what mathematical concepts are composed by them while developing a mathematical activity. Ainley, Pratt and Hansen, (2006) proposed the principles of purpose and usefulness for activities. Ozmantar and Bingolbali (2009) synthesized the principles given in the literature for event design and implementation and presented them as "event design and implementation principles". The necessity of considering the following points during the development of an activity is emphasized: *"the purpose of the activity, inclusion of a daily life context, flexibility and introduction of process-related knowledge, classroom management, more than one starting points, materials/tools, teacher and student roles, students' background knowledge, students' difficulties and misconceptions, measurement and evaluation"* (Brousseau, 2002; Ozmantar & Bingolbali, 2009). If the teacher does not choose or plan appropriate activities for the readiness, mental and physical structure of the class, she may not get the expected result in the activity implementation process (Henningsen & Stein, 1997). The activity planning and implementation knowledge of a teacher may both facilitate and aggravate students' understanding. Griffin (2009) underlined that a well-designed activity would not be sufficient to achieve the desired learning outcome. In other words, it should be emphasized that the activity is as important in the implementation phase as in the development phase. In addition, it is stated that in order to realize more meaningful and permanent learning, the correct and appropriate implementation of the activities as well as the design of the activities is an inevitable situation (Yeo, 2007).

Hence, it is of importance to develop teachers' activity development and implementation skills. Stein and Smith (1998) examined the activities in different stages as the activities given in the textbooks, adapted by the teacher to apply by the students in the classroom. However, before and after the activity, it should be evaluated and revised at many different stages (Liljedahl, Chernoff & Zazkis, 2007). Depending on this, it is necessary to investigate into how teachers and pre-service teachers develop, implement, evaluate and revise activities to achieve mathematical understanding.

When other studies are examined in the literature, there are studies that examine the perceptions of mathematics teachers and prospective teachers about the concept of activity from different perspectives (Bozkurt, 2012), types of mathematical learning activities (Ozgen, 2017), their opinions about learning activities (Toprak, Ugurel, Tuncer & Yigit-Koyunkaya, 2017; Ugurel et al., 2010), activity preparation and implementation processes (Ozturk & Isik, 2018), evaluation of mathematics course book activities (Kerpic & Bozkurt, 2011), effects of teacher and student roles on activity implementation process (Ozmantar & Aslan, 2017), examination of measurement and evaluation processes of implemented activities (Karakus & Yesilpinar, 2013).

In their study, Toprak et al., (2017) studied pre-service teachers' perceptions of mathematics learning activities. As a result of the study, they emphasized a lot of characteristics related to activities, but they determined that the pre-service mathematics teachers could not include these mentioned characteristics in the activities they developed. It was concluded that it would be appropriate to develop pre-service teachers' activity development skills. In his study, Ozgen (2017) examined the mathematical learning activities with regard to skills, purpose, mathematical competence and cognitive processes, and gave place to the examples related to the concept of function with the aim of concretizing different kinds of mathematics learning activities. In their study, Toprak, Ugurel and Tuncer, (2014) analyzed the activities developed by the pre-service teachers with respect to their purpose of design, the subject they chose and the way of implementation. Consequently, it was determined that the pre-service teachers preferred the subjects at different class levels in the mathematics teaching program more frequently in the design of an activity. It was observed that most of the developed activities aimed to develop learning and it was followed by the purpose of consolidating the concept. They reported that the pre-service teachers chose collaborative group work most at the stage of implementing the activities.

In his study, Gok (2019) aimed to examine the elementary pre-service teachers' thoughts about how they developed an activity about a subject and the activities which they designed. As a result of the study, it was concluded that they touched on the evaluation of an activity and the flexibility components a little in the activity development process. Moreover, it was also examined that the elementary pre-service mathematics teachers had challenges in many ways while preparing an activity.

Festus (2013) focused on strategies to realize activity-based learning in the mathematics classroom. Some different strategies such small group learning, classroom discussion and cooperative learning have been seen to be used. Kerpic and Bozkurt (2011) carried out a study to evaluate the activities included in elementary mathematics course book within the framework of activity design and implementation principles. It is remarkable that the examined activities were generally designed in accordance with the implementation and activity design principles such as the purpose of the activity, the students' background knowledge, the necessity of an activity's covering all students, the appropriateness of materials to be used, student roles and measurement and evaluation. However, it was observed that some design principles, which are of importance in an activity design, such as the necessity of an activity's having more than one starting points, the determination of the teacher's role and the students' difficulties and misconceptions were not attached sufficient importance; moreover, the matters of time use and classroom management were not touched on at all. Urhan and Dost (2018) examined the activities in the 9th grade mathematics textbook of MoNE (2013). As a consequence of the study, it has been showed that the activities in the textbook are quantitatively rich but qualitatively insufficient, and however, some activities in the textbook can be transformed into a model building activity that meets the criteria. In their study, Bozkurt and Kuran (2016) examined the teachers' thoughts in relation to the implementation of the activities in the course books and activity development. Besides this, 65% of the teachers stated having tried activity development and organized these according to the class level.

In their study aiming to determine the elementary pre-service mathematics teachers' activity preparation processes, Ozturk and Isik (2018) reached the result that the pre-service teachers did not have sufficient experience and knowledge about activity preparation process. In addition to this, it was determined that the activities prepared by the pre-service teachers primarily aimed to have the students comprehend the subject and it was followed in order of frequency by the activities with the purpose of concretization and evaluation. Ozgen, (2019) the pre-service teachers' skills in associating mathematics with different disciplines were investigated in the activities they developed. When the activities were classified according to cognitive processes, it was observed that the interpretation and the composition types of activities were included the least; when they were classified according to mathematical skills and competence, it was seen that the activities related to generalization, proving and reasoning and the use of technology were included few in number. Literature studies made in this context was determined that the teachers had some difficulties in preparing activities and comprehending the purpose of performing activities (Karakus & Yesilpinar, 2013). Moreover, it was also determined that a great majority of the teachers fell short of turning the designed activities into a valuable experience for the students and needed professional development (Sullivan, Clarke & Clarke, 2013). So, this indicates that the process of the developing activities much less is known. For this reason, recently there has been growing interest in the stage of developing activities. The process of pre-service teachers' developing a mathematical activity requires considering many different situations. The fact that obtaining and examining opinions in this process will create awareness about the points to consider in activities which they are to develop as a teacher in the future is increasing the importance of the study. However, while developing activities, both they should be structured well and the attitudes of individuals to benefit from them should be considered (Horoks & Robert, 2007). Yuksel (2014) concluded in her study that activity-based teaching makes an important addition to students' mathematics attitude and performance. Huang and Lin (2012) studied learning activities designed based on the recognition of central cultural factors using the activity system. They showed that they could improve their students' mathematical learning within the complexity of these learning activities and the cultural flow in their development.

It is known that pre-service teachers and teachers play a determinant role in the preparation and implementation of activities (Kerpic, 2011). According to Lau (2021), pre-service teachers have faiths about different subject areas and develop new faiths while studying at universities. Teachers' beliefs about mathematics and mathematics teaching and accordingly their competencies, it is vital for improving the quality of mathematics teaching (Potari, 2020). In this respect, teachers and pre-service teachers' competences in preparing activities and in relation to the activity concept are increasing the importance of the study. When the complicated content of a mathematical activity is considered, it is of great importance to create information and awareness in relation to the inclusion of this into the teaching process. It is commonly suggested that this should be worked on.

Starting from here, it was intended in the study to reveal the elementary pre-service mathematics teachers' thoughts about the points which they considered while developing activities for mathematics courses. In the direction of this purpose, following research question explored *"What points are consider while developing activities for mathematics courses?"*.

2. METHOD

This section includes the information about the research model of the study, the sample of the study, the data collection process, the data analysis process.

2.1. Research Model

This is a qualitative, special case study which aims to reveal the points which the elementary pre-service mathematics teachers consider in the process of developing activities for mathematics courses. Case study is a qualitative research design. Such research designs in which one or several situations limited by the researcher are investigated in detail and in depth by using data collection methods (interviews, observations, documents, etc.) that include multiple information sources (Creswell, 2007).

2.2. Sample of the Study

This study was conducted with the elementary pre-service mathematics teachers taking education at the Elementary Mathematics Teaching program of a state university and having received Developing Activities in Mathematics Teaching as a field education elective course. In the content of this elective course, after the theoretical explanation of the purpose and importance of the use of activities in mathematics teaching, the characteristics of the activities used in mathematics teaching, what should be considered when preparing and applying the activity, how the activities are evaluated (Council of Higher Education, 2018), the sample activities were examined. Afterwards, students were asked to design an activity and apply these activities in the classroom. At the end of this course the study was conducted with 23 elementary pre-service mathematics teachers based on the principle of voluntariness. The sample group was determined according to the easily accessible sampling method, which is one of the purposeful sampling methods, (Yildirim & Simsek, 2005).

2.3. Data Collection

Within the scope of the study, the participant elementary pre-service mathematics teachers were addressed in written form an open-ended question stated as "What points you are consider while developing activities for mathematics courses?".

The administration lasted about 30 minutes and the pre-service teachers answered freely the open-ended question addressed to them. It was assumed that all the participant pre-service teachers answered correctly and sincerely. In the study, the pre-service teachers were coded as "P1, P2..." while analyzing the data.

2.4. Data Analysis

In this study, in the process of making sense of the data, the content analysis method was used. Content analysis is a process starting with data collection and ending with category and code assignment and where data is interpreted and synthesized by researchers (McMillan & Schumacher, 2010). In this study, firstly, detailed coding and thematic coding were made; then, the data was organized according to the appearing codes and themes; finally, the findings were interpreted. While coding the data, the answers given by the pre-service teachers to the open-ended question addressed to them were read many times at different times and the data remaining outside the research questions were not coded by considering the conceptual framework of the study and, hence, the important dimensions that matter were determined within the framework of the study. Similarities and differences between the appearing codes were determined and the related codes were gathered together. In conclusion, the themes at general level and the sub-themes under these themes were determined and the codes were organized under these themes. Hence, the themes and the sub-themes and the codes were created and tabulated. Some quotations were given directly from the students and interpreted.

In the study, the research question helping to obtain the research data composed the theme at the most general level. For this theme obtained from the data of the study, five different sub-themes, namely general, purpose, scope, planning and the role of the teacher in implementation, were determined. The codes were determined by considering the answers of the pre-service teachers and the findings including these codes and themes were interpreted. The example statements of some of the elementary pre-service mathematics teachers were given place directly. In this process, the data obtained in written form in the study was analyzed via frequency analysis by making it undergo the processes of the content analysis mentioned above in detail and the numerical data was obtained by using Microsoft Excel.

At the stage of content analysis, attention was paid to make the appearing themes constitute a meaningful whole between one another while making a thematic coding although they were different and the internal consistency and external consistency principles were taken into consideration. Within the scope of the validity and reliability of this qualitative study (Yıldırım & Simsek, 2005), plausibility and consistency were achieved through expert examination in this study. The data obtained were evaluated by two researchers and the similarities and differences were discussed between them. The way how the data obtained in this process was gathered under the determined theme and which sub-themes and codes would take place under this theme were determined together. At this stage, the matter of under which sub-theme the code of addressing different learning styles would take place was thought again and again. It was thought that this code could also have taken place under the sub-theme of scope, but it took place within the scope of the sub-theme of planning by considering the pre-service teachers' statements. Hence, the quality of the study tried to be increased. Afterwards, an expert review was conducted. Moreover, care was taken to classify the research data in accordance with the content analysis, its organization in line with the determined theme, its interpretation and its explanation via giving place to some direct quotations.

In the writing of the report related to the research findings, too, attention was paid to the research data's bearing such characteristics as being reasonable, appropriate for individuals' experiences, plausible, important and legible.

3. FINDINGS and INTERPRETATION

In this part, the findings reached as a result of the analyses made with the aim of examining the points which the participant elementary pre-service mathematics teachers consider while developing activities for mathematics courses by taking the pre-service teachers' answers to the open-ended question into consideration and the interpretations made in relation to these findings were given place.

As a consequences of the analyses, it was decided to accept the research problem as the theme in this study. In relation to this theme, it was determined that the elementary pre-service mathematics teachers stated the points which they took into consideration while developing activities with a total of 161 sentences or words.

Statements reached as a result of the analyzes of the answers given by the pre-service teachers to the research problem were examined under five sub-themes, namely *general, purpose, scope, planning* and *the role of the teacher in implementation.* Moreover, the percentage and frequency values reached as a result of gathering the answers given by the pre-service mathematics teachers to the research problem under these five different sub-themes were given in Table 1, too.

Table 1. Distribution of the sub-themes belonging to the knowledge of the pre-service teachers about the points which they consider while developing activities

	Frequency (f)	**Percentage (%)**
General	8	4.96
Purpose	23	14.28
Scope	23	14.28
Planning	47	29.19
Role of the teacher in implementation	60	37.29
Total	**161**	**100.00**

In the analyses made in the study, it was observed that the statements of the participant pre-service teachers in relation to their knowledge in the process of developing activities for mathematic courses were the ones which they most frequently used (37.29%) in relation to the sub-theme of *the role of the teacher in implementation*. This indicates that the pre-service teachers were aware of the importance of the role of the teacher in implementation in the process of preparing activities. However, the participant pre-service mathematics teachers focused, in order of frequency, on the sub-themes of *planning* (29.19%), *scope* (14.28%), *purpose* (14.28%) and then *general*. It was also observed that the statements used by the pre-service teachers least frequently (4.96%) were the ones which focused on the sub-theme of *general*. This indicates that the pre-service mathematics teachers underwent the process of developing an activity by performing the planning via considering the purpose, on the one hand, and by keeping the role of the teacher in implementation in the back of their minds without disregarding the scope, on the other hand.

The codes determined within the scope of the sub-themes related to the knowledge of the participant pre-service mathematics teachers in the process of developing activities for mathematics courses were explained in detail in the following tables. In Table 2, the frequency and percentage values related to the codes appearing in relation to the pre-service mathematics teachers' *scope, purpose* and *general* sub-themes were included.

Table 2. Frequency and percentage values related to the codes within the scope of the pre-service teachers' General, Purpose and Scope Sub-Themes

General	**Frequency (f)**	**Percentage(%)**
Practicability	3	37.5
Being economical	5	62.5
Total	**8**	**100.00**
Purpose		
Having the aiming at reinforcing concepts	1	4.34
Being appropriate for the new or determined acquisition	20	86.95
Providing permanent learning	2	8.69
Total	**23**	**100.00**
Scope		
Being attractive and avocatory	7	30.43
Establishing relationships between concepts or with daily life	14	60.86
Being in line with the principle of flexibility	1	4.34
Being in accordance with the requirements of teaching programs	1	4.34
Total	**23**	**100.00**

It was seen that the elementary pre-service mathematics teachers made the fewest statements about the sub-theme of *general*, an important part of which (62.5%) was composed of the code of *being economical* and 37.5% of which was composed of the code of *practicability*. The participant pre-service mathematics teachers' example statements about the sub-category of *general* were included. In this scope, while P1-coded pre-service teacher said the following while emphasizing the applicability of the activity. *“A developed activity should be applicable in the classroom environment”*. P18-coded pre-service teacher drew attention to the activity's requiring to be economical by stating that *“an activity should be appropriate in terms of cost”.*

Within the scope of the sub-theme of purpose (86.95%), especially that of *being appropriate for a new or determined acquisition* was the most frequently stated code. This is rather important in terms of showing the pre-service teachers' awareness of the purpose of developing an activity in accordance with an acquisition. This situation *indicates* the pre-service teachers' preferring to plan an activity in order to teach an acquisition. Moreover, the statement which the pre-service mathematics teachers uttered most frequently was related to the code of *being appropriate for a new or determined acquisition*. Almost all of the pre-service teachers' being aware of the activity's requiring to be appropriate for the acquisition is important in terms of their comprehending the acquisition-activity relationship. In this scope, P3-coded pre-service teacher laid emphasis on the purpose of being appropriate for the acquisition by stating that *“attention is paid to the appropriateness of the developed activity for the acquisition”*

However, it is attracting attention that only one pre-service teacher stated the purpose expressed via the code of *aiming at reinforcing concepts* (4.34%). This situation indicates that the pre-service mathematics teachers preferred to prepare an activity during teaching a subject, but they did not prefer to use an activity in an implementation.

In the sub-theme of *scope*, the code of *establishing a relationship between concepts or with daily life* (60.86%) was the most-frequently preferred code. This situation indicates the importance given by the pre-service teachers to relationships both with daily life and between concepts while developing activities. The situation attracting attention in this sub-theme is the small number of pre-service teachers preferring the code of *being in line with the principle of flexibility and the requirements of teaching programs*. This indicates that the pre-service teachers disregarded the planning of alternative situations against unexpected situations in the process of preparing an activity. On the other hand, when we consider the statement made by P12-coded pre-service teacher expressed as *“I pay attention to the activity's establishing an association with daily life”* and the statement made by P14-coded pre-service teacher expressed as “*I pay attention to the activity's establishing a relationship between subjects”*, it is found that the pre-service teachers acted by paying attention to the mathematical association under the sub-theme of scope. Moreover, P14-coded pre-service teacher's statement of

“*I pay attention to the activity's attracting students' attention and interest”*

shows us the importance of activities' attracting students' attention.

Table 3 and Table 4 includes the codes used for the points which the participant pre-service mathematics teachers considered while developing activities for mathematics courses are the scope of the sub-themes of *planning* and *the role of the teacher in implementation*, example statements and the frequency and percentage values of these codes.

Table 3. Frequency and percentage values of the pre-service mathematics teachers in relation to the codes used within the scope of the sub-themes of Planning

Planning	Frequency (f)	Percentage (%)
Determining the students' individual or group works	1	2.12
Planning the implementation by considering the students' class levels, background knowledge and readiness levels	15	31.91
Determining correct implementation methods	3	6.38
Allowing for group and class discussions	3	6.38
Planning the effective use of time and duration	3	6.38
Use of materials and tools which are appropriate for acquisitions	1	2.12
Activity's including sequence and guidance	1	2.12
Classroom organization /organizing the physical environment	4	8.51
Planning evaluation	2	4.25
Being clear, understandable, effective in explaining the given subject	7	14.89
Reaching target	4	8.51
Considering different learning styles	1	2.12
Achieving the understandability of instructions	2	4.25
Total	47	100.00

Table 4. Frequency and percentage values of the pre-service mathematics teachers in relation to the codes used within the scope of the sub-themes The role of the teacher in implementation

Role of the Teacher in Implementation	Frequency (f)	Percentage (%)
Achieving the use of materials in a way which is appropriate for the activity, supportive and facilitates learning	6	10
Providing social interaction and communication	2	3.33
Informing students about the tools and materials used in the activity	3	5
Having students participate actively	22	36.66
The teacher's becoming a role model for students through guiding	17	28.33
Allowing students to learn by themselves	4	6.66
Having students discuss on the given concept by confronting them with alternative interpretations	3	5
Having a good command of the subject	1	1.66
Making the student the owner of the activity	2	3.33
Total	60	100.00

The code of *"planning the implementation by considering the students' class level, background knowledge and readiness levels"* occupies the biggest place (31.91%) among the pre-service teachers' statements about the sub-theme of planning. P10-coded student's statement of *"an implementation should be prepared in accordance with the readiness levels of students"* can be given as an example statement for this sub-theme. Planning the activity by checking the students' class level, background knowledge and readiness levels is an indication of the students' acting by being aware of what they know and don't know in relation to the subject. And this is vital in terms of bridging previous knowledge with new knowledge. However, it is observed that the codes of "*the use of materials and tools which are appropriate for acquisitions, inclusion of sequence and guidance, determining students' individual and group work, considering students' different learning styles"* (1.72%) were the least stated codes. The following statement of the P9-coded pre-service teacher included in the sub-category of planning expressed as *"I pay attention to make the student the owner of the activity*" lays emphasis on the importance of the teacher's having the student active in accordance with the constructivist approach. In addition to this, the statement of P11-coded pre-service teacher expressed as *"I pay attention to class organization"* and the statement of P16-coded pre-service teacher expressed as *"the implementation duration of the activity should be determined well"* are an indication of the pre-service teachers' doing the planning by considering not only the activity itself but also the existing situations and the classroom environment during the implementation of the activity. It is attracting attention that P20-coded pre-service teacher having realized the importance of preparing an activity by considering not only the importance of the acquisition but also the students and their learning styles stated this with the following statement: *"I pay attention to the activity's addressing different learning styles".*

One of the points which the pre-service teachers took into consideration within the scope of the sub-theme of planning was the purpose of "*the activity's being clear, understandable, effective in explaining the subject"* (14.89%). And this statement emphasizes the necessity of the activity's being uncomplicated. Moreover, the pre-service teachers mentioned the necessity of the activity's aiming to achieve permanent learning.

Within the scope of the sub-category of "*the role of the teacher in implementation, the pre-service teachers focused on the codes of achieving students' active participation"* (36.66%) and then, being a role model by guiding (28.33%). And this shows us that designed activities by considering the constructivist approach. While the code of "*having a good command of the subject"* (1.66%) took place in the least-stated code category, the codes of "*achieving social interaction and communication and explaining how students will work"* took place in the next categories in the increasing order, which is in line with the pre-service teachers' acting by being aware of the communication at the point of guiding students while performing an activity in the classroom. When the example statements of the pre-service teachers, for example, that of P17-coded pre-service teacher expressed as *"attention should be paid to make the student active and the teacher be a guide"* that of P13-coded pre-service teacher expressed as *"I pay attention to its being an activity in which the student will be active"* and that of P16-coded pre-service teacher expressed as *"the student should be able to reach information by him/herself at the end of the activity"* are considered, the answers given by the pre-service teachers within the scope of the role of the teacher in the implementation of an activity show us that they tended to develop an activity according to the constructivist approach. However, P9-coded pre-service teacher's statement expressed as "I pay attention to make the student the owner of the activity" lays emphasis on the importance of the teacher's making the student active in accordance with the constructivist approach.

4. DISCUSSION, CONCLUSION and SUGGESTIONS

In this study aiming to reveal the elementary pre-service mathematics teachers' thoughts about the points to which they paid attention while developing activities for mathematics courses, it was observed from the answers given to the research question that the pre-service teachers indicated their thoughts about the research problem via a lot of statements. The participant pre-service teachers' statements including the points to which they paid attention to while developing activities for mathematics courses were gathered under five different sub-themes. It was obtained that the pre-service teachers mostly used the statements related the sub-theme of *the role of the teacher in implementation*. This indicates that the pre-service teachers considered the implementation process and the role of the teacher in implementation while developing an activity and this is very important case. This shows us that the participants are aware of how important the implementation process of the activities is. However, the participant pre-service mathematics teachers focused in order of frequency on the sub-themes of *planning* and then *purpose and scope* and *general*. Not just planning since well-determination of purposes and scpoe in an activity will affect the efficiency of the activity, it is important to determine purposes and scope. And the obtained results indicate that the pre-service mathematics teachers were aware of this.

The answers which the pre-service teachers gave within the scope of the sub-theme of the role of the teacher in implementation indicate that they focused on the student's being active and the teacher's being a role model and tended to develop activities according to the constructivist approach. Active participation of students will support reasoning and thinking skills that will enable them to build new knowledge on top of their old knowledge. The codes of *providing social interaction and communication and having students discuss on the given concept by confronting them with alternative interpretations* are in accord with the pre-service teachers' acting by being aware of the communication at the point of guiding students while performing an activity in the classroom. The emphasis laid on making students active via the code of making the student the owner of the activity is attracting attention. Ozturk and Isik (2018) stated that the pre-service teachers took the students' levels and active participations into consideration while preparing activities, which seems to support the findings of the study. In addition to these, the emphasis of the pre-service teachers on the point of ensuring that the materials are used in a way that is suitable for the activity, supportive and facilitating learning is also very important. The thoughts that the materials used can create an obstacle to learning if they are not applied with a planning that supports teaching and facilitates learning (Bell, 1993; Swan, 2008) support the results of the study.

Within the scope of the sub-theme of *purpose,* especially the code of *being appropriate for a new or determined acquisition* is rather important in that it indicates the pre-service teachers' being aware of the purpose of performing an activity which is appropriate for an acquisition. Studies in which it is emphasized that activities should be suitable for learning outcomes (Ainley et al., 2006; MacGrekor, 2004; Ozmantar & Bingolbali, 2010; Stylianides & Stylianides, 2008) also support the results of the research. However, when we consider the importance of determining a purpose in different activities, the finding that the pre-service teachers planned an activity for the explanation of a new subject indicates that the pre-service teachers had top awareness levels. In contrary to this, that only one pre-service teacher expressed the purpose of *reinforcing* concepts indicates that the pre-service teachers preferred to prepare an activity during the teaching of a lesson, but they did not prefer to use an activity aiming at implementation or reinforcing. The results reached by Ozturk and Isik (2018) and Toprak et al., (2014) in the way that the activities developed under the component of purpose aimed to realize one learning at most and have students comprehend a new subject seem to parallel the findings of the present study. Contrary to this, the finding reached by Toprak et al., (2014) in the way that the second purpose was to reinforced the learned concept(s) contradicts with the ones which were obtained in this study. One of the points to which the pre-service teachers paid attention within the scope of the sub-theme of purpose was the activity's aiming to achieve permanent learning. Ugurel et al., (2010) state that activities should allow for permanent and effective learning, which seems to support the study's results.

In the sub-theme of *scope*, the code of *establishing a relationship between concepts or with daily life* was the most-preferred code. This indicates that the pre-service teachers generally attached importance to the establishment of mathematical relationships both with daily life and between concepts while developing activities. And this will make a contribution to their meaningful learning. Haciomeroglu's (2018) study which seems to support study's results. In addition, the studies stated that daily life situations should be included in the activities (Doerr, 2006; Stylianides & Stylianides, 2008; Francom & Gardner, 2014) support the results of the research. Another situation attracting attention in the sub-theme was that only a few pre-service teachers preferred the code of *being in line with the principle of flexibility*. And this indicates that the pre-service mathematics teachers ignored to plan alternative situations against unexpected situations in the process of developing an activity. Moreover, the statement of the pre-service teachers expressed as *"I pay attention to the activity's drawing students' attention and interest"* is an indication of how activities are important in attracting students' attention. In the study made by Doyle (1988), the necessity of the activity's arousing students' interest and being accomplishable seems to support the result of the study. In addition to this, the fact that Brooks and Brooks, (1999) and Watson and Mason (2007) emphasize that the activities should be in a way that arouses curiosity, supports the result of the research.

Of the pre-service teachers' statements belonging to the sub-theme of *planning*, the code of *planning the implementation by considering the students' class levels, background knowledge and readiness levels* was the most-preferred code. Planning by considering students' grade levels, prior knowledge and readiness levels is an indication that pre-service teachers act by taking their knowledge into account. It is observed that the pre-service teachers were aware of the great importance of background knowledge to build a bridge between background knowledge and new knowledge. In their study, Ozmantar and Bingolbali (2009) mentioned the necessity of preparing activities in accordance with students' background knowledge because of the necessity of establishing association with their background knowledge in order to make the activity reach its purpose, which, at this point, supports the results of the study. The findings of the present study, which emphasized the necessity of taking students' background knowledge into consideration overlap the findings of the study made by Olkun and Toluk-Ucar, (2006) and Ozmantar and Bingolbali (2009). In their study, Elçi, Bukova-Guzel & Alkan, (2006) emphasized the importance of associating the activities with other disciplines and background knowledge while designing the activities, which supports the results of the present study. On the contrary, it was obtained that the codes of *using materials and tools which are appropriate for acquisitions*, *Including sequence and guidance*, *Determining students' individual or group works* were stated least frequently. In their study, Toprak et al., (2014) determined that the most-preferred implementation style was the teaching with a small (collaborative) group according to the implementation styles of the designed activities, which supports the findings of the study. In addition to this, the pre-service teachers' statements expressed as *"I pay attention to the class organization"* and *"the implementation duration of the activity should be determined well"* are an indication of the fact that the pre-service mathematics teachers did planning by considering not only the activity itself but also the classroom environment during the implementation of the activity. The study in which Swan (2007) emphasized the necessity of specifying how classroom organization is required to be in order to carry out an activity healthily supports the results of the study. In addition, encouraging the evaluation of a student's idea by the group (Ayalon & Even, 2016) is important in the organization of the classroom environment. Besides to this, the findings indicating the pre-service mathematics teachers' taking the classroom environment and the activity's implementation duration into consideration overlap those of the study made by Ozturk and Isik (2018). Not only that, Francis-Smythe and Robertson (1999) support the study's result that the teacher should predict both the time allotted for the activity and the attention to be paid during the use of this time. And this indicates that the pre-service mathematics teachers prepared the activity by taking not only the activity but also the situations existing when take into consideration the activity implementation.

Moreover, the elementary pre-service mathematics teachers made the fewest statements about the sub-theme of *general*. It was observed that while a considerable number of them used the code of *being economical*, fewer of them used the code of *practicability*. Although it was not stated by many pre-service teachers, the activity's being economical and practical in the classroom indicates that they are the situations considered at the last point. In fact, the interaction between the characteristics of the classroom and the teacher and the mathematical subject, on the one hand, activates the mathematical content that is open to learning in the classroom (Ayalon & Even, 2016), on the other hand, makes the activity practicable.

When we evaluated the study in the general sense, it was determined that while, on the one hand, the elementary pre-service mathematics teachers drew attention to many different points in relation to activity development, the number of the pre-service teachers laying emphasis on some points was low, on the other hand. Because of the low number of pre-service teachers laying emphasis on some points, it was concluded that they did not have sufficient knowledge about developing activities. The result, which Ozturk and Isik (2018) obtained that the elementary pre-service teachers did not have sufficient knowledge and experience about preparing activities overlaps the results of the present study. In the context of all these results, the following suggestions are made:

- It is suggested that similar studies should be made to increase the awareness levels of pre-service mathematics teachers in relation to the concept of activity.
- Elementary pre-service mathematics teachers should be given applied courses aiming to develop their skills in relation to the process of developing activities.
- Pre-service mathematics teachers can be made to perform activity preparation works in the teaching practice course with the aim of having them acquire experience in relation to the activity development process.

Pre-service mathematics teachers can be given training to develop their insufficiencies having appeared as a result of the study in relation to activity development.

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Abstract

Every individual is different from each other, and learning processes can also differ from each other. Therefore, individuals' learning styles may differ from other individual to individual. The purpose of this research is to investigate the learning styles of pre-service teachers in terms of gender, department and class level variables. The survey model, one of the non-experimental research designs, was used in the research. "Kolb Learning Style Inventory" was used as the data collection tool in the research. The sample of the research consists of 328 pre-service teachers who are studying in the 1st, 2nd, 3th and 4th classs of elemantary school teaching (n = 172) and mathematics teaching (n = 156). The data obtained by the Kolb Learning Style Inventory were analyzed using descriptive statistics and chi-square test. As a result of the findings, it was observed that the differentiation of pre-service teachers' learning styles according to their departments, genders and class levels was not statistically significant.

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Research Article

Examining the Learning Styles of Teacher Candidates in Terms of Different Variables *

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Abstract

Every individual is different from each other, and learning processes can also differ from each other. Therefore, individuals' learning styles may differ from other individual to individual. The purpose of this research is to investigate the learning styles of pre-service teachers in terms of gender, department and class level variables. The survey model, one of the non-experimental research designs, was used in the research. "Kolb Learning Style Inventory" was used as the data collection tool in the research. The sample of the research consists of 328 pre-service teachers who are studying in the 1st, 2nd, 3th and 4th classs of elemantary school teaching (n = 172) and mathematics teaching (n = 156). The data obtained by the Kolb Learning Style Inventory were analyzed using descriptive statistics and chi-square test. As a result of the findings, it was observed that the differentiation of pre-service teachers' learning styles according to their departments, genders and class levels was not statistically significant.

Keywords: : Kolb learning style, learning, learning style, pre-service teacher

1. INTRODUCTION

Every individual is different from each other, and learning processes can also differ from each other. Therefore, individuals' learning styles may differ from other individual to individual. Özbay (2006) stated that students have different learning needs and styles, so students cannot benefit from educational activities equally. Knowing one's own learning style and engaging it in the learning process will help his/her learn quickly and be successful in this process (Biggs, 2001). When considered from another point of view, it is necessary for teachers to know the learning styles of their students in order to realize an effective learning and it becomes important.

The teacher, who knows the learning style of his student, can design an appropriate educational environment and teach. Individuals' learning styles may also vary according to age, gender, academic achievement, and culture (Özer, 1998). For this reason, individuals' learning style is not evaluated as good or bad, it can be said that they have different learning styles. Learning style; In addition to the similarities between people while learning and communicating with others, it is the style that affects the individual's individuality, the individual's use of different ways in preparation for learning, learning and remembering, while walking, playing, writing, sitting, at every moment and dimension of life (Vural, 2004). Many definitions of learning styles have been made. One of these is the ways that

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the individual will find his / her own in the process of receiving and processing information, made by Kolb (1987). In Kolb's learning model, the learning styles of individuals are in the form of a cycle and it can be determined where the individuals take place in this cycle. There are 4 learning styles in this cycle.

These are: "Concrete Experience", "Reflective Observation", "Abstract Conceptualization" and "Active Experimentation".

• "Feeling" for Concrete Experience,
• "Watching" for Reflective Observation,
• "Thinking" for Abstract Conceptualization,
• Learning by "doing" for Active Experimentation.

However, there is no single form that determines the learning style of the individual. Learning style of each individual is a component of these 4 basic forms. For this reason, it is placed in a learning situation by combining various situations. The most appropriate learning style is determined by the sum of the individual's scores. These learning styles are;

• *Accomodating *Assimilating *Diverging *Converging.

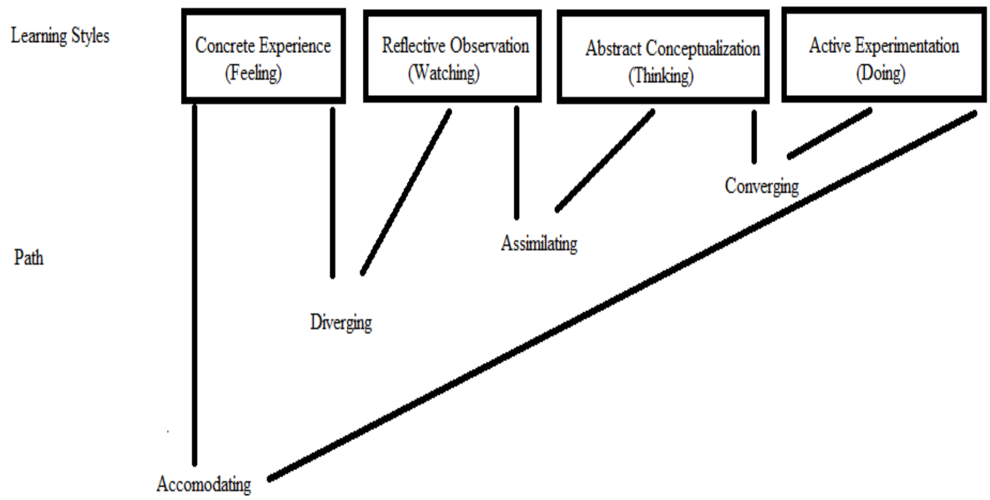

Figure 1.Kolb learning model

The characteristics of individuals with these learning styles are stated as follows. (Aşkar & Akkoyunlu, 1993; Ekici, 2003; Stice, 1987):

• Converging: It covers the forms of Abstract Conceptualization and Active Experimentation. Problem solving, decision making and logical analysis of ideas and systematic planning are its main features. Individuals involved in this learning style are successful in problem solving. The individual makes systematic planning while solving problems. Learning by doing is important.

• Diverging: It covers te Concrete Eperience and Reflective Observation. The most important feature is the ability to think, aware of values and meanings that is. In the learning situation, he/she is patient, objective, one who judges carefully but does not take any action. He/she takes into account his/her own thoughts and feelings while shaping his thoughts.

• Assimilating: It covers the Abstract Conceptualization and Reflective Observation. Creating conceptual models is its most distinctive feature. While learning things, he/she focuses on abstract concepts and ideas.

• Accomodating: It covers Concrete Experience and Active Experimentation. Planning, making decisions and taking part in new experiences are its main features. In the learning situation, individuals are open-minded and easily adapt to changes (Kolb, 1984). There is learning by doing and feeling.

Determining students' learning style and teaching in this direction provides a statistically significant increase in positive attitude towards teaching and academic achievement (Given, 1996). When considered from this point of view, it is of great importance for pre-service teachers who will train students to have knowledge about learning styles and to realize an educational environment that takes students' learning styles into account (Kılıç, 2002). In this context, in this study, it was aimed to reveal the learning styles of prospective teachers and to determine whether there is any differentiation according to gender, department and grade level.

2. METHOD

2.1. Research Model

Since the research aims to determine the learning styles of pre-service teachers in terms of different variables, the survey model, one of the non-experimental research designs, was used in this research. The survey model aims to describe a past or present situation as it is (Karasar, 2012).

2.2. Research Sample

In this research non-random sampling method, the convenience sampling method was used. The sample of the research consists of a total of 328 pre-service teachers who are researching in the first, 2nd, 3th and 4th classs of classroom teaching (n=172) and mathematics teaching (n=156) departments at a state university.

2.3. Instrument

The "Kolb Learning Style Inventory" was used as the data collection tool. This inventory was created by Kolb (1985) and translated into Turkish by Aşkar and Akkoyunlu (1993). Inventory consists of 12 items and each item contains 4 options. Cronbach Alpha reliability coefficients of the inventory were determined as .58 for concrete experience, .70 for reflective observation, .71 for abstract conceptualization, .65 for active life, .77 for abstract-concrete, and .76 for active reflector. The lowest score that can be obtained from this scale is 12, and the highest score is 48. (Aşkar & Akkoyunlu,1993).

2.4. Data Analysis

The data obtained by the Kolb Learning Style Inventory were analyzed using descriptive statistics and chi-square test. This technique tests whether two classified (categorical) variables are independent of each other. In other words, it is determined whether the groups differ in terms of the answers given (Büyüköztürk, 2002)

3. FINDINGS

In this section, findings related to the dominant learning styles of pre-service teachers and whether the dominant learning styles differ at the level of gender, department and class are presented.

Table 1. The dominant learning styles of pre-service teachers according to the departments they research

		Converging	Diverging	Assimilating	Accomodating	Total
Maths	N	43	35	25	53	156
	%	27.6	22.4	16	34	100
Science	N	39	37	44	52	172
	%	22.7	21.5	25.6	30.2	100
T	N	82	72	69	105	328
otal	%	25	22	21	32	100
$\chi 2$=4,723 df=3	p=.193					

Considering the distribution of pre-service teachers' learning styles according to the departments they research in, 27.6% of the pre-service teachers who have a converging learning style are in Mathematics Education, while 224% are in Science Teaching. While 22.4% of the pre-service teachers who have a diverging learning style are in Mathematics Education, 21.5% are in Science

Teaching. While 216% of the pre-service teachers with assimilating learning style were in Mathematics Teaching, 25.6% were in Science Teaching. While 34% of the pre-service teachers who have a accomodating learning style are in Mathematics Education, 30.2% are in Science Teaching. As a result of the $\chi 2$ test conducted to determine whether this change in learning styles according to departments is statistically significant or not [$\chi 2 = 4.723$; df = 3; p = .193> .05] it was found that there is no significant difference. In other words, the learning styles of the pre-service teachers do not differ according to their departments.

Table 2. Dominant learning styles of pre-service teachers according to class levels

		Converging	Diverging	Assimilating	Accomodating	Total
1.Class	N	23	19	16	40	98
	%	23.5	19.4	16.3	40.8	100
2.Class	N	16	19	12	26	73
	%	21.9	26	16.4	35.6	100
3.Class	N	18	17	19	23	77
	%	23.4	22.1	24.7	29.9	100
4.Class	N	25	17	22	16	80
	%	31.3	21.3	27.5	20	100
Total	N	82	72	69	105	328
	%	25	22	21	32	100
χ2=12,791	df=3	p=.172				

Considering the distribution of pre-service teachers' learning styles according to their class levels, 23.5% of pre-service teachers who have a converging learning style are first class, 21.9% are 2nd class, 23.4% are 3th class and 31.3% is researching in the 4th class. Of the pre-service teachers with a diverging learning style, 19.4% were in the first class, 26% were in the 2nd class, 22.1% were in the 3th class, and 21.3% were in the 4th class. 16.3% of the pre-service teachers with assimilating learning style research in the first class, 16.4% in the 2nd class, 24.7% in the 3th class and 27.5% in the 4th class. On the other hand, 40.8% of the pre-service teachers who have a accomodating learning style research in the first class, 35.6% in the 2nd class, 29.9% in the 3th class and 20% in the 4th class. It was determined whether this change seen in learning styles according to the class levels studied was statistically significant. [$\chi 2=12,791$; df=3; p=.172>.05]. In other words, the learning styles of the pre-service teachers do not differ according to their class levels.

Table 3. Dominant learning styles of pre-service teachers by gender

		Converging	Diverging	Assimilating	Accomodating	Total
Female	N	57	52	47	76	232
	%	24.6	22.4	20.3	32.8	100
Male	N	25	20	22	29	96
	%	26	20.8	22.9	30.2	100
Total	N	82	72	69	105	328
	%	25	22	21	32	100
χ2=.502	df=3	p=.918				

Considering the distribution of pre-service teachers' learning styles by gender variable, 24.6% of the pre-service teachers who have a Converging learning style are female, while 26% are male. While 22.4% of pre-service teachers with a Diverging learning style are female, 20.8% are male. While 20.3% of the pre-service teachers with assimilating learning style are female, 22.9% of them are male. While 32.8% of the pre-service teachers with the Accomodating learning style are female, 30.2% are male. As a result of the χ 2 test performed to determine whether this change in learning styles according to gender variable is statistically significant or not [$\chi2 = .502$; $df = 3$; $p = .918 > 0.05$] it was found that there is no significant difference. In other words, the learning styles of pre-service teachers do not differ according to their gender.

4. DISCUSSION and CONCLUSION

According to the findings obtained from the learning styles preferred by the pre-service teachers according to the departments they research in, it was determined that the mathematics pre-service teachers mostly used accomodating learning style and the least assimilating learning style, and when the science pre-service teachers were examined, they used the most accomodating learning style and the least Diverging learning styles. In their research, Aşkar and Akkoyunlu (1993), who conducted studies to translate the Kolb learning style inventory into Turkish, collected data from 103 adults and found that the participants used the learning style that was the most assimilating and the least accomodating. In his research, Ekici (2013) found that according to the findings he obtained from students researching in different departments, pre-service teachers preferred the most diverging learning style and the least assimilating learning style. Kaf-Hasırcı (2006), in his research investigating the dominant learning styles preferred by classroom teacher students, determined that pre-service teachers preferred the most assimilating learning style as the least accomodating learning style. The researches conducted on the shaping of the learning styles of individuals, psychological characteristics, areas of specialization, professions; reveals that factors such as their work and adaptability are effective (Aşkar & Akkoyunlu, 1993; Gregorc & Butler, 1984; Kolb, Boyatsız & Mainemelis, 2000; Kolb & Kolb, 2005).

Another finding obtained in the research is that the learning styles of prospective teachers do not differ according to their gender. Altun and Yılmaz (2016) could not find a significant difference between learning styles and gender in their research with mathematics pre-service teachers. Similarly, Özsoy, Yağdıran and Öztürk (2004) conducted a research with 2ndary education students and found that there was no statistically significant relationship between learning styles and gender in their research. There are studies in the literature that support the findings of our research (Akgün, 2002; Can, 2011; Güneş, 2004; Köseoğlu, 2009; Özgür, 2013). When the studies investigating the learning styles and gender relationship are examined, it is seen that different results have been reached. In some studies with samples of university students and adults, it has been revealed that there are significant relationships between learning styles and gender. (Davis, 1998; as cited from Severines and Dam, Whitcomb, 1999; White, 1994; Tuncer, Dikmen, & Akmençe, 2018). Another finding obtained from the research is that it is not statistically significant for pre-service teachers to differentiate their learning styles according to class level. Özgür (2013) found in his research with Böte students that class level was not effective in learning style preferences. Similarly, Arsal and Özen (2007) and Kaf-Hasırcı (2006) stated in the research they conducted with classroom teacher students that class level had no effect on learning style preference. On the contrary, Durdukoca and Arıbaş (2010) found that class level makes a significant difference in learning style preference. It may be suggested that prospective teachers who will train future students should be aware of their students' learning styles and plan by considering their learning styles while organizing their learning environments. While determining the dominant learning styles preferred by students, studies can be conducted to look at the effects of different variables.

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Abstract

The research was carried out to reveal the discourses, behaviors, and practices of principals working in middle schools in Turkey and Ohio, the US, evaluate them in terms of values education, and compare the two countries. The study is a case study design, one of the qualitative research designs. The research was carried out in two phases, the first phase was in Turkey in 2018-2019 and the second phase was in the US between 2020 and 2022. Totally 24 teachers participated in both countries (12 Turkey and 12 US). As a result of the research, it was found that there are some similarities and differences between the two countries; some suggestions are given according to the research findings. Chromebooks and free lunch can be provided to students by the Turkish Ministry of National Education, and principals in Turkey can communicate more with students by spending their lunches and breaks.

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Research Article

Comparison of Principals' Discourses, Behaviors, and Practices towards the Students in terms of Values Education: Turkey and The US Sample *

Bilgen KIRAL [1]

Abstract

The research was carried out to reveal the discourses, behaviors, and practices of principals working in middle schools in Turkey and Ohio, the US, evaluate them in terms of values education, and compare the two countries. The study is a case study design, one of the qualitative research designs. The research was carried out in two phases, the first phase was in Turkey in 2018-2019 and the second phase was in the US between 2020 and 2022. Totally 24 teachers participated in both countries (12 Turkey and 12 US). As a result of the research, it was found that there are some similarities and differences between the two countries; some suggestions are given according to the research findings. Chromebooks and free lunch can be provided to students by the Turkish Ministry of National Education, and principals in Turkey can communicate more with students by spending their lunches and breaks.

Keywords: Principal, student, value, discourse, behavior

1. INTRODUCTION

An important requirement of humanity is values (Schwartz, 2012), which have not lost their importance from the past to the present and which must be passed on to future generations (Doring, et al., 2015). People make judgments based on criteria such as good, bad, useful, useless, desirable, undesirable, valuable, worthless. These judgments also create values (Lee & Manzon, 2014). Values are accepted concepts or beliefs (Finegan, 2000), behaviors or expressions desired by people (Schwartz, 1992). In short, values are beliefs, standards, and principles that guide the behavior of individuals (Lyons, Higgins & Duxbury, 2010). It is primarily the duty of the family to transfer values to children. Afterward, this process continues in schools.

It is the responsibility of both teachers and principals to show values in education to students with their communication and behaviors, to be role models for them. In fact, principals play a leading role in values education by using various practices and communication ways to keep school culture and climate (Eksi & Okudan, 2011). In this age when value judgments begin to decline, it is important to reveal the communication of principals in different countries towards students. For this reason, in the study, firstly, a literature review was conducted on the studies of principals on communication, behavior, and values education; secondly, the discourses, behaviors, and practices of principals working in middle schools in Ohio, the US, and Turkey were evaluated in terms of values education and the two countries were compared.

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1.1. Literature Review

Children learn the values primarily from their families, peers, playgroups, society, and media (Halstead & Taylor, 1996). This coincides with the first years of children's development. Afterward, children who start school learn different values from school (Halstead, 1996). Schools have a diverse range of roles. These roles include transferring the values existing in the society to children, enabling them to form value judgments, and enabling children to understand, thinking about and apply values to their lives (Halstead & Taylor, 2000). The aim of values education in schools is to create a healthy, consistent, and balanced personality (Meydan, 2012).

When it comes to values education, it is not just the education given for values; it also includes citizenship and moral education (Halstead & Taylor, 2000). When values education is examined, actually as a part of public education (Veugelers & Vedder, 2003), it is seen that it is a very important issue that should be supported in schools (Veugelers & Vedder, 2003). For this reason, states do deliberate enculturation through schools to bring various values to their citizens and keep the existing culture (Kıral, 2018). Placing the values desired by the child in the family, school, and society guarantees the continuity of society and culture (Doring et al., 2015).

The interest in values education started in the second half of the 20th century. In the 50s, the emphasis of values education was on harmony in society. In the 60s, democracy, social responsibility, and self-actualization in education and in the whole society were emphasized in values education. In the 80s, values were among the less used concepts in educational practices and teachers' activities, and it was seen that concepts such as technical and instrumental thinking were dominant, in the 90s, it is observed that there was a tendency toward value systems consistent with society (Veugelers & Vedder, 2003). Today, it can be said that importance is given to teaching universal, national, and spiritual values through values education.

Programmed studies on values education are carried out in schools. Transferring, placing, and disseminating values education to students is a responsibility not exclusive to the teacher. School principals also play a leading role in values education practices by using various communication and education paths (Ekşi & Okudan, 2011). Since many duties of the school principal are carried out in the presence of others, it benefits the entire school community. This includes respecting each individual and making them feel special, communicating honestly, accurately, and to the point, fostering self-confidence in those around them, and being caring (Riehl, 1998). Barker (2011) said that if you cannot communicate, you cannot be a principal.

It has been determined that firstly feature of effective principals is to communicate effectively; secondly, to have a high level of motivation to people, and the last feature is to make the organization function as a team (Barker, 2011; Robbins, 2003). Bursalıoğlu (2010) states that principals will be effective by communicating and behaving to change people's behavior and affect them, establish an effective communication network, develop relationships between individuals, groups and teams, and coordinate individuals.

In short, the principals should become leaders by using the communication process effectively. There are some studies on it. Fidan's (2013) study determined in the relationship between the communication skills of principals and organizational values was investigated, it was concluded that organizational values are also high in a school where communication skills are high. As a matter of fact, Lickona (1991) states that with their words and behaviors, principals should be role-models for students, they should carry out moral leadership by carrying and reflecting ethical characteristics, and they should be pioneers and guides in adding value and creating a character.

The studies carried out also support administrative communication. Fidan and Küçükali (2014) determined that there is a moderate, positive, and significant relationship between the principals' communication skills and the schools' values. Gürgen (1997) and Tutar (1997) state that values and communication are complementary to each other for schools. Vurgun and Öztop (2011) concluded in the research they conducted to reveal the importance of values for the organization and administration and concluded that the values affect the perceptions of the principals about individual and organizational success, their relations with people, and their decisions.

Duer, Parisi, and Valintis (2002) conducted several studies on students and parents in two high schools and one secondary school in the US. These include meetings involving values, activities embedded in the course, story analyzes with values, and dramas, etc. A program was prepared and implemented. Davidson and Stokes (2001), determined 25 basic values for primary schools, and the effect on students was investigated by processing a value every week. As a result, it was concluded found that four-fifths of the students showed improvement in their behavior, and two-thirds of the parents communicated better with their children and started to take care of them more closely. As a result of the research, participants stated that this education positively affects students, discipline problems, violence, disrespect, etc. stated that the problems were reduced.

As seen in the studies mentioned above, studies related to communication and values positively affect students. It can be said that teachers and principals have an important role in this. Because principals are the people in front of the school's eyes and they are the people that teachers and students constantly see and communicate with (Açıkalın, Şişman & Turan 2007), they should exhibit exemplary behaviors and play a leading role in communication (Illich, 2012). Principals have a key role in the survival of the school, revealing the values and achieving the school goals (Mullins, 2005). Through communication, principals can influence people, make them work, unite groups and change people's behavior (Pradhan & Chopra, 2008). They can spread values through communication, bring people together, create school culture and keep existing ones alive (Berkowitz & Bier, 2004).

There are several reasons why values education studies are given importance and applied: Disruption of traditional family structure, erosion of the value system of key institutions, secondary perspective to the value system, declining work ethic, reduced civil responsibility, and disrespect for authority, dishonesty, violence, and moral ignorance. It is seen that studies have begun to be carried out due to disturbing trends in the population (Demmon, Rice & Warble, 1996). The decrease in value judgments is experienced in different countries. For example, according to the Turkish Statistical Institute (2021) data, the number of incidents involving children coming to or brought to the security unit in 2020 is 114,038. These children's 31.4% were injured, 30.5% theft, 5.0% using, selling or buying drugs or stimulants, 4.4% were threatened, 3.4% violation of passport law. While a total of 18,859 transactions were made regarding juvenile crimes in 2005, this rate increased to 114,038 in 2020.

When all 2019 crime rates of children were examined in the US, it was determined that there were 696,620 arrests. Simple assault 126,130, property crime index 119,790, drug abuse violations 81,320, larceny-theft 83,690, disorderly conduct 53,990, violent crimes 44,010, vandalism 31,950 are seen as the most committed crimes. Between the years 2010-2019 are examined, the crime rates are 58%. It is seen that it decreased by 24% between 2015-2019 and 4% in 2018-2019 (US Department of Justice, 2020). When these official statistics are compared, it is noticeable that the crime rate in Turkey has increased over the years, while in the US has decreased. It can be concluded that the subject of values education should be handled sensitively, and researching the values education system and revealing relevant studies carried out in US schools might be effective in guiding other countries.

Many studies on values education are available in the literature (Eksi & Okudan, 2011; Fidan, 2013; Fidan & Küçükali, 2014; Meydan, 2012). While there are studies on different subjects comparing the US and Turkey (such as Gümüş, 2012); no studies directly focusing on the comparison of the values education efforts of school principals in Turkey and in the US were encountered. Only Yenen and Ulucan (2021) compared American and Turkish pre-school programs regarding values education, but they conducted their study through document analysis. It is thought that awareness of the administrators will be created by sharing the data obtained as a result of a comparative research abroad and the application examples with the educators.

Turkish Basic Law of National Education, the inclusion of values in the educational programs since 2005, the decisions of the 20th National Education Council, the 2023 Vision Document, the 2019-2023 Strategic Plan of the Ministry of National Education, the teaching of values education in schools, and the fact that the crime rate has not decreased or even increased despite the implementation of most of the decisions, make it necessary to deal more with this issue, to study intercultural studies and adapt them to the Turkish education system. For this reason, the research was carried out to reveal the discourses, behaviors, and practices of principals working in middle schools in Turkey and Ohio, the US to evaluate them in terms of values education and compare two countries. Based on this general purpose, the following questions were sought.

How the comparison is between Turkey and Ohio, the US:

1. How are the discourses, behaviors, and practices of principals towards students in general within the scope of values education?
2. What are the discourses of school principals towards students in general?
3. What effect do principals' discourses, behaviors, and practices have on students within the scope of values education?

2. METHOD

The study is a case study design, one of the qualitative research designs. According to Creswell (2007), case studies aim to study, reveal and explain current situations in real life within the scope of research. In this study, principals' discourses, behaviors, and practices towards students are a current situation that exists in real life. The effect of these on the student's gaining value has been studied, analyzed, described, interpreted, and evaluated in its context (Merriam, 2009). This study is also a multiple case study. Because the data was collected from different countries (Paker, 2017). According to Zainal (2007), when a study is conducted on more than one situation or on a group of participants, the validity of the study increases.

2.1. Participants

While selecting schools within the aim of the research, the criterion sampling method was used (Patton, 2014). These schools are urban immigration region middle schools and public schools where the children of families from middle/lower socio-economic level. The study was two phases. In the first phase was in Turkey, the participants consisted of migration region middle schools with similar profiles in the Aegean Region in 2018-2019. While choosing the teachers, different gender, branch, and seniority at school were preferred, and the maximum diversity sampling method was used. The reason for using maximum diversity in purposive sampling methods is to benefit from different perspectives (Patton, 2014) and diversity spectrum (Glesne, 2012). The aim is to monitor the diversity of views to the maximum extent possible. Thus, what is tried to be done is to reveal the commonality and similarities between various situations (Yıldırım & Şimşek, 2005). 12 volunteer teachers participated in the research. Three of them are male and nine of them are female teachers; their seniority is between eight and 27 years.

The second phase was carried out in 2020-2022 in Ohio, the US. The research was conducted in different years in Turkey and the US for a longer period of time because of the pandemic. In the US, like in Turkey, middle, urban immigration region, and public schools were selected for children of middle/lower socioeconomic level families. 12 volunteer teachers participated in the study. 11 females and one male; their seniority is between six and 36 years.

2.2. Data Collection and Analysis

For the purpose of the research, the literature was first read, and then a semi-structured interview form was created. While preparing the form, the opinions of two faculty members who are experts in their fields were taken. A preliminary application was made with a teacher in Turkey, and then the form was given its final shape. The research was planned in two phases. The first phase was in Turkey; the second was in the US. In both countries, official permissions were first obtained to conduct research, and then interviews, observations were started.

The interviews were recorded with the participants' permission, and it was also tried to take notes. After recording, the data was analyzed with the content analysis method. The researcher created codes, categories, and subcategories; and similar statements were combined to reduce of groups. Natural observations were made in both countries for the research. The researcher went to schools from time to time for observations in Turkey. In the US, principals did not want to a stranger in school because of the pandemic. Several observations have been made.

2.3. Validity and Reliability

In this study, the use of multiple methods, triangulation, such as analyst, participant verification, observation, interview, and document review (Patton, 2014) and direct quotations were used for validity (Yıldırım & Şimşek, 2005), and purposive sampling method, making a rich description in the literature review were used. The researcher conducted the study by excluding own prejudice and personal views the research giving importance to professional and academic ethics. She used direct quotations, as it were, without deflecting them. The researcher gave code names to participants such as Zeynep, Aslı in Turkey; Kelly, Margaret in the US.

3. FINDINGS

The findings of the data obtained as a result of observation and interview in the research are presented in this section.

3.1. Principals' Speeches and Discourses (About Values and All Speeches)

The results of the content analysis of the speeches made by the principals in line with the teachers' opinions in Turkey and the US are given in Table 1.

Table 1. Value words used directly from principals

Country	Value Words Used Directly
Turkey	Respect, kindness, responsibility, honesty, justice, have character, tolerance, importance of flag ceremony, love, human values, confidence, to be encouraged, proud, sharing, mercy, freedom, solidarity, rights, law, equality, be fair, to be reliable, helpfulness, conscience
US	Respect, kindness, responsibility, honesty, justice, have character, tolerance, pledge of allegiance, word of the week, safe, responsible, respectful, safety, empathy, thoughtfulness, caring, perseverance, being citizen, consistent, help, PBIS, positive behavior

*First eight values were the same.

As shown in Table 1, it has been determined that the principals of both countries used the words of value directly in their speeches. The same value words used in the two countries were determined as "respect, kindness, responsibility, honesty, justice, have character, tolerance". It is seen that the values used in both countries are universal values. It has been noted, however, that in attention-grabbing US, the "Pledge of Allegiance" is read from the television every morning before class, with students standing up and placing their hands over their hearts. This is an event to bring a national value. In Turkey, a flag ceremony is held every Monday morning before classes and at the end of every Friday evening, and from time to time the importance of the national anthem and flag is recalled. This is an activity to teach a national value of Turkey. A direct quote from the participants in both Turkey and the US is given below.

Be respectful, responsible, and safe. He targets those three. Pieces of information as much as the possible he can. He reminds that almost every conversation with the kids (Maria, US).

The principal also talks to the children in the direction of developing values… that is, being honest or loving school, or the concept of respect, sharing… so these kinds of things are the basis of their conversations (Aslı, Turkey).

It has been determined that the principals have discourses about values without using the word value. These are given in Table 2.

Table 2. No direct value words from principals

No Direct Value Words (Principals don't say respect, responsibility, and love directly)		
Values	Turkey	US
Respect	Not making jokes (physical, verbal etc.) Not to make fun of Not to hurt/harm/interrupt each other/someone else Not to underestimate Not to swear Not to fight Not to speak bad Not using slang words Peer bullying	Talking nice to other students Trying to keep it as a positive attitude
Responsibility	Not bringing school supplies	Charging your Chromebook at night Duties
Love	Calls to girls my pearls, boys my lions	Build commitment Our community Remember "You Are in ……… Community"

When the Table 2 is examined, it is seen that the principals actually point to values without using the value of the words. These values are respect, responsibility and love (building commitment to school). It is seen that the principals in Turkey have discourses about not saying bad words to students, not hurting each other and not making bad jokes. This may be due to the following reason. First of all, there are 10-15-minute breaks between classes in schools in Turkey. Students go out to the garden during this period, go to the canteen, use the restroom, and spend time in classrooms or hallways. There is a same classroom application for students in Turkey. For example, if students are in class 6A, they complete the whole part of the day (if there is no special course) in that class. They spend time with their friends during recess hours. However, there is no such thing as students being in the same classroom all day in the US. Because each teacher has their private classroom, students go to the other teacher's classroom between classes. For this reason, they do not have time to play or spend with their friends.

Another reason is that lunches in US are only eaten at a certain time. Outside of these hours, there is no canteen practice where students can shop with money, and it is forbidden to eat in the corridors and classrooms, except for lunchtime, as per school rules. However, in Turkey, students have at least 40 minutes for lunch. At this time, the student can eat from the school canteen or go home. Apart from that, the school canteen sells food to students for money at every recess. The fact that students in Turkey have more time to spare for each other during recess and lunch breaks may cause various jokes, bad words, or hurt each other from time to time. Direct citations of the participants from both countries are given below.

He says every day without fail "You are in …… Community," which kind of help build community, you are in the part of same thing, same community, same team (Sonya, US).

Every morning, he calls out to the female students at school as "my pearls" and to the male students as "my pieces of a lion" (Murat, Turkey).

All other speeches of principals are given in the Table 3.

Table 3. Principals' all speeches (except value words)

Category	Turkey	US
Discipline	No disrupting the class Behavior problems and how to fix them Violent students School layout Being disciplined Not to disturb the order of the courses	Behavior expectations Behavioral problem Best, positive behavior
Rules	Garden games Recycling Don't throw garbage on the ground Course repetition Social rules School rules Entry-exit hours School uniforms Courses Don't run in the hallways	Walking hallways/hallway rules Keeping your voice too low Not screaming Walk on the right Ask teacher before you leave to go to the restroom Class change rules Cafeteria rules during lunch Raise hands Ask questions Answers School culture School rules Detention
Remind	Cleaning (classroom, school, environmental) Positive behaviors Absenteeism Reading pleasure Study your courses Exams Ladder use Using doors properly Various advice Listening to the teacher	Different quote by someone famous Major events happening Some reminds Anything with you need help Performance Quite Listening Crazy walking Teacher knows where you are Making connections Come back from eating Upcoming events The information that they need to know Environment Birthdays Activities Think Positive person TİK TOK (Social Media)
Project	Clean class project Student of the week Class of the week Reading time project	Word of the week
Honor/ Proud	Award ceremonies Achievements in sports, artistic and cultural activities Commending/honoring students Share students' excitement	You are in advanced We are really appreciating Good students Sports team/some activities Honor award
Other	Special conversations Greetings Daily conversations (how are you? etc.)	Building relationships Greetings General announcement Advisory Daily conversations (how are you? etc.)

As seen in Table 3, it is seen that in both countries, principals' discipline, rules, reminders, expressions of pride for students and other speeches were made. It is expressed in various other projects in Turkey. In fact, it has been observed that various projects have been carried out in the US, although the term project is not directly mentioned in the interviews. Among these, word of the week and competition projects can be given as examples. It is seen that there are more conversations about discipline and rules in Turkey and more reminders in the US. Examples of teachers' views in Turkey and the US are given below.

Ask teacher before you leave to go to the restroom. You know the teacher should know where you are (Margaret, US).

If he notices the students be struggling a little bit. He asks to students "what can I do to help you?" (Talia, US).

In the hallways, you know it is "how are you?" "how is it going?" aware you able to turn in your math assignments?" "how is your parents doing?" "how is your siblings doing?" more general topics (Rose, US).

Pay attention to your actions towards children, keep the environment clean, do not fight, do not swear, study your lessons, he says such things (Fatma, Turkey).

These are emphasized every time the doors in the classrooms are not opened or closed too hard, attending the courses, coming to the classes with the necessary materials, notebooks and books (Yasemin, Turkey).

Being disciplined, respecting their teachers and friends, obeying the classroom order, obeying the discipline at school (Emirhan, Turkey).

3.2. Effects of Principals' Communication with Students

Teachers in both countries think that principals have good communication with students, their speaking has a positive effect on students, and principals are positive models for students. Examples of participant views on this subject are given below.

The much our students come from unparented homes. Many kids come to us without the basic family dynamic you would expect them to have. So we have to raise them much as we possibly can. So those things like responsible, respectful and safe, and important as math and language arts……….you see him interacting with the students probably more than the teachers more than in the hallway. He comes to classes almost every class changes. He speaks definitely about what they doing at lunch with them. He walks back with the kids from lunch. He is very involved with the students (Maria, US).

He is a good model for good positive behavior. And he models respectful, responsible, and safe. He models that (Sonya, US).

I think, his communication is very, very good because our principal is not standing in his room. He is constantly in the garden, inside the teachers' students, or chasing school-related projects, he is always around the school. He is with the students. He has such a communication with the students, for example, every morning he calls the female students at school as "my pearls" and the male students as "my lion pieces". He establishes positive communication within the school. Because of these statements, students love our principal very much (Murat, Turkey).

I have seen that it is gradually imposed on students in this school. What a communicative principal says, he also jokes about students. They hang around with children, that is, they try to get down to their jargon and this means they speak a language that they can understand to catch them, but generally tries to make them feel valued (Zeynep, Turkey).

3.3. Principals' Behaviors and Practices

Similar activities are carried out in both countries to gain students. Principals in both countries address students by name, act as a model for them, reward and honor them in various ways, and chat with students when they see them. Likewise, in both countries, it has been determined that principals do not sit in their rooms except for compulsory situations; they walk in the corridors, canteen, classrooms, in various parts of the school, and are visible in the school. Apart from this, it has been observed that the principals in Turkey attach importance to projects, sportive cultural and artistic competitions and frequently express their pride and honor at the festivals, flag ceremonies and school ceremonies. On the other hand, it has been seen that principals in the US celebrate their birthdays, raise awareness about us, sportive competitions, honor successful students in front of others, in ceremonies, and in TV announcements.

In both countries, school boards and rule posters about values are hung. It has been stated by teachers and observed in school observations that the three values established by the city school district are more strongly emphasized in schools where research is conducted in the US. These are the values of respect, responsibility and safe. Apart from this, the word of the week also indicates a value. In Turkey, on the other hand, although there is the application of the value of the month, there are no value words specifically determined by the provincial directorate of national education. In line with the middle school program, the values determined by the Ministry of National Education are processed.

4. DISCUSSION and CONCLUSION

The research was carried out to reveal the discourses, behaviors, and practices of principals working in middle schools in one city center in Turkey and Ohio, the US, it aims to evaluate them in terms of values education and to compare the two countries. As a result of the research, it was found that there are some similarities and differences between the principals of the two countries. In Turkey, they try to teach national values such as the homeland, the national anthem, and the flag with the flag ceremony held on Mondays to Fridays. In the US, it was noted that attempts are made to teach students national values such as the homeland and the flag with the Pledge of Allegiance, which can be read every morning on the TV. In both countries, principals make speeches before competitions and social events. Teachers, students, and even families are honored in these speeches. Students' achievements and behavior are emphasized. In both countries, the principals know the names and surnames of the students and address them. In both countries, there are boards on which values are displayed. Value words change every month and boards in Turkey; it changes every week in the US. In both countries, principals talk about values almost every day, principals visit the classrooms and are always present in the hallways between the change of classes. Common value words used by the principals of the two countries were respect, kindness, responsibility, honesty, justice, character, tolerance, the importance of the flag. They communicate with problem students between class changes and chat with students face to face. They try to improve their behavior by talking. Their behavior has an impact on the student. Principals in both countries are role models for students. In both countries, the values of respect, responsibility, and love are emphasized both directly and indirectly.

The reason why principals put special emphasis on values is to transfer the values existing in society to children, enable them to form value judgments, and enable children to understand, think about, and apply values to their lives (Halstead & Taylor, 2000). Because the expectations of societies from schools are good citizens, good people, decent society, and people living in values (Yücel, 2011).

Principals should be role models for students and use various communication channels for this

(Eksi & Okudan, 2011). Research already supports this; Fidan and Küçükali (2014); Gürgen (1997); Tutar (1997); Vurgun and Öztop's (2011) studies in Turkey; Duer et al. (2002); Davidson and Stokes' (2001) studies in the US also support this. Through their communication, principals can spread values, bring people together, affect the school climate and culture, and make values living (Berkowitz & Bier, 2004). For this reason, principals have a key role in creating and sustaining values at school (Mullins, 2005).

The research has determined that the principals in Turkey and the US have different discourses and practices. In Turkey, principals especially emphasize the words respect, rules, and school order; in the US, safe, responsible, respectful, positive behavior values are emphasized. It is constantly reminded that principals in Turkey use words of praise for students individually, while those in the US are both individuals and members of the school community. When the principals' different speeches are examined, it is mostly about discipline, rules, and reminders in Turkey; it was found to be most related to rules, reminders, and students' honor in the US.

In Turkey, students gather in school garden every morning and enter the classrooms in turn. On Monday mornings, before the classes and on Friday after the last lesson, the flag ceremony is held in the school garden by singing the national anthem. Principals always make speeches when they gather in the school garden in Turkey. Values, rules, announcements, reminders are made in these speeches. In the US, students enter school in the morning or on a certain day of the week without any ceremony or assembly. Every morning, on TV, the Pledge of Allegiance is read by the students. Principals address students during advisory hour via the classroom television or smartboard. These announcements tell students about important events of the day, upcoming events, birthdays, specific days, and contests. In Turkey, the student has a class to which they belong. In addition, there is time between classes at least ten minutes. During this time, students run and play, go to the cafeteria and spend time in the hallways. By attending the same class all day and with the practice of recess, students spend more time together, which increases their ability to make physical and verbal jokes with each other and to be sincerer. In the US, the teachers have their class. Since students change classes, they do not have time for activities such as resting and playing, have different friends in each class, and do not have recess, they do not have to be sincere and joke with each other as in Turkey. Because they have no time for these. They must go to different teachers' classes.

Students are more likely to get bored and harm their environment in traditional lectures. Courses in Turkey are usually taught with textbooks or smart boards. In the US, the lessons are taught with the textbooks, smart boards, and Chromebooks given by the school and the applications in them. These computers have games related to lessons. Students who are too busy with the computer so that they do not get bored in the lessons. Since they are not bored, they do not harm their environment, do not enter each other's private space, and adopt a more respectful attitude.

In Turkey, the cafeteria is always open throughout the school day until class ends. The students may be late for the lesson while waiting their turn in the cafeteria. This means disrespects to both the teacher and friends. With the pandemic, it provides free breakfast and lunch to all students in the US. Before the pandemic, these were very little cost. Except for lunch, students are not allowed to eat in the classroom or in the hallway. The cafeteria is "only" open for lunch in the US.

There is a need for a discipline system that includes rules and goals in school. Principals; manage the school with the legal texts determined by the state; principals and teachers have the authority to carry out and supervise all the school's works according to the school's rules (Bursalıoğlu, 2010). For this reason, principals should ensure the effectiveness and continuity of disciplinary practices (Akcakoca & Bilgin, 2016). It is the responsibility of principals not to make concessions from the rules and to try to place them in the school culture. Principals should be role models seen throughout the school by displaying effective management and exemplary personality (Garrett, 2015), are responsible for visiting every unit of the school, communicating at school, and solving the problems in the school as soon as possible, not sitting in their rooms (Aydın, 2010).

According to the findings obtained from the research, it is seen that there is absolutely no concession from the rules in the US, and that teachers and principals place this in the school culture by being effective communication and role models to the students. The absence of running, shouting, and eating in the hallways and the cafeteria being open only during lunch time are also related to school and state rules. In addition, the teacher's class and the presence of a Chromebook for each student keep the school tidy. Since our age is communication and technology, children tend to use applications on their computers at school instead of disturbing their environment. Students who change classes can also be evaluated positively as they do not have time to harm each other, disrespect each other, run in the hallways, and play.

In fact, all of the values education studies are to ensure the order of the society. The establishment of values education is possible with communication, being a role model, and the determination of all school stakeholders to establish the rules. The success of value education means a clean, orderly and regulated society with rules, good citizens, good people. This can be done through families and schools. Principals are therefore an important element that must be seen by all.

4.1. Limitations and Suggestions

The research is limited to the opinions of 24 teachers working in schools where families have immigrated and middle/low socioeconomic in a city center in Ohio, the US and Turkey. This study does not include elementary, high, private, and village-town schools. For this reason, similar studies can be conducted with teachers, principals, and parents in these school types. Suggestions such as principals in Turkey talking more to raise community awareness, not making concessions to school rules, starting the practice of teacher classes, keeping the school cafeteria open only during lunch, distributing Chromebooks to students and using them to design lessons can be given. Just like in the US, a text like the Pledge of Allegiance can be read to students every morning to create to love a flag and patriotism in students. Chromebooks and free lunch can be provided to students by the Turkish Ministry of National Education, and principals in Turkey can communicate more with students by spending their lunches and breaks.

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Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Aydın Adnan Menderes University with the decision dated 19/09/2020 and numbered 48692.

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Abstract

In this study, the aim was to examine the effect of the question preparation training program that measures higher order thinking skills on the self-efficacy of science teachers. The research is in a pre-experimental design model with quantitative origin pre-test/post-test application. The example of the study comprises of 25 science teachers working in public middle schools in Çorum. "Question Developing Self-Efficacy Scale Measuring High Level Learning Level of Science Teachers" was used as data collection tool. Descriptive analysis, difference analysis and effect size analysis were used in the assessment of the data. The t-test for dependent samples were employed to compare the teachers' self-efficacy before the application and their self-efficacy at the end of the application. With the research, it was confirmed that the applied training program significantly increased teachers' self-efficacy in preparing questions measuring higher order skills. Herewith, multifarious proposals were made, like turning the training program into a book, and arranging the content of the in-service training programs by considering the items with low item averages.

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Research Article

The Effect of Question Preparation Training Program that Measures Higher Order Thinking Skills on the Self-Efficiency of Science Teachers*

Ahmet BOLAT [1] **Sevilay KARAMUSTAFAOĞLU** [2]

Abstract

In this study, the aim was to examine the effect of the question preparation training program that measures higher order thinking skills on the self-efficacy of science teachers. The research is in a pre-experimental design model with quantitative origin pre-test/post-test application. The example of the study comprises of 25 science teachers working in public middle schools in Çorum. "Question Developing Self-Efficacy Scale Measuring High Level Learning Level of Science Teachers" was used as data collection tool. Descriptive analysis, difference analysis and effect size analysis were used in the assessment of the data. The t-test for dependent samples were employed to compare the teachers' self-efficacy before the application and their self-efficacy at the end of the application. With the research, it was confirmed that the applied training program significantly increased teachers' self-efficacy in preparing questions measuring higher order skills. Herewith, multifarious proposals were made, like turning the training program into a book, and arranging the content of the in-service training programs by considering the items with low item averages.

Keywords: Science teacher, teacher education, measuring and assessment, question preparation, higher order thinking skills

1. INTRODUCTION

Today's individuals are expected to have high-level thinking skills to satisfy the demands of the modern age. For this reason, more emphasis has been placed on higher-order thinking skills in curricula in recent years. High-level thinking skills are also emphasized in the current science curriculum (Ministry of National Education, [MoNE], 2018). Measuring and evaluating these skills has an important place in the improvement of students' higher-order thinking skills (Risner, 1987).

Higher-order thinking skills require using knowledge rather than having knowledge (Wellman, 1997). In particular, the individual should be able to solve real life problems using the knowledge he has. Individuals with high-level thinking skills identify the problem in real life, develop a method for solving the problem, present a hypothesis, test the hypothesis, and decide the correctness of the hypothesis for the solution. In other words, he tries to figure out the issues he encounters in his everyday life with a scientific approach.

Students' higher-order thinking skills can be developed (Greeno, 1989). One of the significant factors in the development phase is teachers. Teachers make crucial contributions to the improvement of students' (pupils') higher-order thinking skills through education. In order to ensure the

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development of higher-order thinking skills, it is necessary to measure and evaluate the level of these skills. High-level thinking skills are difficult to measure because they include many thinking skills. Teachers should have knowledge and experience specific to this subject (Driana & Ernawati, 2019).

When the national literature on high-level thinking skills is searched, it is understood that there are sworks to determine the cognitive levels of the questions in the textbooks (Çakıcı & Girgin, 2012; Doğan, 2019). In their study, Çakıcı and Girgin (2012) analysed unit assessment questions in secondary school science textbooks. According to the research, the questions mostly belong to traditional question types and are intended to measure low-level thinking skills. Doğan (2009) examined the questions in the 4th grade science textbooks in his research. At the end of the research, the questions mostly belong to traditional question types and are intended to measure low-level thinking skills. Similarly, in a study in the international literature, Risner (1987) examined the epistemic level of the questions in the 5th grade science textbook in his research. She determined that the cognitive level of the questions was below the evaluation level and that they were mostly not intended to measure higher-order thinking skills. According to these studies, textbooks give little or no place to high-level thinking skills (Çakıcı & Girgin, 2012; Doğan, 2019; Risner, 1987). According to the research conducted by Akpınar and Ergin (2006), 1% of the questions asked by science teachers in exams measure high-level thinking skills. In the study conducted by Ayvacı and Türkdoğan (2010), the questions in the exams prepared by the 6th grade science teachers were analysed in regard to the revised Bloom Taxonomy. At the end of the research, 32.1% of the questions consisted of high-level questions. Cansüngü-Koray and Yaman (2002) examined the question preparation skills of science teachers according to Bloom's Taxonomy. 3.83% of the questions arranged by science teachers are aimed at measuring high-level thinking skills. In the study conducted by Özüuygun (2004), 26.9% of the questions prepared by science teachers at the 6th grade are questions that measure high-level thinking skills. According to Dindar and Demir's (2006) study, it was determined that 1.25% of the questions prepared by science teachers in the 5th grade class measured high-level thinking skills. In the study conducted by Mutlu, Uşak and Aydoğdu (2003) they classified and compared the questions prepared by the science teachers working in primary schools and the science questions asked in the High School Entrance Exam (HSEE) according to the Bloom Taxonomy. Accordingly, while 1% of the questions prepared by the teachers' measure their high-level thinking skills, 52% of the 2001 and 2002 LGS questions measure their high-level thinking skills. Güven (2014) examined the questions in the science and technology curriculum published in 2006 in his research. At the end of the research, it was determined that the questions in the program were mostly questions measuring low-level thinking skills. In the study conducted by Umur (2019), it was determined that undergraduate and graduate students of science teaching were insufficient in preparing questions suitable for the outcome. Similar results have emerged in studies conducted in the international literature. The questions prepared by both science teachers and teachers of other courses are insufficient to measure higher-order thinking skills (Driana & Ernawati, 2019; Marso & Pigge, 1988).

In his research, Ar (2019) organized an in-service training program on life-based open-ended question preparation for science teachers. At the end of the study, it was determined that there was a positive change in the thoughts of teachers about preparing life-based open-ended questions. In addition, it has been determined that there is research in the quality of life-based open-ended questions prepared by teachers. Similarly, there are studies that support that applied training programs improve teachers' competence in preparing questions that measure high-level thinking skills (Yip, 2004).

According to the national literature examined, it is seen that studies on questions measuring high-level thinking skills in our country are mostly in the screening model. However, it is understood that there are limited number of experimental studies on teachers' question writing competencies or development (Ar, 2019). It is thought that this study will contribute to the literature at this point. It is thought that the development of teachers' self-efficacy in preparing questions that measure high-level thinking skills will be beneficial in the development of teacher competencies. The problem of this study is "What is the change in the self-efficacy of science teachers in preparing questions measuring high-level skills in the Education Program for Measuring High-Level Cognitive Skills?" and accordingly, the aim of the study is to investigate the effectiveness of the question preparation training program that measures high-level cognitive skills for science teachers.

2. METHOD

2.1. Research Design

This research was implemented in accordance with a pre-experimental model with a quantitative approach with pretest-posttest application. In this research method, a pre-test is performed to state the level of behaviour of the teacher or students in any subject before the application, and a post-test is applied to determine the level of behaviour at the end of the application. However, there is no control group in the study. The aim here is to reveal the impact of the interference applied to the empirical group on the development of the determined skill (Çepni, 2010). In this study, the change in the self-efficacy of science teachers in preparing questions measuring high-level skills of the "Training Program for Measuring "Higher Order Thinking Skills" applied to the experimental group was examined.

2.2. Universe and Sample

The universe of the research comprises of science teachers working in public middle schools in Çorum in Turkey. The sample of the study is 25 science teachers who worked in Çorum in Turkey and participated in this study. In the selection of the sample, the typical case sampling technique was used from non-probability based sampling techniques. Purposeful typical sampling the sample consists of individuals with an average level of knowledge who are representative of the universe and are considered appropriate for the purpose of the research (Canbazoğlu-Bilici, 2019). Since the thesis study in which this study was obtained was conducted in the field of science education, science teachers were preferred as a sample. The characteristics of these teachers are introduced in Table 1.

Table 1. Statistical distribution of the demographic characteristics of the teachers constituting the sample

Features		f	(%)	Features		f	(%)
Seniority	0-5 Years	1	4	Gender	Male	13	52
	6-10 Years	7	28		Female	12	48
	11-15 Years	8	32		Total	25	100
	16-20 Years	6	24				
	21-25 Years	2	8	Education Level	Licence	20	80
	26 Year and Above	1	4		Master	5	20
	Total	25	100		Total	25	100

While Table 1 is examined, it is understood that the sample is proportionally close to each other with regards to gender, and mostly graduates in terms of education level. In terms of seniority, it is ufound out that the most of teachers have professional experience of 6-20 years. In experimental studies, at least 10-20 sample groups are sufficient for research (cited in Roscoe, 1975; Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2012). Since the sample size of this study is 25, it can be considered that it meets the minimum sample size requirement for an experimental study.

2.3. Research Process

This study aims to investigate the change in the self-efficacy of science teachers in preparing questions measuring high-level skills in the "Training Program for Measuring High Level Cognitive Skills". For this purpose, 16 weeks (96 hours) online training was given to science teachers working in official secondary schools in Çorum.

The training program was developed by the researcher. The program has been developed in accordance with the Taba Curriculum Development Model. The Taba Model attaches importance to the development of the program by the people who will implement the program. The Taba Model is implemented by following the stages of determining entails, determinant aimss, selecting content, organizer content, choosing learning experiences, organizer learning activities, and evaluating (Erişen, 1998).

While developing the education program, the scale used in the research was applied to the teachers. In addition, interviews with teachers were made to determine the competencies and needs of science teachers regarding high-level thinking skills and measurement. In addition, by scanning the literature, information was obtained about the competencies of teachers in this subject. Thanks to these studies, a needs analysis was carried out. Depending on the data derived from the needs analysis, the objectives of the training program were established. According to the established objectives, 4 acquisitions were prepared. In order to achieve the gains, the main subject headings were created. The basic titles are gathered under 5 titles as “Basic concepts and principles in Measurement and Evaluation in Education”, “Higher Order Thinking Skills”, “Question Development”, “Question Development to Measure Higher Order Thinking Skills”, “Basic Stages of the Test Plan Process”. Then, basic headings were listed and subheadings were prepared. The implementation of the training program was made through distance education due to the global epidemic of covid19. Each field expert completed the training in two stages. In the first stage, theoretical education was given, and in the second stage, an application was made depending on the theoretical education. During the applications, the teachers prepared questions according to the theoretical training given in the first stage. Each prepared question was examined by the field expert and feedback was given to the teachers. After the training program was implemented, the scale was applied again.

The training program started to be implemented in March 2021. 14 different trainings were applied to science teachers. Science education specialists, program development specialists and assessment and evaluation specialists took part in the trainings. The trainings were implemented in two sessions each week. Science teachers who participated in the training prepared questions about the achievements in the determined science curriculum. The prepared questions were examined by expert educators and they gave feedback to the teachers.

In the first week of the training, the assessment and evaluation specialist gave training on the basic concepts in assessment and evaluation. As a part of the training, the points to be considered during the preparation of valid and reliable measurement tools are explained within the framework of the concepts of measurement, evaluation, validity and reliability. In the second week of the training, training on high-level thinking skills was given by the program development specialist. Within the framework of this subject, the concept of high-level skills, the determination of high-level skills and high-level thinking skills according to taxonomies are explained. In detail, it was focused on associating higher-order thinking skills with Bloom's Taxonomy. In the third week of the training, a science education expert gave training on the acquisitions and skills in the science curriculum. As a part of education, the study was conducted to analyze and classify the acquisitions in the science curriculum according to the cognitive levels and life skills in Bloom's taxonomy. In the fourth week of the training, open-ended question preparation training was given to measure high-level thinking skills. The training was implemented in two sessions by the assessment and evaluation specialist. Within the scope of the training, open-ended questions, preparing rubrics, and preparing questions measuring high-level skills were studied and questions were prepared.

In the fifth week of the training, multiple choice question preparation training was given by the science education specialist. Within the scope of the training, the subject of writing multiple-choice questions suitable for the acquisitions and skills in the curriculum was explained and a question writing study was carried out. The prepared questions were examined together with the teachers and feedback was given to the teachers. In the sixth week of the training, the multiple-choice question preparation training that measures high-level thinking skills was given by an assessment and evaluation specialist. Within the scope of the training, skills, low-level and high-level thinking skills, real-life situations were emphasized. Then, questions measuring higher-order thinking skills were explained through examples. Multiple choice questions measuring high-level thinking skills were prepared by the teachers, and in the second session of the training, these questions were examined and feedback was given to the teachers. In the seventh week of the training, test development training was given by the science education specialist. Within the scope of the training, the steps of the test development process are explained. After the theoretical training, item and test analysis was carried out using the data of a previously applied science test. After the analyzes, the items to be tested were decided and the final version of the test was created. In the second month of the training, the questions prepared by the teachers were examined in two sessions with the participation of assessment and evaluation specialists, language specialists and science education specialists, and the questions were corrected. The questions designed by the teachers were examined separately with regard to scientific accuracy, measurement and evaluation principles, and grammar, and necessary corrections were made in the questions, and thus practical feedback was provided to the teachers. These sessions were held online for two months. The content of the training program is summarized in Table 2.

Table 2. Subject distribution of the training program by week

Week	Basic Subject	Subtopic
1	Basic Concepts and Principles in Measurement and Evaluation in Education	Measuring Evaluation Validity Reliability
2	Higher Order Thinking Skills	Critical Thinking Skill Analytical Thinking Skill Creative Thinking Skill Decision Making Skill Problem Solving Skill
3	Classification of Acquisitions and Skills	Bloom’s Taxonomy Scientific Process Skills Life Skills Engineering-Design Skills
4	Open-Ended Question Preparation	Open-Ended Questions Rubric Preparation Preparing a Question to Measure High Level Skills
5	Preparing Multiple Choice Questions	Structure of Multiple Choice Problem Multiple Choice Question Types Writing Multiple Choice Questions Appropriate for Acquisitions and Skills Considerations
6	Preparing Multiple Choice Questions that Measure Higher Order Thinking Skills	Low Level Question Higher Order Thinking Skills Question Context and Features Real Life Situations Question Examples

7	Test Development Stages	Determining the Purpose of the Test Question Preparation Question Editing Pilot Application Main Application Item Analysis Choosing a Question for the Test
8	Redaction	

Continuation of Table 2.

9-16.	Redaction	

The study was planned as a single-group empirical design with quantitative approach, pretest-posttest application. The processes of the study are presented in Figure 1.

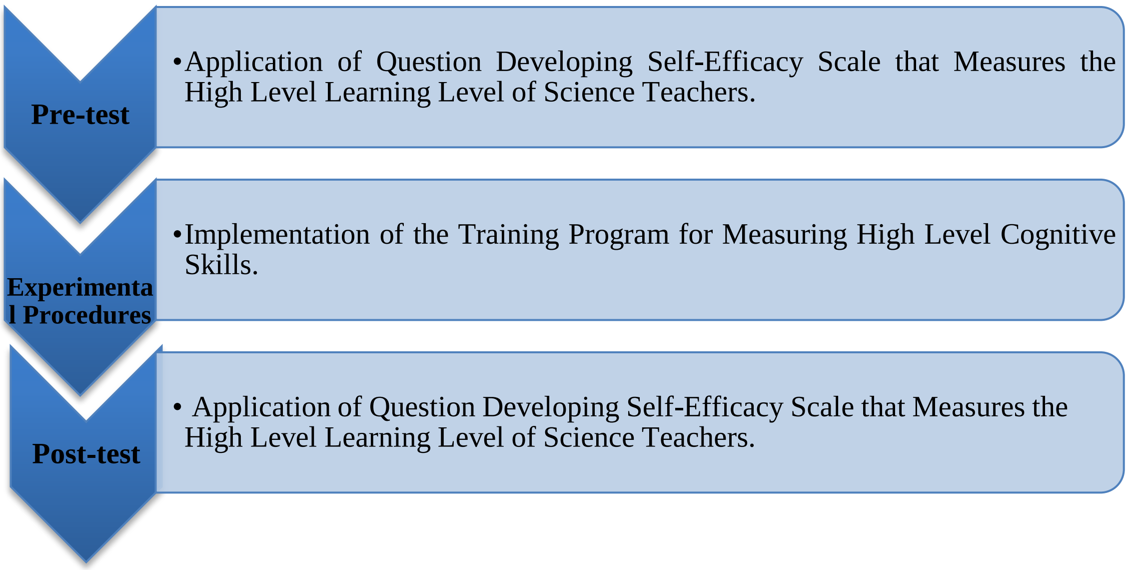


Figure 1. Flow Chart of the Research Process

Before the study, the Question Development Self-Efficacy Scale measuring the High-Level Learning Level of Science Teachers (Bolat, Korkmaz & Karamustafaoğlu, 2021) was applied as a pre-test by the researchers. "Training Program for Measuring High Level Cognitive Skills" was implemented to science teachers for 16 weeks. After the training program, the scale was applied as a post-test.

2.4. Data Collection Tool

In this study, "Question Development Self-Efficacy Scale Measuring Higher Order Thinking Skills of Science Teachers" developed by (Bolat et al., 2021) was used as a data collection tool. The scale is a five-point Likert scale. These options are; strongly disagree (1), disagree (2), undecided (3), agree (4) and strongly agree (5). The scale is a one-dimensional scale comprising of 30 items.

Table 3. Psychometric properties of the scale

Validity				**Reliability**	
Feature	**Value**	**Feature**	**Value**	**Feature**	**Value**
KMO	0,967	x^2/d	2,657	Cronbach Alfa	0,977
x^2	8057,031	RMSEA	0,84	Test Retest r_{min}	0,380 (p< 0,01 and p < 0,05)
sd	435	S-RMR	0,025	Test Retest r_{max}	0,836 (p< 0,01 and p < 0,05)
pp	0	NNFI	0,828	Test Retest r_{top}	0,833 (p < 0,05)
Factor Load (min)	0,713	CFI	0,884		
Factor Load (max)	0,856	GFI	0,768		
Variance Explanation Rate	63,86%	AGFI	0,729		
Continuation of Table 3.					
Common Variance Value	**> 0,50**				
t-test (lower-upper group)	< 0,05				
r_{min}	0,701				
r_{max}	0,826				

When Table 3 is examined, it can be understood that the psychometric properties of the scale are valid and reliable.

2.5. Analysis of Data

For the data analysis of the scale applied in the research, first of all, the arithmetic mean and standard deviation values were calculated. The differences between the individual averages of the items were calculated, and the change in the averages of the items was calculated according to the responses of the participants. According to the pre-test and post-test data obtained from the scale, the t-test was performed to state whether there was a crucial variation between the pre-test and post-test averages. Before the analysis, assumptions were tested for the parametric tests of the data. For this purpose, the dispersion of the data was analysed. When the distribution of the data was analysed, it was understood that the asymmetry and flatness values of both the pre-test and post-test data varied between +1 and -1. Since it was determined that the data were at equal interval scale level and both pre-test and post-test data were normally distributed, t-test was performed for dependent samples (Green & Salkind, 2005). The t-test for dependent samples is performed to state whether there is a crucial variation between the means of the tests if the same test is applied to the same group at certain time intervals (Can, 2019). To calculate the effect size (d) with the t-test for dependent samples, it was calculated by dividing the difference between the means of the measurements by the standard deviation of the series of difference scores [d=Difference between the means of measurement/Standard deviation of the difference scores] (Green & Salkind, 2005). An impact size greater than 1.0 is considered a huge impact, a large effect of 0.8, a medium effect of 0.5, and a minor effect of 0.2 (Morgan, 2004).

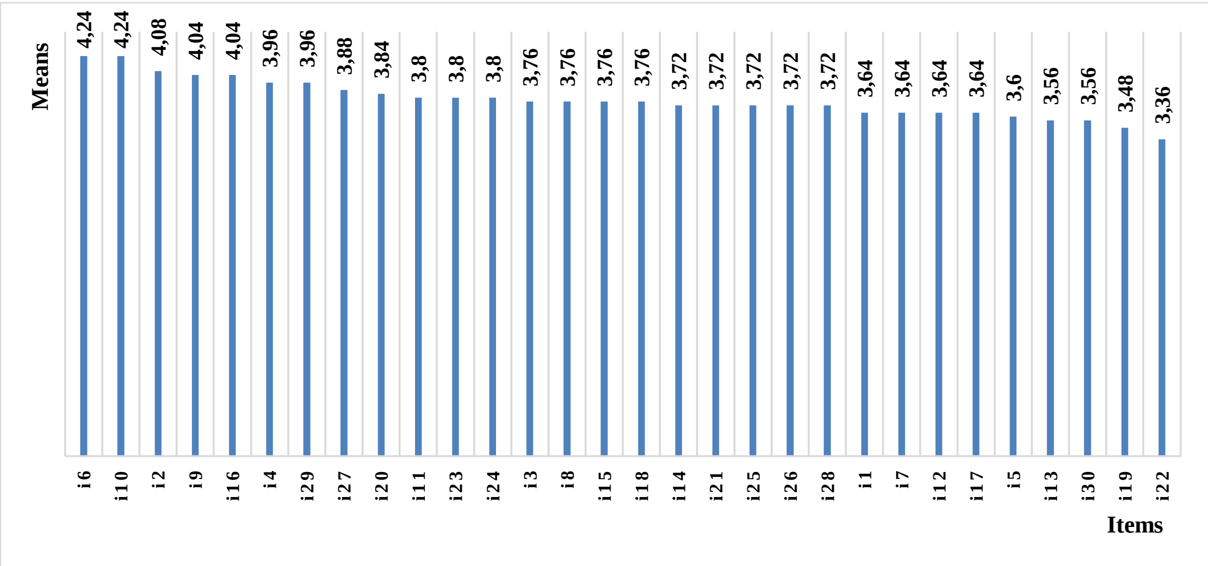
3. FINDINGS

To find a solution to the problem of the research, “Question Development Self-Efficacy Scale Measuring the High Level Learning Level of Science Teachers” was applied as a pre-test before the training program. The item averages calculated from the scale pre-test data are presented in Table 4.

Table 4. Descriptive analysis results of the pre-test data obtained from the scale data.

Item	n	$\bar{X}$	sd	Item	n	$\bar{X}$	sd
i1	25	3,64	0,64	**i16**	25	4,04	0,61
i2	25	4,08	0,49	**i17**	25	3,64	0,76
i3	25	3,76	0,78	**i18**	25	3,76	0,66
i4	25	3,96	0,68	**i19**	25	3,48	0,92
i5	25	3,6	0,87	**i20**	25	3,84	0,85
i6	25	4,24	0,66	**i21**	25	3,72	0,84
i7	25	3,64	0,81	**i22**	25	3,36	0,81
i8	25	3,76	0,72	**i23**	25	3,8	0,91
i9	25	4,04	0,61	**i24**	25	3,8	0,76
i10	25	4,24	0,72	**i25**	25	3,72	0,79
i11	25	3,8	0,71	**i26**	25	3,72	0,74
i12	25	3,64	0,81	**i27**	25	3,88	0,73
i13	25	3,56	0,92	**i28**	25	3,72	0,68
i14	25	3,72	0,79	**i29**	25	3,96	0,74
i15	25	3,76	0,66	**i30**	25	3,56	0,87

The item averages calculated from the scale pre-test data are also presented sequentially in Graph 1.



Graph 1. The item averages calculated from the scale pre-test data

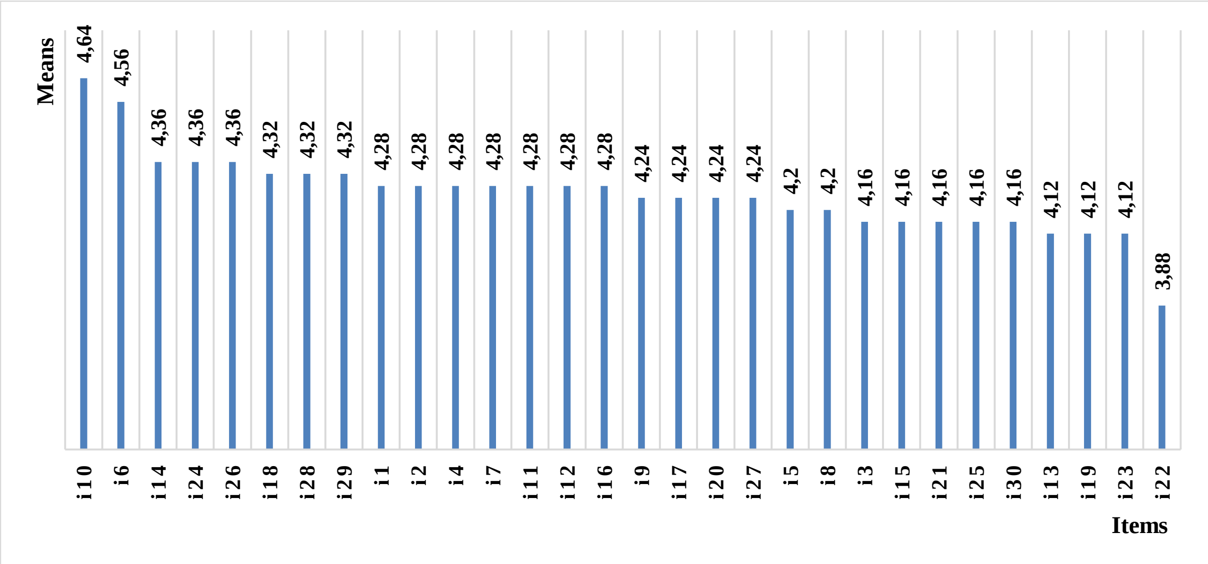
When Table 4 and Graph 1 is examined, it is understood that the item averages vary between 3.36 and 4.24. The 22nd item of the item with the lowest average is "*I can write a question item that measures the ability of students to share the product they have achieved*" is the item. The item with the highest average is item 10, "*I can write a question item that measures the ability of students to determine the independent variable in a given event*" is the item.

After the training program, "*Question Development Self-Efficacy Scale Measuring the High Level Learning Level of Science Teachers*" was applied as a post-test. The item averages calculated from the scale post-test data are presented in Table 5.

Tablo 5. Descriptive analysis results of the post-test data obtained from the scale data.

Item	n	$\overline{X}$	sd	Item	n	$\overline{X}$	sd
i1	25	4,28	0,46	**i16**	25	4,28	0,46
i2	25	4,28	0,46	**i17**	25	4,24	0,52
i3	25	4,16	0,55	**i18**	25	4,32	0,56
i4	25	4,28	0,46	**i19**	25	4,12	0,53
i5	25	4,20	0,58	**i20**	25	4,24	0,52
i6	25	4,56	0,51	**i21**	25	4,16	0,55
i7	25	4,28	0,54	**i22**	25	3,88	0,73
i8	25	4,20	0,65	**i22**	25	4,12	0,67
i9	25	4,24	0,44	**i24**	25	4,36	0,57
i10	25	4,64	0,49	**i25**	25	4,16	0,62
i11	25	4,28	0,54	**i26**	25	4,36	0,57
i12	25	4,28	0,54	**i27**	25	4,24	0,66
i13	25	4,12	0,53	**i28**	25	4,32	0,56
i14	25	4,36	0,49	**i29**	25	4,32	0,63
i15	25	4,16	0,62	**i30**	25	4,16	0,55

The item averages calculated from the scale post-test data are also presented sequentially in Graph 2.



Graph 2. The item averages calculated from the scale post-test data

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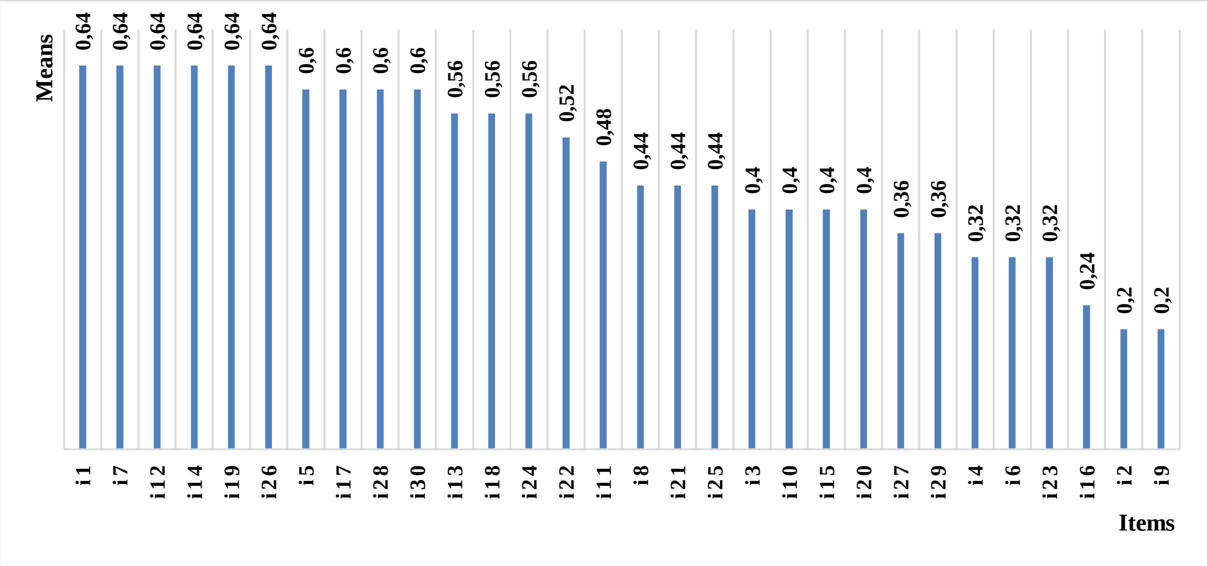
When Table 5 and Graph 2 is examined, it is understood that the item averages vary between 3.88 and 4.64. It is understood from the scale items that both the pretest and the posttest have the same item with the lowest mean and the highest mean. As in the pretest, the item with the lowest average is the 22nd item, "*I can write a question item that measures the ability of students to share the product they have achieved*" is the item. The item with the highest average is item10, "*I can write a question item that measures the ability of students to determine the independent variable in a given event*" is the item. The results of the change between the mean of the pre-test and post-test items are presented in Table 6.

Tablo 6. Descriptive analysis results of the posttest-pretest differences obtained from the scale data.

Item	n	$\overline{X}_{pre\text{-}test}$	$\overline{X}_{post\text{-}test}$	$\overline{X}_{post\text{-}test}$- $\overline{X}_{pre\text{-}test}$	Item	n	$\overline{X}_{pre\text{-}test}$	$\overline{X}_{post\text{-}test}$	$\overline{X}_{post\text{-}test}$- $\overline{X}_{pre\text{-}test}$
i1	25	3,64	4,28	0,64	**i16**	25	4,04	4,28	0,24
i2	25	4,08	4,28	0,20	**i17**	25	3,64	4,24	0,60
i3	25	3,76	4,16	0,40	**i18**	25	3,76	4,32	0,56
i4	25	3,96	4,28	0,32	**i19**	25	3,48	4,12	0,64
i5	25	3,60	4,20	0,60	**i20**	25	3,84	4,24	0,40

i6	25	4,24	4,56	0,32	**i21**	25	3,72	4,16	0,44
i7	25	3,64	4,28	0,64	**i22**	25	3,36	3,88	0,52
i8	25	3,76	4,20	0,44	**i23**	25	3,80	4,12	0,32
i9	25	4,04	4,24	0,20	**i24**	25	3,80	4,36	0,56
i10	25	4,24	4,64	0,40	**i25**	25	3,72	4,16	0,44
i11	25	3,80	4,28	0,48	**i26**	25	3,72	4,36	0,64
i12	25	3,64	4,28	0,64	**i27**	25	3,88	4,24	0,36
i13	25	3,56	4,12	0,56	**i28**	25	3,72	4,32	0,60
i14	25	3,72	4,36	0,64	**i29**	25	3,96	4,32	0,36
i15	25	3,76	4,16	0,40	**i30**	25	3,56	4,16	0,60

The results of the change between the mean of the pre-test and post-test items are also presented sequentially in Graph 3.



Graph 3. The difference between the item averages calculated from the scale pre-test/post-test data

When Table 6 and Graph 3 is examined, it is understood that there is an increase in the averages of all items in the post-test compared to the pre-test. Items with the least increase, item 2, "*I can write a question item that measures students' ability to identify significant similarities and differences between objects or events*" with the 9th item "*I can write a question item that determines the ability of students to measure some kind of magnitude*" are items. The items with the highest increase are the 1st item, "*I can write a question item that measures the ability of the students to record the data obtained as a result of observation and measurement in accordance with the purpose of the problem with various methods such as written expression, picture, table and drawing*" *I can write a question item that measures the ability of students to present their product in appropriate ways using verbal, written or visual materials*", item 12 "*I can write a question item that measures the ability of students to predict the possible solution to a problem they encounter*", item 14 "*I can write a question item that measures the ability to identify one or more of the most prominent variables in an event or relationship*", item 19, "I *can write a question item that measures students' ability to gather information from different sources*" and the 26th item "*I can write a question item that measures the level of being able to establish a relationship between the data collected by the students*" in the articles. Finally, necessary analyzes were made to state whether there was a crucial variation between the pre-test and post-test averages according to the collected data. Before the analysis, it was examined whether the data met the assumptions of the parametric tests. Since it was understood that both pre-test and post-test data were normally distributed, it was analyzed by t-test for dependent samples. Analysis results are presented in Table 4.

Table 4. t-test results for dependent samples of pretest-posttest data obtained from scale data

Measurement	n	($\bar{X}$)	sd	df	t	p*	d
Pre-test	25	3,78	0,57	24	-3,636	0,001	0,72
Post-test	25	4,25	0,41				
Difference Between Means		0,47	0,65				

p*:0,05

When Table 4 is analysed, it is understood that the pre-test mean ($\bar{X}_{pre\text{-}test}$=3,78), and the post-test mean ($\bar{X}_{post\text{-}test}$=4,25). When t-test results for dependent samples are assessed, it is seen that there is a crucial variation between pre-test mean score and post-test mean [$t_{(24)}$=-3,636, p<0,05].

4. DISCUSSION and CONCLUSION

The study was conducted to investigate the question preparation training program that measures high-level thinking skills for science teachers, and to investigate question preparation self-efficacy that measures science teachers' high-level thinking skills. The study was conducted as a single-group empirical design with pre-test/post-test application. 25 science teachers working in public schools in Çorum province attended in the study. As a data collection tool (Bolat et al., 2021), the "*Question Developing Self-Efficacy Scale that Measures the High-Level Learning Level of Science Teachers*" was used. Before the training program, the scale was implemented to the teachers participating in the study as a pre-test. A training program that lasted for 16 weeks was implemented to the teachers. After the training program, the scale was implemented to the teachers again. The study was reported by analysing the pre-test and post-test data.

According to the pre-test results of the scale, it was determined that the item averages ranged between 3.36 and 4.24. The 22nd item of the item with the lowest average is "*I can write a question item that measures the ability of students to share the product they have achieved*" is the item. The item with the highest average is item 10, "*I can write a question item that measures the ability of students to determine the independent variable in a given event*" is the item.

According to the post-test results of the scale, it is understood that the item averages vary between 3.88 and 4.64. It is understood from the scale items that the item with the lowest mean and the highest mean in both the pre-test and post-test are the same. As in the pre-test of the item with the lowest average, the 22nd item "*I can write a question item that measures the ability of students to share the product they have achieved*" is the item. The item with the highest average is "*I can write a question item that measures the ability of students to determine the independent variable in a given event*" is the item. According to the post-test/pre-test differences of the scale, it is understood that there is an increase in the averages of all items in the post-test compared to the pre-test. The 2nd item with the least increase was "*I can write a question item that measures students' ability to identify significant similarities and differences between objects or events*" in the article. The highest increase was item 26, "*I can write a question item that measures the level of being able to establish a relationship between the data collected by the students*" in the article. This situation may have arisen from the types of questions asked in the central exams applied in Turkey. Because teachers tend to use question types in this direction in their own exams (Güleryüz & Erdoğan, 2018). When the central exams applied in the last five years are examined, it is understood that the questions in which the variables are determined are directed to the candidates (2018-2022). It was understood that in the exams of the relevant years examined, there were at least two questions in some years, even five questions for determining the variables. In these exams, the question that the teachers answered at the lowest level according to the findings of the study and that measures the ability to share the product obtained was never included. The mentioned situations may have led to the findings obtained by affecting the question writing practices of the teachers. It may be due to the fact that the least increase was in the preparation of questions that measure the ability to identify and measure the similarities and differences of objects, the psychomotor aspect of the measurement behavior and the difficulty of measuring psychomotor skills with cognitive diagnostic tools. On the other hand, the low increase in the average of the item about preparing a question that measures the ability to identify the similarities and differences of objects may be due to the fact that this item had a high average in the pretest as well.

When the results of the study are assessed in general, it can be said that the self-efficacy of science teachers in preparing questions measuring high-level thinking skills is high ($\overline{X}_{pre\text{-}test}$=3,78) and ($\overline{X}_{post\text{-}test}$=4,25). In the literature, there are studies that both support and do not support the results of this study. In the study carried out by Kılıç (2020), it was stated that teachers' perceptions of using alternative assessment and evaluation techniques were sufficient and very sufficient. Çakan (2004), Volante and Fazio (2007) determined in their research that teachers' self-efficacy for assessment is low. The voluntary participation of teachers in the training program in this study may indicate that they have a high interest in the subject. Self-efficacy is directly proportional to interest. Because psychological factors such as individuals' interests positively affect self-efficacy (Taylor & Bury, 2007). For these reasons, teachers who are interested in writing questions have high self-efficacy in preparing questions that measure their high-level thinking skills.

When the t-test results for dependent samples are evaluated on the data obtained from the scale, it is seen that there is crucial variation between the pre-test mean score and the post-test mean [$t_{(24)}$=-3,636, p<0,05]. It was observed that the effect of the experimental intervention on the change of science teachers' self-efficacy was moderate (d=0,72). There are studies that show that educational programs increase teachers' self-efficacy are found in the international literature. Gotch, Poppen, Razo, and Modderman (2021), in their research, examined the effect of the professional development training program they implemented on teachers' self-efficacy with different educational tasks, and they found that teachers' self-efficacy was very high and at the end of the training program, teachers' self-efficacy regarding assessment and evaluation was very high. In their study, In their study, Hartell, Gumaelius, and Svärdh (2015) examined the difference between the assessment and evaluation self-efficacy of 60 technology teachers who did not receive any training and 28 technology teachers who had a training program, and compared their assessment-evaluation self-efficacy. The self-efficacy perception of 28 teachers whose training program was applied was found to be significantly higher than the teachers who had never received any training. These results show parallelism with the views of Bandura (1976). According to Bandura, increasing the knowledge and experience of individuals increases self-efficacy.

When the results obtained from the research are compared with the national literature, it is understood that there are look-alike results. Çepni and Şenel-Çoruhlu (2010) determined that the in-service training course prepared for alternative assessment and assessment techniques positively affected the in-class assessment and evaluation competencies of science teachers. Şenel-Çoruhlu, Er Nas and Çepni (2008) determined that the in-service training course they organized for alternative assessment and evaluation techniques had positive changes in the perspectives and skills of science and technology teachers who attended the course. In the study carried out by Ar (2019), there was an increase in the competencies of science teachers in preparing life-based open-ended questions with the applied in-service program. Aslan (2011) determined that at the end of the curriculum he applied for Turkish language and literature teacher candidates, the question-writing skills that measure the higher order thinking skills of the pre-service teachers developed. Bay and Alisinanoğlu (2013) determined that the rate of questions measuring higher order thinking skills in the questions prepared by teachers increased after the training program applied to preschool teachers. Büyükalan-Filiz (2009) determined that the question-answer method training given to classroom teachers improved the skills of preparing questions that measure teachers' higher order thinking skills. Cumhur (2016) determined that the questioning behaviors of teacher candidates changed positively at the end of the lesson study practice that he applied to the mathematics teachers' candidates. Gürbüz (2014) determined that the mathematics literacy curriculum that he applied to pre-service mathematics teachers increased the question-writing competencies of pre-service teachers that measure their higher order thinking skills. Research in both international, national literature and according to the results of this research, question preparation trainings that measure higher order thinking skills for teachers significantly increase teachers' self-efficacy in preparing questions that measure higher order thinking skills.

In consideration of the results obtained from the research, the undermentioned recommendations are presented:

* Widespread application of the training program applied within the scope of the research can be made.
* The training program can be applied to science teachers in different cities and the results of this research can be supported.
* Training programs for different branch teachers can be organized and their effectiveness can be investigated.
* The training program can be made into a book and made available to teachers.
* Statistical evaluations of teachers' self-efficacy can be examined through interviews and the underlying reasons for the results can be investigated.
* In this study, activities related to skills with low item averages can be designed in an enriched way in in-service training programs to be prepared for teachers.
* Due to the importance of experience in writing questions, the training programs to be prepared should be designed in such a way that teachers practice writing questions during the long process.
* In the training program to be prepared, planning can be made to cover the sub-skills of higher order thinking skills for the questions to be prepared by the teachers.

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Abstract

In order to improve people's behavior in line with the spirit of fair play, both in the world of athletics and in the social sphere, it is vital to challenge the phenomenon of fair play at all educational levels. All social actors agree that it is possible to establish communities in which fair play behaviors are common, but only with the education that must be provided from a young age. This study aims to investigate high school students' perceptions of fair play, both among those who participate in and among those who do not participate in school sports. A total of 145 female students make up the study's sample, including 104 female students studying in the Mardin province who have previously participated in volleyball at their schools and 41 female students who have not. Aside from the demographic information form created by the researchers, the "Multidimensional Sportsmanship Orientation Scale" was used as a data collection tool in the study. The package program SPSS 21.0 was used to analyze the information that had been gathered. The information collected from the participants was interpreted using frequency, percentage distributions, and nonparametric tests. Significant differences were found in the variables of age (in favor of older age), school type (in favor of imam hatip high school), and mother's employment status (in favor of non-working). Variables such as involvement in school sports, family income, mother's education level, and father's occupation were not found to differ significantly.

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Research Article

Examination of Fair Play Approaches of High School Students who Participate in School Sports and not*

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Abstract

In order to improve people's behavior in line with the spirit of fair play, both in the world of athletics and in the social sphere, it is vital to challenge the phenomenon of fair play at all educational levels. All social actors agree that it is possible to establish communities in which fair play behaviors are common, but only with the education that must be provided from a young age. This study aims to investigate high school students' perceptions of fair play, both among those who participate in and among those who do not participate in school sports. A total of 145 female students make up the study's sample, including 104 female students studying in the Mardin province who have previously participated in volleyball at their schools and 41 female students who have not. Aside from the demographic information form created by the researchers, the "Multidimensional Sportsmanship Orientation Scale" was used as a data collection tool in the study. The package program SPSS 21.0 was used to analyze the information that had been gathered. The information collected from the participants was interpreted using frequency, percentage distributions, and nonparametric tests. Significant differences were found in the variables of age (in favor of older age), school type (in favor of imam hatip high school), and mother's employment status (in favor of non-working). Variables such as involvement in school sports, family income, mother's education level, and father's occupation were not found to differ significantly.

Keywords: : Fair play, school sports, volleyball, high school, student

1. INTRODUCTION

Sport is an important activity that supports physical social, and mental development, as well as providing individuals to struggle, have fun, socialize, stay away from bad habits, have a status. This development is an uninterrupted progress that begins with an individual's birth and continuous until death Education is a concept that includes entire progress (Ergün, 1999). Although formal education programs are created according to the interests, desires, and needs of students, it is a fact that these programs are insufficient in achieving their goals. It is possible to reduce this disability to a minimum by participating in extracurricular activities (Pehlivan, 1998). It is a common idea that these will be a decrease in the academic success of students who participate in sport activities in public (Bailey et al. 2009). Contrary to this common misconception, there are many academic studies that sport activities provide some behaviors that education programs cannot provide students with, which are related to academic education (Bozyiğit & Gökbaraz, 2020; Harackiewicz, 1979). Academic studies indicate that students who participate in schools tend to be better academically and adopt better to school

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(Oldenkamp, 2012). It is also stated that there is an increase in students' skills and abilities in line with their interests, expectations and needs, they acquire regular and systematic work habits, develop a sense of self confidence, comply with the rules of society and gain excitement, enthusiasm, unity and togetherness (Akgül, Göral, Demirel & Üstün, 2012).

The fair play concept, which was first used in England in the late 18th century, means to act honestly in a job that requires effort and to live in a dignified, humane way (Erdemli, 2002). In addition to complying with the rules, fair play is a virtue that commits athletes to act in accordance with the spirit of the sport and compete within the framework of general moral norms (Keating, 1964). There is a truth accepted by everyone which is that basis of everything is education. Based on this main idea, it is an undeniable fact that extracurricular sport activities should be planned as a continuation of education. It is a fact that fair play, which defines social and moral norms, being included in the planning of education will contribute to students being encouraged to social interactions and the development of their social and moral selves (London, Westrich, Stokes-Guinan & McLaughlin, 2015).

Today's school sport activities aim to teach students not only sports but also moral norms that cannot be taught through formal education, with a focus on fair play. In this context, school sports activities have a more vital and socially functional structure, apart from the physical education lesson that the students take during their formal education. In this respect the main goal in school sports should never be to win matches (Orhun, 1992). Unfortunately, in the 21st century, the increasing commercial and political expectations in sports have left the fair play spirit behind. In the face of this negative situation, the idea that starting point should by primary school students in order to allocate a fair play culture has started to gain importance (Yıldıran, 2005).

2. METHOD

2.1. Research Model

In the research, descriptive survey model was used in guantitative research methoods. Descriptive scanning is research conducted on large groups, in which the opinions and attitudes of the individuals in the group about a phenomenon and event are taken, and cases events are tried to be described (Karakaya, 2012: 59).

2.2. Participants

The population of the research consists of students studying at secondary school level in the Mardin province of Turkey in the 2022-2023 academic year. The sample of the study was chosen by random sampling method. Consists of 104 female students who have previously participated in school sports in the volleyball branch and 41 female students who have not participated in school sports before.

2.3. Data Collection Tool

In the addition to personal information form prepared by the researcher to measure demographic characteristics, the "Multidimensional Sportsmanship Orientation Scale" developed by Vallerand, Briere, Blanchard and adopted to Turkish by Gülfen Sezen Balçıkanlı was used as a data collection tool (Balçıkanlı, 2009; Vallerand et. al. 1997). Multidimensional Sportsmanship Orientation Scale (MSOS-25) is a 5-point Likert-type scale consisting of 25 items and 5 sub-dimensions. Multidimensional sportsmanship the Turkish version of the orientation scale has 4 sub-factors and 20 items. When the reliability of the scale is tested, Cronbach Alpha values are; Factor 1 (Compliance with Social Norms) 0.86; Factor 2 (Respect for Rules and Management) 0.83; Factor 3 (Commitment to Responsibilities in Sports) 0.91; Factor 4 (Respect for the Opponent) is 0.82. The values range between .82 and .91 and are at a highly reliable level.

2.4. Analysis of Data

SPSS 21.0 package program was used to analyze the data obtained from the scales applied to the students participating in the research. In addition, complementary statistical operations, frequency and percentage calculations were made. Non-parametric tests were used in interpreting the obtained data.

3. FINDINGS

In this section, many variables such as the age of the students participating in the research, the educational status of the family, whether they have participated in school sports before, and the type of the high school the students studied. In addition, the findings of the fair play survey applied to the students are presented in the forms of tables.

Table 1. Demographic information table of the research group

Gender	**Frequency**	**%**
Age	Frequency	%
13 years	7	4,8
14 years	11	7,6
15 years	20	13,8
16 years	38	26,2
17 years	53	36,6
18 years and older	16	11,0
School type	**Frequency**	**%**
Anatolian High School	49	33,8
Science High School	25	17,2
Vocational High School	29	20,0
İmam Hatip High School	42	29,0
Have you participates in school sports before?	**Frequency**	**%**
Yes	104	71,7
No	41	28,3
Family income status	**Frequency**	**%**
Low	17	11,7
Middle	108	74,5
High	17	11,7
Very high	3	2,1
Age to start sport	**Frequency**	**%**
6-7 years	13	9,0
8-9 years	21	14,5
10-11 years	35	24,1
12-13 years	47	32,4
14 years and older	29	20,0
Mother's working status	**Frequency**	**%**
Yes	16	11,0
No	129	89,0
Father's working status	**Frequency**	**%**
Officer	28	19,3
Worker	28	19,3
Craft	15	10,3
Farmer	6	4,1
Retired	18	12,4

Self-Employment	50	34,5
Mother's education status	**Frequency**	**%**
Illıterate	10	6,9
Literate	43	29,7
Primary School	47	32,4
Secondary School	22	15,2
High School	19	13,1
University	4	2,8
Father's education status	**Frequency**	**%**
Illıterate	12	8,3
Literate	6	4,1
Primary School	39	26,9
Secondary School	30	20,7
High School	36	24,8
University	22	15,2

As seen in Table 1, 4.8% of the participating students were 13, %7.6 were 14, %13.8 were 15, 26.2% were 16, 36.6% were 17, and 11% were 18 years old and older. In addition, %71,7 of the participants had participated in school sports before, while %28,3 had not participated in school sports before.

Table 2. Mann Whitney U test result according to the variable of participation in school sports

Scale total score and sub-dimensions	Have you participated in school sports before?	N	Mean	U	p
Total scale	Yes	104	73,39		,859
	No	41	72,01	2091,500	
	Total	145			
Compliance with social norms	Yes	104	73,42		,848
	No	41	71,94	2088,500	
	Total	145			
Respect for rules and management	Yes	104	73,75		,732
	No	41	71,11	2054,500	
	Total	145			
Commitment to responsibilities in sport	Yes	104	74,90		,380
	No	41	68,18	1934,500	
	Total	145			
Respect to opponent	Yes	104	71,30		,436
	No	41	77,30	1955,500	
	Total	145			

Looking at Table 2, no significant difference was found between the groups in the total score and sub-dimensions of the scale, according to the Mann-Whitney U test result for the variable of participation in school sports.

Tablo 3. The result of Mann Whitney U test for the maternal employment status variable

Scale total score and sub-dimensions	Mother's working status	N	Mean	U	p
Total scale	Yes	16	56,38		,093
	No	129	75,06	766,000	
	Total	145			
Compliance with social norms	Yes	16	64,13		,368
	No	129	74,10	890,000	
	Total	145			
Respect for rules and management	Yes	16	53,09		**,043**
	No	129	75,47	713,500	
	Total	145			
Commitment to responsibilities in sport	Yes	16	62,34		,276
	No	129	74,32	861,500	
	Total	145			
Respect to opponent	Yes	16	56,81		,100
	No	129	75,01	773,000	
	Total	145			

Looking at Table 3, while there was no significant difference in the total score of the scale according to the result of the Mann-Whitney U test variable, a significant difference was found between the groups in the sub-dimensions of respect for rules and management of the scale. It seems that this difference is in favor of those whose mother do not work.

Table 4. The result of Kruskal Wallis test for age variable of participants

Scale total score and sub-dimensions	Age	N	Mean	X^2	p	Difference
Total scale	13 years[a]	7	69,21	8,829	,116	-
	14 years[b]	11	54,64			
	15 years[c]	20	69,60			
	16 years[d]	38	62,95			
	17 years[e]	53	80,75			
	18 years and older[f]	16	89,75			
Compliance with social norms	13 years[a]	7	68,21	11,809	**,037**	**a-f**
	14 years[b]	11	46,77			
	15 years[c]	20	65,88			
	16 years[d]	38	64,53			
	17 years[e]	53	83,53			
	18 years and older[f]	16	87,28			
Respect for rules and management	13 years[a]	7	70,07	4,245	,515	-
	14 years[b]	11	66,09			
	15 years[c]	20	69,10			

	16 years[d]	38	65,03			
	17 years[e]	53	78,08			
	18 years and older[f]	16	86,00			
Commitment to responsibilities in sport	13 years[a]	7	85,79	9,937	,077	-
	14 years[b]	11	76,77			
	15 years[c]	20	79,38			
	16 years[d]	38	54,97			
	17 years[e]	53	79,04			
	18 years and older[f]	16	79,66			
Respect for the opponent	13 years[a]	7	64,21	7,688	,174	-
	14 years[b]	11	51,18			
	15 years[c]	20	70,98			
	16 years[d]	38	67,37			
	17 years[e]	53	78,20			
	18 years and older[f]	16	90,53			

Looking at Table 4, while there was no significant difference between the groups in the total score of the scale according to the Kruskal Wallis test result for the age variable, it was found that there was a significant difference between the groups in compliance with social norms sub-dimensions of the scale. It seems that this difference is in favor of the 15 years and older group.

Tablo 5. The result of Kruskal Wallis test of the participants' school type variable

	School type	N	Mean	X^2	P	Difference
Total scale	Anatolian High School[a]	49	74,91	14,249	**,003**	**d-b, d-c**
	Science High School[b]	25	46,84			
	Vocational High School[c]	29	72,59			
	İmam Hatip High School[d]	42	86,63			
Compliance with social norms	Anatolian High School[a]	49	75,49	10,163	**,017**	**d-b**
	Science High School[b]	25	49,72			
	Vocational High School[c]	29	75,19			
	İmam Hatip High School[d]	42	82,44			
Respect for the rules and management	Anatolian High School[a]	49	74,68	11,849	**,008**	**d-b**
	Science High School[b]	25	48,54			
	Vocational High School[c]	29	74,81			
	İmam Hatip High School[d]	42	84,35			
Commitment to	Anatolian High School[a]	49	77,18	19,357	**,000**	**a-b,**

responsibilities in sport	Science High School[b]	25	41,54			d-b
	Vocational High School[c]	29	73,43			
	İmam Hatip High School[d]	42	86,55			
Respect for opponent	Anatolian High School[a]	49	75,78	10,458	**,015**	**d-c,**
	Science High School[b]	25	54,78			**d-b**
	Vocational High School[c]	29	64,62			
	İmam Hatip High School[d]	42	86,39			

Looking at Table 5, It was found that there was a significant difference between the groups in the scale total score and scale sub-dimensions according to the school type variable Kuruskal Wallis test result. In general, it seems that this difference is in favor of students studying in İmam Hatip High School.

Tablo 6. The result of Kruskal Wallis test of participants' age at starting sports variable

	Age to start sports	N	Mean	X^2	P
Total scale	6-7 years	13	78,77	1,138	,888
	8-9 years	21	64,74		
	10-11 years	35	72,93		
	12-13 years	47	74,52		
	14 years and older	29	74,02		
Compliance with social norms	6-7 years	13	76,62	1,362	,851
	8-9 years	21	68,07		
	10-11 years	35	68,07		
	12-13 years	47	77,14		
	14 years and older	29	74,19		
Respect for the rules and management	6-7 years	13	74,54	5,408	,248
	8-9 years	21	54,02		
	10-11 years	35	78,06		
	12-13 years	47	77,40		
	14 years and older	29	72,81		
Commitment to ɔonsibilities in sport	6-7 years	13	72,23	,786	,940
	8-9 years	21	66,43		
	10-11 years	35	73,64		
	12-13 years	47	75,98		
	14 years and older	29	72,50		
Respect for the opponent	6-7 years	13	77,19	,767	,943
	8-9 years	21	68,02		
	10-11 years	35	76,77		
	12-13 years	47	71,74		
	14 years and older	29	72,21		

Looking at Table 6, according to the results of the Kuruskal Wallis test, the variable of starting sport age, there was no significant difference between the groups in the total score and sub-dimensions of the scale.

4. DISCUSSION and CONCLUSION

In this study aimed at examining the fair play understanding of high school students who participate in school sports in the volleyball branch and those who do not; the majority of the students were in the 16-17 (62.8%) age range, 104 (71.7%) had not participated in school sports before, and 108 (89%) had not worked in any job. When the students participating in the study were evaluated according to the "Multidimensional Sportsmanship Orientation Scale", it was seen that although there were 5.5% to 13.7% negative opinions on all subjects as 'it doesn't describe me at all', the majority of them obeyed the rules.

In the study titled "A study on the relationship between empathy skills and fair play behaviors of basketball player students at different educational level" conducted by Bozdemir in 2017, a questionnaire was applied to a total 382 athletes, 140 girls and 242 boys, who played basketball in Kastamonu province and Azdavay and Tosya districts during the 2013-2014 academic year. As a result of this study, significant positive difference was found between students' high school type, grade level, maternal education status and whether they played in the school team or not, and the level performing fair play behaviors. There is a parallelism between Bozdemir's study and our own study (Bozdemir, 2017).

In the study titled "Investigations of sportsmanship behavior of secondary school students in physical education and sport lesson according to some variables" conducted by Altun and Güvendi in 2019, it seems that the scores of exhibiting positive behaviors in physical education of students who do sports are seen to be significantly higher than the scores of students who do not do sports (Altun & Güvenli, 2019). This situation does not parallel the result of the fair play behaviors between the participation of the students in school sports or not.

In the study titled "Investigation of the attitudes of physical education and sports school students" conducted by Kilci, Goktaş and Özdayı (2018), a questionnaire was applied to 200 students who were actively engaged in sports at Balıkesir University's physical education and sport college during the 2017-2018 academic year. According to the findings obtained as a result of the survey, there was no significant difference according to age, branch, department of education and family income level variables. It shows parallelism with the family income variable data obtained in our study (Teke, 2018).

In the study titled "Examination of sportsmanship understanding of footballers at different levels" conducted by Kalkavan and Mete in 2018, a questionnaire was applied to a total of 201 football players, 95 of which were amateur athletes playing in the Black Sea Regional Bal League, and 106 of them were professional athletes playing in the professional league. According to the results obtained from the survey, there were significant differences in sportsmanship perceptions according to age, education, years of doing sports and nationality. In our study, the difference in the sub-dimension of compliance with social norms of the scale, in which the age variable was applied shows parallelism with the data obtained in the study of Kalkavan and Mete (2018).

In the "Compliance with social norms" and "respect for the opponent" sections, which are the sub-dimensions of the "Multidimensional Sportsmanship Orientation Scale" conducted with students who participate and do not participate in school sports, it seems that they exhibit less fair play behavior, while it seems that they exhibit more fair play behaviors in the sub-dimension of "respect for rules and management" and "commitment to responsibilities in sport".

The erroneous thoughts that exist on athletes in society such as 'hit, break, smash, win the match, be a champion; you should not lose at all costs' creates pressure on athletes and keeps them away for exhibiting fair play behaviors. Coubertin stated that the main thing is not to win the match, and pointed at that fair play behaviors are the essence of sports and that societies need these behaviors (URL-1). In addition, the technique of rewarding the successful are used in sports competition is thought to prevent fair play behaviors. Successful athletes should definitely be rewarded, but is foreseen that the recognition and rewarding of unsuccessful athletes who fight in a gentlemanly manner and exhibit fair play behaviors. It is believed that emphasizing the importance of exhibiting for fair play behavior will help to achieve more positive results. In addition, it should not be overlooked that a legal regulation in this regard could also be important in the reward system.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Fırat University with the decision dated 10/05/2023 and numbered 322391.

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Abstract

This study aims to develop a Turkish reading anxiety scale (TRAS) for secondary school students whose mother tongue is not Turkish. In addition, since the subject of our study is people who do not receive education in their mother tongue, but receive education in a second language, it aims to develop a measurement tool to determine the effect of this difference on second language learning anxiety. The data of the study were applied to 432 8th grade secondary school students whose mother tongue was Kurdish and who learned Turkish afterwards. As a result of the exploratory factor analysis (EFA), it was seen that the items in the scale were collected in three factors and consisted of 19 items. These three factors are: "Fear", "Anxiety" and "Preference". It is seen that the three-factor structure obtained as a result of EFA was confirmed as a result of CFA. It is seen that the three-factor structure obtained as a result of EFA contributed 46.280% to the total variance. It is seen that the factor load values of the items ranged from 0.487 to 0.789. As a result of the item analysis, it is seen that the items in the scale are distinctive. As a result of the ANOVA analysis, it was concluded that students' Turkish reading anxiety differed significantly according to gender, mother's knowledge of Turkish, and the language that parents wanted to be spoken at home. However, it was concluded that there was no significant difference between the father's knowledge of Turkish and the language spoken at home preference. The Cronbach's alpha reliability coefficients of the three-factor structure obtained from the TRAS were calculated as .81, .75 and .70, respectively, and the alpha coefficient for all items of the scale was calculated as 0.87. As a result, considering the validity and reliability analyzes, it was concluded that the TRAS is a reliable and valid measurement tool.

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Research Article

Development of Turkish Reading Anxiety Scale*

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Abstract

This study aims to develop a Turkish reading anxiety scale (TRAS) for secondary school students whose mother tongue is not Turkish. In addition, since the subject of our study is people who do not receive education in their mother tongue, but receive education in a second language, it aims to develop a measurement tool to determine the effect of this difference on second language learning anxiety. The data of the study were applied to 432 8th grade secondary school students whose mother tongue was Kurdish and who learned Turkish afterwards. As a result of the exploratory factor analysis (EFA), it was seen that the items in the scale were collected in three factors and consisted of 19 items. These three factors are: "Fear", "Anxiety" and "Preference". It is seen that the three-factor structure obtained as a result of EFA was confirmed as a result of CFA. It is seen that the three-factor structure obtained as a result of EFA contributed 46.280% to the total variance. It is seen that the factor load values of the items ranged from 0.487 to 0.789. As a result of the item analysis, it is seen that the items in the scale are distinctive. As a result of the ANOVA analysis, it was concluded that students' Turkish reading anxiety differed significantly according to gender, mother's knowledge of Turkish, and the language that parents wanted to be spoken at home. However, it was concluded that there was no significant difference between the father's knowledge of Turkish and the language spoken at home preference. The Cronbach's alpha reliability coefficients of the three-factor structure obtained from the TRAS were calculated as .81, .75 and .70, respectively, and the alpha coefficient for all items of the scale was calculated as 0.87. As a result, considering the validity and reliability analyzes, it was concluded that the TRAS is a reliable and valid measurement tool.

Keywords: Second language acquisition, reading anxiety, bilingualism, language development

1. INTRODUCTION

Bilingualism can have both positive and negative effects on second language anxiety. On the one hand, individuals who are already bilingual may have an advantage in learning a second language, as they have already developed the language learning skills and cognitive flexibility required for language acquisition. According to Horwitz, Horwitz, and Cope (1986), anxiety plays a key role in determining a language learner's success or failure in second language acquisition. Bilinguals may also feel more comfortable in multicultural and multilingual settings, which can help reduce anxiety. On the other hand, bilingualism can also create anxiety if the learner feels pressure to maintain both languages or experiences negative feedback about their language abilities. For example, some bilingual individuals may feel that they are not proficient enough in either language, leading to self-doubt and anxiety. Additionally, the relationship between the two languages can also play a role in second language anxiety. If the two languages are similar, learners may experience interference or confusion, leading to frustration and anxiety. If the two languages are very different, learners may struggle to differentiate between them, leading to similar feelings of anxiety and confusion.

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Second language anxiety is a complex phenomenon that can impact language learning progress. According to Horwitz, et al. (1986), second language anxiety is "*a distinct complex of self-perceptions, beliefs, feelings, and behaviors related to classroom language learning*" (p. 128). It can manifest in a variety of ways, including fear of speaking, anxiety about making mistakes, and concern about not being able to understand others or express oneself adequately. Research has shown that second language anxiety can have a negative impact on language learning outcomes. Studies by MacIntyre and Gardner (1989) and Young (1991) found that high levels of anxiety were associated with decreased motivation and avoidance behaviors, which in turn led to slower language acquisition and lower proficiency levels. One potential factor contributing to second language anxiety is the learning environment. As noted by Bailey, Onwuegbuzie, and Daley (2000), "*the nature of the classroom and the teaching practices of the instructor can greatly impact the level of anxiety experienced by language learners*" (p. 359). Learners who feel unsupported or judged in their language classes may be more prone to anxiety. However, there are strategies that language learners can use to manage second language anxiety. Horwitz et al. (1986) suggest that building a supportive learning environment and developing relaxation techniques can help reduce anxiety. Exposure therapy, in which learners gradually expose themselves to anxiety-provoking situations in a controlled setting, can also be effective in reducing anxiety (Kasap, 2021). Overall, second language anxiety is a complex phenomenon that can impact language learning progress. It is important for language learners to recognize the sources of their anxiety and seek support to overcome it. By understanding and managing second language anxiety, learners can improve their language proficiency and achieve their language learning goals.

Second language anxiety can stem from a variety of factors, including (Aydın & Zengin, 2008):

1) Fear of making mistakes: One of the most common reasons for second language anxiety is the fear of making mistakes. Learners may worry about being corrected or judged by others, which can lead to feelings of embarrassment or shame.
2) Lack of confidence: Some learners may feel insecure about their language skills, which can result in a lack of confidence when using the language.
3) Cultural differences: Learning a new language often involves exposure to a different culture, which can be overwhelming for some learners. This can lead to feelings of confusion, frustration, and even homesickness.
4) Pressure to perform: Learners may feel pressure to perform well in a second language, whether it be for academic, professional, or personal reasons. This pressure can create stress and anxiety, which can impede language learning progress.
5) Past negative experiences: Learners who have had negative experiences with language learning in the past, such as being ridiculed or bullied, may be more prone to second language anxiety.
6) Learning environment: The learning environment can also play a role in second language anxiety. For example, learners who feel unsupported or isolated in their language classes may experience more anxiety than those who feel part of a supportive community.

Overall, second language anxiety is a complex phenomenon that can arise from a range of factors. It is important for language learners to recognize the sources of their anxiety and seek support to overcome it. The relationship between mother tongue and second language anxiety is complex and can vary from individual to individual. In general, research suggests (Liu & Jackson, 2008) that individuals who are more proficient in their mother tongue may experience less second language anxiety, while those who struggle with their mother tongue may be more prone to anxiety when learning a second language. This is because individuals who are more proficient in their mother tongue are likely to have stronger language learning skills, such as phonological awareness, syntax knowledge, and vocabulary acquisition. These skills can be transferable to the learning of a second language, making the process less challenging and less anxiety-inducing.

Conversely, individuals who struggle with their mother tongue may find the learning process of a second language more difficult and stressful (Kasap & Power, 2019). They may lack the necessary language learning skills or struggle with language processing, which can lead to frustration and anxiety. However, it is important to note that this relationship is not always straightforward, and there are many exceptions to this general trend. For example, some individuals may have strong language learning skills but still experience second language anxiety due to cultural or social factors. Ultimately, the relationship between mother tongue and second language anxiety is complex and multifaceted. It is important for language learners to recognize their individual strengths and weaknesses and seek support to overcome any challenges they may encounter in their language learning journey.

1.1. Purpose of the Study

Measuring reading anxiety is important to understand a person's level of anxiety. This can help educators identify how an individual's reading skills can be improved. Reducing reading anxiety can help students improve their reading skills. Students with high reading anxiety should be able to make the reading process less stressful and more enjoyable. Knowing the level of reading anxiety can help adjust the curriculum accordingly. This scale can be used to develop teaching strategies to reduce students' reading anxiety. Measuring reading anxiety is important for understanding how to improve students' reading skills. Teachers can help students increase their self-confidence and achieve better reading results. Measuring reading anxiety contributes to educational psychology and learning research. Such a scale can contribute to research on the causes, consequences and effects of reading anxiety. In conclusion, the importance of creating a reading anxiety scale in Turkish has several benefits such as improving students' reading skills and confidence, improving educational programs, contributing to research, and improving student support services. Such a scale can help to understand and manage reading anxiety.

2. METHOD

2.1. Research Pattern

It was patterned using the survey method. The screening model aims to reveal characteristics such as opinions, interests, abilities and attitudes from the participants about an event or a subject. Therefore, a larger sample is required compared to other research methods. This research aims to make a description by taking a picture of the existing situation (Fraenkel, Wallen & Hyun, 2012).

2.2 Study Group

The study group of the research consists of 432 8th grade secondary school students studying in Ağrı, one of the eastern provinces of Turkey, in the 2022-2023 academic year. Of the students participating in the study, 60.6% (n=262) were male and 39.4% (n=170) were female. The descriptive information of the secondary school students participating in the research is given in Table 1.

Table 1. Descriptive information about the participants of the study

Variable	Category	N	%
Gender	Male	262	60.6
	Female	170	39.4
Does the mother speak Turkish?	Yes	303	70.1
	No	129	29.9
Does the father speak Turkish?	Yes	421	97.5
	No	11	2.5
Language spoken at home	Turkish	84	19.4
	Kurdish	348	80.6
Your mother and father at home for you language does he want you to speak	Turkish	199	46.1
	Kurdish	233	53.9
Total		432	100

2.3. Preparation of Data Collection Tool

The Turkish reading anxiety scale was conducted to determine the Turkish reading anxiety levels of secondary school students whose mother tongue is not Turkish, who did not receive any education in their mother tongue, and who later learned Turkish. First of all, an item pool of scale items was created by scanning the literature. The item pool consists of 40 items, and the resulting item pool was transformed into a draft form. It was submitted to the opinion of experts (n=5) who are experts in their fields (Assessment and Evaluation, English, psychological counseling and guidance, classroom education and science education) in order to determine whether the items in this form will measure the Turkish reading anxiety levels of secondary school students and to determine their understanding as a language. Necessary corrections were made in line with the suggestions of the experts, and a form consisting of 32 items was created. The prepared form consists of "Never" (1), "Rarely" (2), "Sometimes" (3), "Often" (4), "Always" (5) categories. Accordingly, the high score obtained from the scale indicates that Turkish reading anxiety is high.

2.4. Process of Preparing Data for Analysis

Assumptions of the data obtained by using the data collection tool prepared for the study. In this direction, it was examined whether it would be suitable for factor analysis. These; sample size, missing data, normality, linearity, outliers, and factorability of R. First of all, sample size adequacy for factor analysis was checked. According to the researchers, it can be said that there is no consensus on the sample size for factor analysis (İlhan & Çetin, 2014). However, according to some researchers, 200 participants were suitable for factor analysis, it was very good to apply to 500 participants, and it was stated that the number of items in the scale should be applied to 3 to 6 participants (Cattell, 1978). The factor structure becomes more evident with the increase in the number of participants, but it is acceptable if 5 times the total number of items is reached (Gorsuch, 1983; Stevens, 2002). 432 secondary school students participated in this study and when the data set obtained from the data collected from secondary school students was examined, no missing data was found. In order to test the normality and linearity of the data set, it was checked whether the total scores were normally distributed. Skewness and kurtosis coefficients were evaluated and normality tests were performed. By examining the Z scores, it was determined whether there were outliers in the data set. It was observed that the z scores of the variables were in the range of ±3.00.

Then, distance values of all variables were examined in order to determine the extreme values in multiple variables. It was determined that there were no outliers in the analyzed data set. To control the factorability of R, the KMO (Kaiser-Meyer-Olkin) value and Bartlett Test results were examined. The KMO value was found to be .84, and the result of the Bartlett test testing multivariate normality (x^2=886.382, $p<0.01$) was also found to be significant. According to this result, it can be said that the data are suitable for factor analysis.

2.5. Analysis of Data

In order to determine the content validity of the scale, interviews were conducted with 5 different experts in the field and content validity rates and indices were calculated accordingly. Afterwards, statistical analysis was performed to determine the characteristics of the measurements made after the TRAS was applied to the participant group. Both EFA and CFA were applied to examine the construct validity of the developed TRAS and to reveal the factor structure of the scale. While applying EFA and CFA during the test development phase, different versions are applied, but when the sample size is sufficient, it is recommended to apply EFA to half of the data and DFA to the other half, and this approach is generally used in the test development phase (Henson & Roberts, 2006). In this study, assuming that the sample size was sufficient, it was decided to apply EFA to half of the data and to apply CFA to the remaining half. In this study, a 32-item scale was applied to 432 participants. While doing EFA, direct the Oblimin rotation technique was used. The sub-dimensions of the scale correlations were found to be low. Therefore, it was seen that the sub-dimensions were independent of each other. In factor analysis, it is recommended to use the varimax method for less related and independent sub-dimensions (Tabachnick & Fidell, 2007). For this reason, “principal components analysis” was used as factorization method and "varimax" method, which is one of the vertical rotation methods, was used as the factor rotation method while performing EFA. To ensure the reliability of the scale and for each sub-dimension, Cronbach's alpha internal consistency and score-total correlation were calculated. In addition, within the scope of the criterion validity of the scale, the difference between the scores of the upper group, which constitutes 27% of the scale, and the lower group, which constitutes 27%, was examined with the t-test for independent groups. In order to determine the Turkish reading anxiety of secondary school students, the total scores they got from the measurement tool were gender. Whether the mother knew Turkish, whether the father could speak Turkish and the language is spoken at home. It was examined whether it differed according to the desired language to be spoken at home. When the data were analyzed, it was seen that the total scores showed a normal distribution ($p>.05$). For this reason, the significance of the difference between the total scores of the participants according to the mentioned variables was tested using ANOVA, one of the parametric methods used for unrelated measurements. In addition, the analysis of the data was collected in writing with the help of the data collection tool; it was made with the help of SPSS 23 package program and LISREL 8.7 program.

3. RESULTS

In this section, validity and reliability information about the “Turkish reading anxiety scale” is given.

3.1. Scope Validity

The Turkish reading anxiety scale was evaluated by experts from 5 different fields who provided their opinions on the items of the scale. If more than half of the experts deemed an item “Suitable”, CVR>0, while if less than half did, CVR<0, and if exactly half did, CVR=0 (Yurdugül, 2005). To meet the minimum coverage accuracy criterion for 5 extensions, set at 0.99 by Veneziano and Hooper (1997), the content validity index (CGI) was obtained by averaging the significant CVR values at the $\propto$ =.05 level. Based on expert recommendations, 10 out of 40 items were deemed insufficient for measuring Turkish reading anxiety in secondary school students, and 2 of those were modified based on content validity rates. The remaining 8 items were excluded, and the CGI was recalculated and found to be sufficient. A small group of students tested the clarity of the final version of the scale, providing opinions and agreement levels for each item. The scale was then administered face-to-face to voluntary students after being reproduced in written form. A preliminary application study was conducted, followed by a pilot application. 598

3.2. Construct Validity

EFA and CFA were conducted to determine the construct validity of the Turkish reading anxiety scale (TRAS).

3.2.1. Exploratory factor analysis (EFA)

The construct validity of the Turkish reading anxiety scale (TRAS) was determined through EFA and CFA. EFA was used to determine the item factor loads and construct validity of the TRAS. The Kaiser-Meyer-Olkin (KMO) coefficient and Barlett were used to test the suitability of the data for analysis before conducting EFA. The EFA results showed that the items with an eigenvalue greater than 1 were collected in 8 factors, which explained 59.044% of the scale .In line with the recommendation of the literature research, items with a factor load of 0.30 and below were not included in the analysis (Floyd & Widaman, 1995; Tabachnick & Fidell, 2007). Therefore, six items with a factor load of .30 or less were excluded from the analysis .The EFA also revealed that four items were overlapping, and three items were not included in the analysis because the item-total correlation was less than 0.30. The items obtained from the EFA were collected in three factors, as decided by the researchers. Table 2 presents the characteristics of the items related to the repeated EFA results, and the eigenvalues obtained from the EFA analysis and the percentages of total variance explained are given in Table 2.Additionally, Figure 1 shows the scree line graph result .

Table 2. Explanatory factor analysis and disclosed eigenvalue results

	EFA Eigenvalue Results	Variance Explained
Factor 1	5.487	18,430
Factor 2	1,963	16,213
Factor 3	1,343	11,637

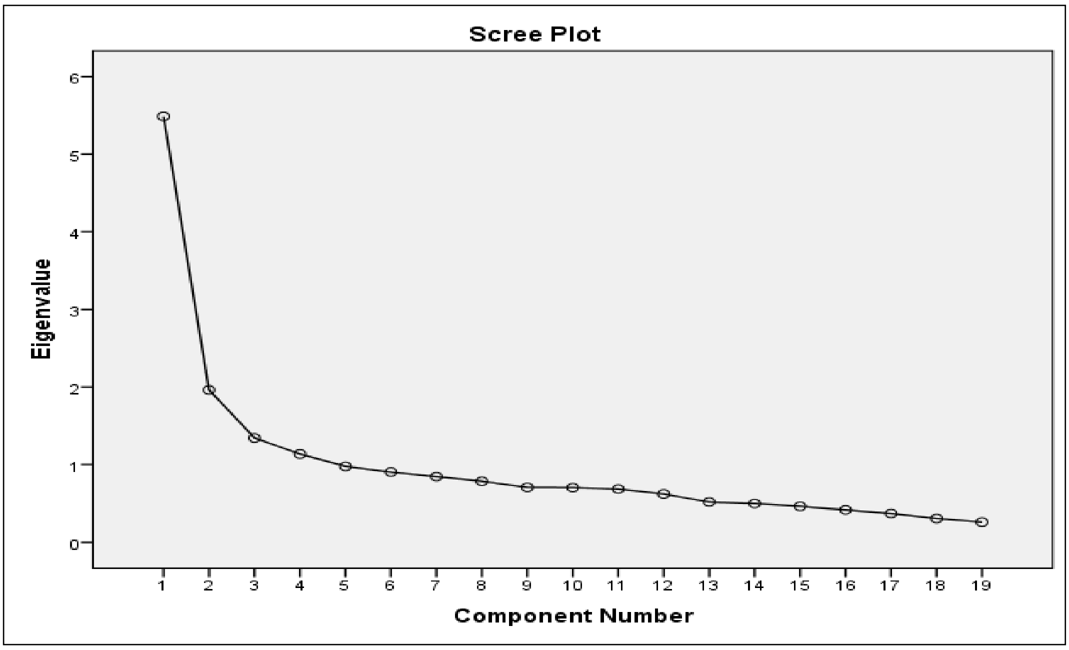

Figure 1. Line chart

Table 2 According to the results obtained from the EFA analysis, it was seen that the items were collected in three factors. Considering all dimensions of the scale, it was seen that the items explained 46.280% of the total variance. It was concluded that the items in the first dimension of the scale explained 18,43% of the total variance, the items in the second dimension of the scale explained 16,213% of the total variance, and the items in the third dimension of the scale explained 11.637% of the total variance. It would be good if the total variance of the variables included in the analysis is 66%. However, it is difficult to achieve this value in social sciences. Therefore, 30% may be considered sufficient in single-factor structures. In multi-factor structures, this value is expected to be slightly higher (Büyüköztürk, 2017). Thus, as a result of the EFA analysis, it was decided that the scale should have a three-dimensional structure. Items and factor loadings are given in Table 3.

Table 3. Factors and factor loads resulting from EFA

Factor 1 (Fear) Cronbach Alpha = 0.819; Explained variance = 18,430%			
	Factor Load		
	1	**2**	**3**
1. I am afraid to read a Turkish text.	.499		
12. Novels, stories etc. written in Turkish. Reading posts like this makes me anxious.	.674		
26. The idea of reading Turkish worries me	.493		
29. When I read Turkish texts, when there are idioms that I do not understand, my desire to read the text disappears.	.571		
30. I hesitate to read a Turkish text because my friends will laugh at me.	.775		
31. I don't want to read reading passages in class because I don't read Turkish well.	.768		
32. I am very afraid that the teacher will give me a reading task in class	.789		
Factor 2 (Anxiety) Cronbach Alpha = 0.756; Explained variance = 16.213%			
	Factor Load		
	1	**2**	**3**
2. Reading Turkish texts slowly bothers me.		.554	
4. When I read any Turkish text, the words I don't understand bother me.		.695	
5. Not being able to pronounce some Turkish sounds makes me nervous.		.622	
17. I cannot pronounce some words while reading Turkish.		.487	
18. Misreading some words in Turkish bothers me.		.684	
19. When I read in public, I worry that someone will make fun of me.		.661	
27. Reading a Turkish text excites me.		.497	
Factor 3 (Preference) Cronbach Alpha = 0.70; Variance Explained = 11.637%			
	Factor Load		
	1	**2**	**3**
10. I prefer to read in my mother tongue rather than Turkish.			.698
11. I don't prefer to read Turkish except in compulsory situations.			.510
22. I prefer speaking Turkish rather than reading it.			.615
25. I think that the Turkish spoken in the environment I live in and the Turkish in the book texts are not the same.			.586
28. When I read Turkish, I feel relieved when I see words similar to my mother tongue.			.540
Total Disclosed Variance = 46,280%			

The first factor "Fear", the second factor as "Anxiety" and the third factor as "Preference", considering the content and theoretical structures of the items resulting from the EFA analysis. The total variance in the first factor It is seen that it explains 18,430% of it and there are 7 items. It was concluded that the factor loads of the items in this factor ranged from .493 to .789. In the second factor, the total variance It is seen that it explains 16.213% of it and there are 7 items. It is seen that the factor loads of the items in this factor ranged from .487 to .695. In the third factor, the total variance It is seen that it explains 11.637% of it and there are 5 items. It is seen that the factor loadings of the items in this factor ranged from .510 to .698. In this study, items with factor load values of 0.30 and above were evaluated (Büyüköztürk, 2017). When these three dimensions are taken into account, it is seen that the items explain 46.280% of the total variance.

Correlation analysis was performed between the sub-dimensions of the scale. As a result, it was concluded that there was a low correlation. As a result of the correlation between dimensions, it was seen that the correlation between the first dimension and the second dimension factors was 0.29. The correlation between the first dimension and the third dimension factors was found to be 0.27. The correlation between the second dimension and the third dimension factors was found to be 0.29.

According to this correlation result, it was concluded that the relationship between the sub-dimensions was low. Therefore, it was concluded that the sub-dimensions were independent from each other.

Therefore, it was concluded that it is appropriate to apply the vertical rotation method in factor analysis. Varimax, one of the vertical rotation methods, was applied. The correlation coefficients between the scale sub-dimensions are presented in Table 4.

Table 4. Correlation coefficients between factors

Factors	Anxiety	Unwillingness	Insufficiency
Anxiety	1.00	0.299	0.271
Reluctance		1.00	0.292
Insufficiency			1.00

3.2.2. Confirmatory factor analysis (CFA)

CFA was conducted to assess the construct validity of the TRAS using the 19 items obtained from the EFA analysis. The fit indices of the TRAS are presented in Table 4. The chi-square, chi-square/degree of freedom, and goodness-of-fit indices were calculated to evaluate the fit of the model, and the results are shown in Table 5. The criteria for evaluating the indices were based on the recommendations of Schermelleh-Engel, Moosbrugger, and Müller (2003).

Table 5. DFA results of the three-dimensional implicit structure established with CFA

Model	÷^{2}	÷^{2}/ sd	NNFI	NFI	CFI	RMSEA
Three-Factor Structure	276.10	1.89	0.96	0.95	0.97	0.058
Criteria		3.0	≥0.95	≥0.95	≥0.95	≤0,08

When Table 5 was examined, it was seen that the three-dimensional structure obtained as a result of EFA was confirmed by CFA. The t-test values of the three-factor structure confirmed as a result of CFA are given in Table 6.

Table 6. t-test values obtained from CFA for EPTS

Item No.	t	Item No.	t	Item No.	t
M1	10.16*	M17	9.81*	M28	6.14*
M2	7.52*	M18	12.49*	M29	12.28*
M4	10.27*	M19	9.87*	M30	12.00*
M5	11.44*	M22	6.05*	M31	12.51*
M10	7.69*	M25	10.29*	M32	12.07*
M11	8.32*	M26	11.89*		
M12	11.42*	M27	3.15*		

*p<.01

Construct validity was examined through both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) for the Turkish reading anxiety scale (TRAS). EFA was conducted to determine the item factor loads and construct validity of the scale (section 3.3). The Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's test were used to test the suitability of the data for analysis, and the items with a factor load of 0.30 or below were excluded from the analysis. Ultimately, the items were collected into three factors, and the model was confirmed through CFA (section 3.2). CFA was applied to test the accuracy of the construct forming the 19 items collected in three factors as a result of EFA (section 3.2). The fit index values of TRAS were presented in Table 4, and the square, chi-square/degree of freedom, and goodness-of-fit indices calculated were presented in Table 5. The t-test values of each dimension were significant at the .01 level, indicating the sufficiency of the number of participants and the accuracy of the items included in the model.

It was concluded that the three-factor structure formed as a result of EFA was confirmed as a result of CFA (section 3.2). As a result of the literature review, it was seen that the structure created was statistically confirmed, and the model created as a result of DFA is given in Figure 2 (section 3.2).

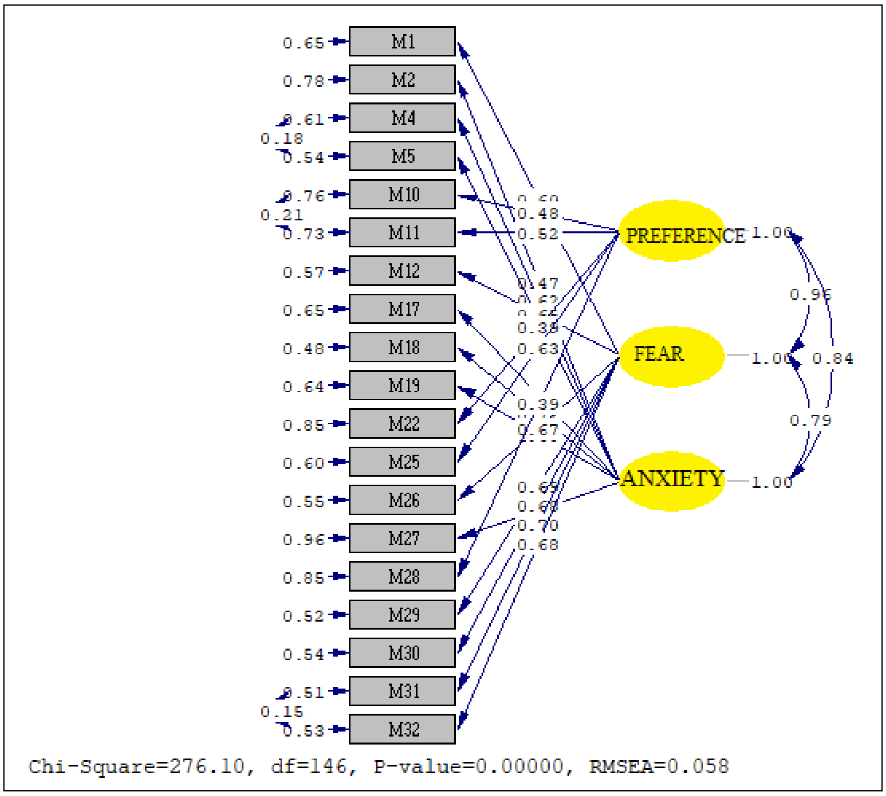

Figure 2. Measurement Model for TRAS

3.4. Reliability

This study factor loads of substances equal not (congeneric measuring) and of the scale only dimensional is not then seen sub-dimensions of the scale and of the scale all for McDonalds reliability coefficient calculated (Lucke, 2005). With this coefficient DFA get has been Turkish read anxiety McDonald's ω coefficient of sub-dimensions in the scale ("congeneric as "credibility" known) .81, .75 and .70, respectively of the scale all substances McDonald's ω coefficient for .87. In scale get McDonald's ω value consideration when taken reliability coefficient of high is can be said. These findings according to the scale Trustworthy One measuring the middleman to the conclusion that has been reached.

3.4.1. Item analysis

The adjusted total correlation was calculated to determine item discrimination and predictive power of the total score. In addition, 27% lower-upper groups were compared. The findings that emerged as a result of the item analysis are given in Table 7.

Table 7. TRAS item analysis results

Item No.	When Substance Is Removed Scale Alpha	Item Total Correlation	Average	Standard Deviation	Distortion
M1	.872	.528	1.52	1.113	2.149
M12	.872	.546	1.75	1,237	1,357
M26	.870	.598	1.88	1,237	1,227
M29	.896	.623	1.99	1,302	1,064
M30	.870	.583	1.82	1,258	1,415

M31	.871	.569	1.76	1,225	1,347
M32	.871	.574	1.78	1.264	1,477
M2	.876	.413	2.34	1.405	.725
M4	.872	.535	2.30	1,359	.667
M5	.870	.586	2.08	1,277	.944
M17	.872	.520	2.17	1,268	.881
M18	.870	.577	2.31	1,383	.763
M19	.874	.471	2.23	1.431	.762
M27	.884	.215	2.86	1,547	.192
M10	.875	.436	2.21	1,476	.824
M11	.874	.466	2.03	1,342	1,046
M22	.880	.336	2.41	1,521	.577
M25	.871	.557	2.11	1,233	.856
M28	.877	.396	2.59	1,514	.442

*p<.005

Table 7 presents the item-total correlation results for the three factors, which range from .546 to .623 for the first factor, from .215 to .586 for the second factor, and from .336 to .557 for the third factor. The accepted threshold for a sufficient total item correlation is .30 or higher for items used to distinguish the features being measured (Büyüköztürk, 2017; Erkuş, 2012; Kasap, 2021). It is observed that this value is met for all items except for M27. However, the t-test values obtained from the lower-upper group comparisons of 27% are significant for M27. According to Erkuş (2012), if the t value is significant in the comparison of 27% lower-upper groups, the item can be considered distinctive. Therefore, it was concluded that the M27 item is distinctive. In light of the item analysis results, it is determined that all items in the scale are distinctive.

To assess the construct validity of the upper and lower groups' scores, an Independent Samples t-test was conducted. The purpose of this analysis was to determine the difference between the total scores of the 27% lower and upper groups of the 432 8th-grade students who participated in the study. Table 8 presents the group statistics of each item and the t-test results based on the scores of each group from the scale.

Table 8. Item analysis results based on 27% sub-top groups of TRAS

Article	Group	$\bar{X}$	t	p	Article	Group	$\bar{X}$	t	p
1	Top	2.44	10,871	.00	22	Top	3.22	9,798	.00
	Lower	1.00				Lower	1.58		
2	Top	3.11	11,015	.00	25	Top	3.11	16,700	.00
	Lower	1:50				Lower	1.21		
4	Top	3.29	13,522	.00	26	Top	3.02	16,971	.00
	Lower	1.41				Lower	1.03		
5	Top	3.10	14,803	.00	27	Top	3.32	7.801	.00
	Lower	1.22				Lower	1.98		
10	Top	3.32	11,952	.00	28	Top	3.26	13,066	.00
	Lower	1.47				Lower	1.56		
11	Top	3.03	12,754	.00	29	Top	3.26	16,514	.00
	Lower	1.24				Lower	1.16		
12	Top	2.78	12,889	.00	30	Top	2.93	15,220	.00
	Lower	1.15				Lower	1.05		
17	Top	3.13	14,266	.00	31	Top	2.93	13,462	.00
	Lower	1.29				Lower	1.15		
18	Top	3.41	17,064	.00	32	Top	2.96	14,095	.00
	Lower	1.19				Lower	1.03		
19	Top	3.20	14,502	.00					
	Lower	1.19							

When Table 8 is examined, it is seen that there is a significant difference between the upper group and the lower group (p<.05). When the averages of the items in the upper-lower group of 27% are compared, it can be said that the averages of the students in the upper group are higher. For this reason, it was concluded that there was a difference between the items in the upper group and the lower group, and therefore the items were distinctive.

In order to determine the construct validity level of the scale, the scale was applied to 8th grade students. One-factor analysis of variance (One-Way) in an unrelated sample was used to determine whether the items differ according to the gender of the students, whether the mother speaks Turkish, whether the father speaks Turkish, the language is spoken at home and the language desired to be spoken at home. ANOVA results are given in Table 9.

Table 9. ANOVA results of secondary school 8th grade students' total scores from TRAS according to gender, whether the mother speaks Turkish, whether the father speaks Turkish, the language spoken at home and the language desired to be spoken at home

Variables	Groups	N	$\bar{X}$	SS	F	p
Gender	Male	262	42.46	15.17	18,457	.000
	Girl	170	36.55	11.91		
Father in Turkish. Does he know?	Yes	421	40.11	14.21	.060	.807
	No	11th	41.18	16.81		
Speaking at Home Desired Language	Turkish	84	36.54	15.03	6.706	.010
	Kurdish	348	41.00	13.95		
Your mother's Turkish Does he know?	Yes	303	39.24	14.33	4,071	.044
	No	129	42.25	13.93		
Spoken at Home Language	Turkish	199	38.86	14.23	2,947	.087
	Kurdish	233	41.22	14.22		

When Table 9 is examined, it is seen that there is a significant difference between the Turkish reading anxiety of 8th grade students and their gender, $F_{(1, 430)}$ = 18,457, p<.05. In other words, it can be said that 8th grade students have higher Turkish reading anxiety levels for boys ($\bar{X}$ = 42.46) and girls ($\bar{X}$ = 36.55). It is seen that there is no significant difference between the Turkish reading anxiety of 8th grade students and whether their fathers know Turkish or not, $F_{(1, 430)}$=0. 060, p>.05. It can be said that there is no difference between 8th grade students' Turkish reading anxiety whether their fathers know Turkish or not. It is seen that there is a significant difference between the Turkish reading anxiety scores of the 8th grade students and the language preferences they want to be spoken at home, $F_{(1, 430)}$= 6.706, p<.05. In other words, it can be said that the language preference of 8th grade students to be spoken in Kurdish at home ($\bar{X}$ = 41.00) is higher than their Turkish reading anxiety ($\bar{X}$ = 36.54). It is seen that there is a significant difference between the Turkish reading anxiety of 8th grade students whether their mothers know Turkish or not, $F_{(1, 430)}$ = 4.071, p<.05. In other words, it can be said that the mothers of 8th grade students have higher Turkish speaking anxiety of those who do not speak Turkish. It is seen that there is no significant difference in eighth grade students' Turkish reading anxiety in terms of the language spoken at home, $F_{(1, 430)}$ = 2.947, p>.05. In other words, it can be said that there is no difference between the 8th grade students' Turkish reading anxieties and the language preference spoken at home. It is recommended to use the eta -square (η 2) correlation coefficient to determine the effect size (Büyüköztürk, 2017). The effect size takes a value between 0-1. Between 0.00 and 0.06 is interpreted as a small effect, between 0.06 and 0.14 as a medium effect, and values greater than 0.14 are interpreted as a large effect (Büyüköztürk, 2017; Cohen, 1988). In this study, the effect size of 8th grade students according to their gender was found to be 0.04 for their Turkish reading anxiety, 0.009 for their mother' knowledge of Turkish, and 0.01 for the Language Preferences You Want to speak at home. In this case, it can be said that the effect size obtained in this study has a low level of effect.

4. DISCUSSION AND CONCLUSION

In this study, it was aimed to develop a measurement tool to measure 8th grade students' Turkish reading anxiety in a valid and reliable way. While developing the TRAS, an item pool consisting of 40 items was created. The opinions of five experts were taken to ensure the scope and face validity of the scale. In line with the suggestions of the experts, a 32-item measurement tool was obtained. Items in the scale; It was applied to 8th grade students with a five-point Likert- type grading of Never (1) → Rarely (2)→ Sometimes (3)→ Often (4)→ Always (5). EFA and CFA were used to test the construct validity of the scale. As a result of EFA, it was obtained from a three-factor structure consisting of 19 items. It is seen that this structure explains 46.280% of the total variance. Considering the content and theoretical structures of the items that emerged as a result of the EFA analysis, the first sub-dimension of the scale was named as fear, the second as anxiety, and the third as preference. CFA was applied to test the accuracy of the three-factor structure obtained as a result of EFA. As a result of the CFA, it is seen that the fit indices of this three-factor structure of TRAS have taken appropriate values. The variance rate explained in the EFA was 30% and higher values were taken as a criterion. It is seen that the CFA fit indices are suitable for the value taken as a criterion. According to the results of EFA and CFA conducted for TRAS, it was concluded that construct validity was achieved. The internal consistency reliability of the results of the analyzes for TRAS was tested with the method (Cronbach's Alpha reliability coefficient) and the item-total correlations were examined. For the criterion validity of the data obtained from the scale, the difference between the total scale scores of the 27% upper-lower groups was analyzed using the independent sample t-test.

McDonald's ω coefficient was calculated as .81 for fear sub-dimension, .75 for the anxiety sub-dimension, 0.70 for preference sub-dimension, and .87 for the whole scale. Liu (2003) states that the internal consistency coefficients are .70 and above as proof that the scale can be qualified as reliable.

Item analysis was performed to reveal the predictive power of the items obtained from the scale and to determine the item discrimination levels. In the item analysis, 27% lower and upper groups were compared and the corrected item-total correlation was examined. The item analysis result and item-total correlation results were found to be between .546 and .623 in the first factor, between .215 and .586 in the second factor, and between .336 and .557 in the third factor. In addition, as a result of the t test performed between the 27% lower group and the upper group, it was seen that the t-value was significant for all items of the scale. As a result of the analyzes made, it is seen that all items in the scale are distinctive. According to the findings obtained in the research, it was concluded that TRAS would make valid and reliable measurements in determining the Turkish reading anxiety of 8th grade students.

This study was applied to 8th graders in secondary school. The fact that it consists only of students whose mother tongue is Kurdish and who later learned Turkish can be considered as a limitation. It is important to include participants from various groups such as different age groups, genders, education levels. As a sample, research can be conducted by selecting participants who live in Turkey as refugees and learn Turkish later. This study focused on reading anxiety. Different dimensions (writing anxiety, performance anxiety, etc.) can be looked at. Once the scale is developed, you can conduct comparative research among different groups to examine how reading anxiety is related to different factors (age groups, gender, education level).

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Appendix. Turkish reading anxiety

Türkçe Okuma Kaygı Ölçeği	**Hiçbir Zaman**	**Nadiren**	**Bazen**	**Sıklıkla**	**Her Zaman**
1. Türkçe bir metni okumaktan korkuyorum.					
2. Türkçe metinleri yavaş okumak beni rahatsız ediyor.					
4. Herhangi bir Türkçe metni okurken anlamadığım kelimeler beni rahatsız ediyor.					
5. Bazı Türkçe sesleri telaffuz edememek beni geriyor.					
10. Türkçe okumaktansa anadilimde okumayı tercih ederim.					
11. Zorunlu durumlar dışında Türkçe okumayı tercih etmem.					
12. Türkçe yazılmış roman, hikâye vb. gibi yayınları okumak beni endişelendirir.					
17. Türkçe okuma yaparken bazı kelimeleri telaffuz edemiyorum.					
18. Türkçedeki bazı kelimeleri yanlış okumak beni rahatsız ediyor.					
19. Topluluk önünde okuma yaptığım zaman birilerinin dalga geçmesinden endişe duyarım.					
22. Türkçe okumaktansa konuşmayı tercih ederim.					
25. Yaşadığım çevrede konuşulan Türkçe ile kitap metinlerindeki Türkçenin aynı olmadığını düşünüyorum					
26. Türkçe okuma fikri beni kaygılandırıyor					
27. Türkçe bir metni okumak beni heyecanlandırıyor.					
28. Türkçe okurken kendi anadilime benzer kelimeler gördüğümde rahatlarım.					
29. Türkçe metinleri okurken anlamadığım deyimler olunca metni okuma isteğim kaybolur.					
30. Arkadaşlarım bana güler diye Türkçe bir metni okumaya çekinirim.					
31. Türkçe okumam iyi olmadığı için derste okuma parçalarını okumak istemiyorum.					
32. Öğretmenin derste bana okuma görevi vermesinden çok korkarım					

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Abstract

The aim of the study is to examine Problem Based Learning (PBL) studies in terms of descriptive and semantic content analysis by using topic modeling. For this purpose, descriptive and topic modeling analyzes were used together in the research. In order to include the highest number of articles on Scopus, the term "problem based learning" was searched in the title, abstract and keywords and only journal articles (research and review) were selected. Thus, 7289 articles in 1987-2021 were included in the study. Firstly, the subject area, author and country distributions are listed. In addition, it showed that the most studied topics were education curriculum (39.15%), teaching strategies (14.90%), critical thinking skill (12.29%) and patient simulation (8.88%). When examined in seven five-year periods between 1987 and 2021, it was determined that the most voluminous topic was education curriculum, and the most accelerated topic was clinical education. Considering the number of publications in five-year periods, it was determined that the topics of critical thinking skills and teaching strategies accelerated more in the percentages calculated according to the topics. It is expected that the results obtained will be important reference points for the studies to be carried out in the field of PBL.

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Research Article

A Broad View of the Problem-Based Learning Field Based on Machine Learning: A Large-Scale Study Based on Topic Modeling*

Özcan ÖZYURT [1] **Alper ASLAN** [2]

Abstract

The aim of the study is to examine Problem Based Learning (PBL) studies in terms of descriptive and semantic content analysis by using topic modeling. For this purpose, descriptive and topic modeling analyzes were used together in the research. In order to include the highest number of articles on Scopus, the term "problem based learning" was searched in the title, abstract and keywords and only journal articles (research and review) were selected. Thus, 7289 articles in 1987-2021 were included in the study. Firstly, the subject area, author and country distributions are listed. In addition, it showed that the most studied topics were education curriculum (39.15%), teaching strategies (14.90%), critical thinking skill (12.29%) and patient simulation (8.88%). When examined in seven five-year periods between 1987 and 2021, it was determined that the most voluminous topic was education curriculum, and the most accelerated topic was clinical education. Considering the number of publications in five-year periods, it was determined that the topics of critical thinking skills and teaching strategies accelerated more in the percentages calculated according to the topics. It is expected that the results obtained will be important reference points for the studies to be carried out in the field of PBL.

Keywords: : Problem based learning, latent dirichlet allocation, topic modeling, research trends

1. INTRODUCTION

With the change in the world of information, the speed in knowledge production has caused some concepts in the literature to be reconsidered. Today, beyond accumulating knowledge, individuals who discuss, question, identify the problems around them and develop solutions to these problems are needed. Trilling and Fadel (2009) explain this situation with the increasing information resources and the developments in the speed of access to these resources, so they state that the competencies that individuals should have need to be redefined. Voogt and Roblin (2012) stated in their research that self-management, cooperation, communication, Information and Communication Technologies (ICT) proficiency, social skills, creativity, critical thinking and problem solving skills are among the basic competencies of the 21st century. Among these competencies, problem solving skills come to the fore (Phungsuk, Viriyavejakul & Ratanaolarn, 2017). Problem solving skills are accepted among higher-order thinking skills (Lewis & Smith, 1993).

One of the approaches frequently used to make the students gain problem-solving skills is the PBL approach. Hmelo-Silver (2004) states that PBL is designed to provide students with guided experiences in learning by solving complex, real-world problems. According to Manalo and Chua

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(2020), PBL is an active learning methodology that encourages critical thinking. Dolmans and Gijbels (2013) define PBL as a student-centered learning approach. PBL has emerged as a medium to make applications more realistic in medical education in higher education (Barrows & Tamblyn, 1980). Later, the PBL approach was widely used in many fields in different disciplines. With the spread of internet-based applications, digital PBL has gained popularity recently (Chao et al., 2021).

There are many studies in the literature on PBL, which is used in many disciplines in both face-to-face and distance education environments. In this context, especially in recent years, many bibliometric studies or systematic reviews on PBL have contributed to the literature. However, as can be seen in the literature, systematic review studies are generally conducted with a small number of studies (Haymana & Dağhan, 2020; Yang, Lo, Xia, Wan & Sun, 2016). When examining some of the studies in this sense;

- Newman (2003) conducted a systematic review to examine the effect of PBL in his research and this research included 12 studies.
- Kong, Qin, Zhou, Mou and Gao (2014) examined the effect of the use of PBL on students' critical thinking in nursing education skills in their study and included 9 articles in their systematic review.
- Williams and Beattie's (2008) research on the use of PBL in clinical education included 5 articles.
- Jin and Bridges (2014) focused on instructional technologies in the use of PBL in health sciences within 28 articles in their study.
- Koh, Khoo, Wong and Koh (2008) conducted a systematic review of 13 articles, including the use of PBL in medical education.
- Polyzois, Claffey and Attheos (2010) examined the short and medium term effects of PBL use in health education in their study and included 13 qualitative studies.
- Wilder (2015) also examined the effect of PBL on academic achievement in secondary education and conducted a systematic review study with 13 articles.
- In the study conducted by Sayyah, Shirbandi, Saki-Malehi and Rahim (2017), the use of PBL in medical and nursing education was examined by including 21 articles in their research.
- Galvao, Silva, Neiva, Ribeiro and Pereira (2014) examined the effect of PBL on student achievement in pharmacy education through 5 articles.

As can be seen from the studies, many systematic reviews have been conducted in the field of PBL. The fact that systematic reviews studies were generally conducted with a small number of articles or research does not mean that they do not contribute to the literature, but this can be considered as an important limitation (Gurcan, Cagiltay & Cagiltay, 2021; Ozyurt & Ozyurt, 2022). The processing of data by researchers in systematic review studies makes it difficult to carry out such studies on big data (Gurcan, Ozyurt & Cagiltay, 2021). Bibliometric studies can be considered as an alternative because they are conducted with big data. However, due to the fact that the studies examined in bibliometric analysis studies are carried out using only certain descriptive parameters, they provide very limited information in terms of the content of the studies (Gurcan et al., 2021). For example, Hallinger (2021) examined 14130 studies (articles, papers, reviews, etc.) between 1972 and 2019 in his bibliometric review and stated this as a limitation in the last part of his study that bibliometric reviews did not focus on the content of the studies. In this regard, topic modeling studies based on data-text mining can create an alternative solution. The themes and trends of the studies in the field examined in topic modeling studies can be handled on a very large scale (Gürcan & Özyurt, 2020; Gurcan et al., 2021). In recent years, it is seen that topic modeling studies have been preferred to overcome similar limitations. (Hu, Boyd-Graber, Satinoff & Smith, 2014; Ozyurt & Ozyurt, 2022). In terms of PBL field, it was stated that an important limitation was created in the number of studies examined in order to achieve more generalizable results in many systematic review studies and this should be overcome (Azer & Azer, 2015; Jin & Bridges, 2014; Li, Wang, Zhu, Zhu & Sun, 2019; Yuan, Williams & Fan, 2008). In addition, some of the systematic review studies in the field of PBL are limited to certain databases such as databases in the field of medicine (Koh, Khoo, Wong & Koh, 2008). Based on all these, it is considered the study will make significant contributions to the literature as it has the potential to overcome a few important limitations in the literature in the field of PBL, new research is needed as PBL has started to find its place in distance education environments as well as in face-to-face education environments, and it is one of the most extensive and comprehensive studies in the literature in terms of scale. In this context, it was aimed to determine the interests and trends of research in the field of PBL by examining the studies on the PBL approach in terms of content and descriptive analysis by using the topic modeling analysis. For this purpose, answers to the following research questions were sought:

- What are the descriptive characteristics of the studies on the PBL?
    - RQ1. What is the distribution of PBL studies by years?
    - RQ2. What are the prominent subject areas in PBL studies?
    - RQ3. Which authors and countries stand out in PBL studies?
- What are the topics and what kind of changes have come out in the studies on the PBL?
    - RQ4. What are the prominent topics in PBL studies?
    - RQ5. How do the prominent topics in PBL studies change over time?

1.1. Literature Review

1.1.1. Problem based learning

PBL is a student-centered learning method and learning process that provides an organizational method for a course (Barrows & Kelson, 1993). The PBL approach exposes students to real-life problems (Savery, 2015). Students take an active part in the learning process while solving the problems they encounter. While discussing the problems they encounter, students can construct new knowledge based on what they know (Bransford & McCarrell, 1977). One of the modern learning approaches on which PBL is based is collaborative understanding. Shen, Wang, Yang and Yeh (2012) define PBL as a learning method in which the teacher presents a problem to the students and initially watches them work on their own, then they discuss possible solutions to the problem with group work and find the most appropriate solution.

While the PBL approach facilitates students' learning, it increases their motivation for the lesson (Hallinger & Lu, 2011). In addition, small group discussions improve students' problem-solving and higher-order thinking skills (Blumenfeld, Marx, Soloway & Krajcik, 1996). Thanks to this approach, students can increase their communication skills (Uden & Beaumont, 2006) and improve their critical thinking skills (Goodnough & Cashion, 2006). According to Hmelo-Silver (2004), PBL has advantages such as easier adaptation to changes, finding solutions to problems, critical and creative reasoning, collaborating with the group, identifying their own strengths and weaknesses, acquiring self-learning skills, being open-minded and encouraging active learning. Because, in traditional approaches, the role of the student, who acquires knowledge only by listening to the teacher, leaves its place to the role of the student who makes his knowledge permanent by researching, examining, experimenting and interacting with his environment. However, as with many learning approaches, PBL has some limitations. Compared to traditional approaches, the workload of both the teacher and the student increase in the PBL approach. In addition, some courses and curricula are not suitable for PBL (Nicholl & Lou, 2012).

In the PBL approach, the learning process is expected to encourage students to solve problems using active learning and higher-order thinking skills (Albanese & Mitchell, 1993; Jonassen, 2000). For this, scenarios are prepared in which students will encounter problems similar to those in real life. Scenarios are an important part of the PBL approach and these scenarios need to have some characteristics. Scenarios should not be well-structured, simple and understandable in a way that students can encounter in daily life (Hmelo-Silver, 2004). It is important to ensure that each scenario focuses on only one problem situation (Ram, 1999). There should be guiding tips for teachers and students in the prepared scenarios. Thus, it can be ensured that students evaluate their problem situations without moving away from their learning goals (Aksoy, 2011). The problem situation in the scenarios should be challenging, multi-directional and interesting for the student (Hmelo-Silver, 2004). Scenarios should be suitable for children's mental development, in a size that can be solved within the learning period, and should allow students to form hypotheses (Ram, 1999). Thus, students will be able to actively participate in the learning process.

In the PBL process, students need to be guided so that they can perform the problem solving process (Peterson, 2004). Teachers have important responsibilities during and after the PBL preparation process. In the PBL process, teachers are the individuals who facilitate learning, encourage students to think reflectively (Hmelo-Silver, 2004), organize activities and discussions (Hoffman, 1998), and are cognitive and metacognitive guides. Although it is thought that the real heroes of the process are the students, it is very difficult to manage the process without the guidance and direction of the teachers. In the PBL approach, students work collaboratively in small groups. It is very important in this approach to provide students with environments where they can structure their own learning by benefiting from each other's experiences (Taylar & Hamdy, 2013), enable students to acquire new information about the problem situation (Song, Grabowski, Koszalka, & Harkness, 2006). Carey and Whittaker (2002) stated that it is very important for a successful PBL process that students work as a member of a team and have the ability to collaborate with their peers. In the PBL process, students work in groups of 5-7 collaboratively to solve the problem. At this stage, it is very important that the groups are formed correctly because sloppy forming of groups can turn a positive learning experience into a negative one (Alfonseca, Carro, Martín, Ortigosa, & Paredes, 2006). Lei, Kuestermeyer, Bailey and Westmeyer (2010) identified at least six main factors to be taken into consideration when grouping students; gender, ethnicity, familiarity among members, ability, level of motivation and resources. According to Chan et al. (2010), on the other hand, stated that students' academic achievements should be taken into account while forming groups in a heterogeneous way. Random grouping (Chan et al., 2010; Huxland & Land, 2000), selection by teacher (Hilton & Phillips, 2010), and selection by students (Hilton & Phillips, 2010) are among the most commonly used methods for group formation.

1.1.2. Using ICT in problem based learning

PBL approaches require a change in the teacher-student relationship that emphasizes access to resources and student-centered approaches. At this point ICT can act as a lever for PBL (Lone Dirckinck-Holmfeld, 2009). In addition, ICT makes PBL practically applicable. In this context, PBL is considered as a suitable alternative for ICT integration (Pearson, 2006). As a matter of fact, the emphasis is on the fact that ICT can be used to solve real-world problems in the real learning process (Jimoyiannis, 2010). Similarly, Koehler and Mishra (2005), emphasizes that teachers consider the inclusion of ICT in collaborative authentic problem-solving tasks as an effective way of learning. Karami, Karami and Attaran (2013) states that some students, who are less interested in classroom activities, enjoy working with computers, and that they can play a more active role in the classroom thanks to this integration. In this context, many studies can be mentioned in the literature on the integration of ICT into PBL environments (Osman & Kaur, 2014; Virtanen & Rasi, 2017). The common consensus in these studies is that the integration of ICT into PBL can support and facilitate learning by structuring students' real-world problems in a meaningful way (Donnelly, 2010; Fidan & Tuncel, 2019; Jin & Bridges, 2014). In the light of these studies, it can be said that the integration of ICT into PBL environments is important and necessary to enrich learning.

2. METHOD

2.1. Research Design

Descriptive analysis and topic modeling analysis were used in this research, which aims to examine the studies on the PBL approach in terms of descriptive and semantic content analysis. Descriptive analysis involves organizing, categorizing, and comparing texts and thus obtaining results from texts (Cohen, Lawrence & Morrison, 2017). With this analysis, the descriptive features of the field were revealed. Topic modeling analysis also aims to extract semantic patterns latent in large data sets (Blei, Ng & Jordan, 2003). In other words, topic modeling is an unsupervised machine learning method used to automatically discover latent semantic structures called "topics" in a certain whole (Blei, 2012; Gurcan & Cagiltay, 2019). Topic modeling, which is a probabilistic approach, is often preferred for discovering latent semantic patterns from large data piles that are difficult to handle and analyze (Blei, 2012; Gurcan et al., 2021). In this approach, textual documents contain latent semantic patterns called "topics". Latent Dirichlet Allocation (LDA) algorithm (Blei et al., 2003), which is a generative approach for probabilistic topic models, was used in the study. LDA is widely used in natural language processing, information extraction, job postings, literature research, and content analysis based on topic modeling (Blei & Lafferty, 2007; Gurcan, et al., 2021; Gurcan & Cagiltay, 2020; Ozyurt & Ozyurt, 2022; Ozyurt & Ayaz, 2022). In addition, the LDA algorithm provides an efficient method to calculate the consistency score for the estimation of the optimal number of topics and is therefore widely used for topic modeling (Blei, 2012; Gurcan et al., 2021; Gurcan & Cagiltay, 2019). In this context, LDA analysis was used in the study.

While conducting the research, data collection process, data preprocessing stages, topic modeling and reporting stages were carried out. These stages are presented sequentially in Figure 1.

Figure 1. Stages of the research

2.2. Data Collecting

One of the most critical stages in literature research-based topic modeling studies is the creation of the imperial corpus (Gurcan et al., 2021) because the creation of the corpus is important in terms of determining the scope of the field. In this context, the Scopus database was chosen to reach as many articles as possible. The Scopus database has been used to obtain articles relevant to the scope of the study as it covers more than 7000 publishers worldwide, including Elsevier, Emerald, IEEE, Sage, Springer, Taylor & Francis, and Wiley Blackwell, and this number is increasing day by day (Evia, Sharp & Perez-Quinones, 2015; Scopus, 2022). In order to include the highest number of articles on Scopus, the term "problem based learning" was searched in the title, abstract and keywords and only journal articles (research and review) were selected. Finally, the year 2022 excluded from the search query, all journal articles published from the past to the present (as of the end of 2021) were selected. This selection has returned a total of 7317 articles on scopus from past to present (between 1974 and 2021). In the preliminary examination, it was seen that the total number of articles in 1974-1986 was 28, and its ratio in the total number of articles was below 0.5%. This situation was evaluated by the researchers and it was decided to exclude 28 articles before 1987. Based on these criteria, the following final query was created:

> TITLE ("problem based learning" OR "problem-based learning") OR ABS ("problem based learning" OR "problem-based learning") OR AUTHKEY ("problem based learning" OR "problem-based learning") AND PUBYEAR > 1986 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (EXCLUDE (PUBYEAR , 2022))

This query was used to construct the empirical corpus of the research from the Scopus database. The query was run on June 1, 2022. The search returned a total of 7289 articles (6625 research and 664 review). The title, abstract, author and keywords of these articles were added to the data set.

2.3. Data Pre-processing Stages

The data pre-processing stage is an important sequence of operations that directly affects the success of the analysis in data/text mining (Aggarwal & Zhai, 2013; Gurcan & Cagiltay, 2020). With the sequence of these processes, raw data is converted into a clean dataset ready for analysis (Aggarwal & Zhai, 2013). In this empirical analysis, the following sequential steps were carried out in the preprocessing process in order to successfully apply the topic modeling process to the PBL corpus.

First, all textual content in the dataset was converted to lowercase, and web links, tags, publisher information, numeric expressions, punctuation and symbols in the dataset were cleaned. Then, word tokenization was applied to represent the textual contents as single words. Then, words and stop words (a, an, is, the, of, for, etc.) that do not make sense in the text were discarded. Similarly, generic words (e.g. literature, purpose, article, research, study, and copyright) that are frequently observed in articles but do not contribute to the establishment of semantically coherent topics are also added to the stop word list. Lemmatization was performed to reach the stem of the words. In this way, it is ensured that words derived from the same root are singular. Finally, each of the articles forming the corpus was converted into a word vector using the "word bag" approach to provide a numerical representation of the words in the corpus. At the end of all these processes, a document term matrix (DTM), which represents the whole corpus and provides the necessary matrix form for the topic modeling analysis, was created by combining these vectors (Blei et al., 2003; Gurcan et al., 2021). All these processes were carried out using Python language and data analysis libraries.

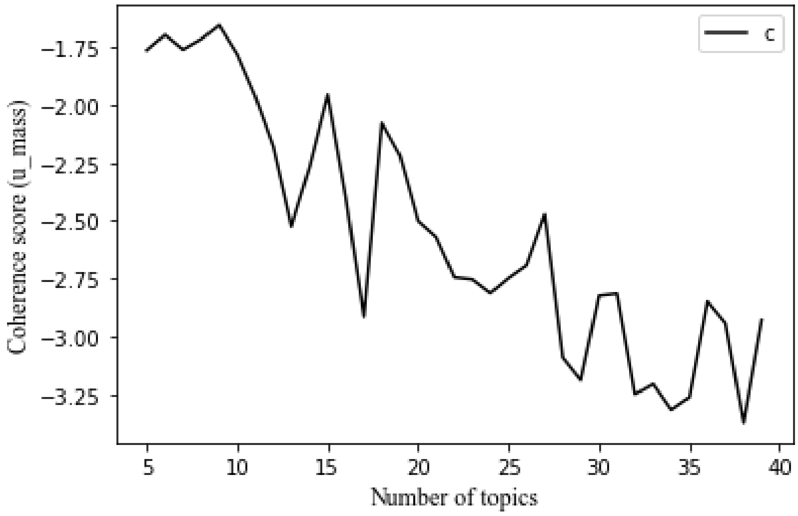
2.4. Data Analysis

After the preprocessing stage, LDA based topic modeling analysis was performed with the data set ready for analysis. LDA calculates the topic distribution per document, the word distribution per topic, and the topic and word assignments per document using an iterative process based on the Dirichlet distribution (Blei, 2012). In this study, the Gensim library, a comprehensive toolkit developed for text mining and topic modeling in Python, was used to adapt and apply the LDA based topic modeling procedure to the PBL corpus (Prabhakaran, 2018). In order to adapt the LDA model to the corpus, the initial values of the parameters of α, which determines the topic distribution in the documents, and β, which determines the distribution of the words in the topics, were chosen as default.

In the pilot analysis, it was observed that the words “problem”, “based”, “learning” and “pbl” were used in almost every topic. Since the corpus is directly in this field, two field experts were consulted and it was decided to add these two words to the stop words. Then, LDA analysis was performed again.

“u_mass coherence measure” was taken into account in determining the appropriate number of topics in the LDA analysis. U_mass value is accepted as one of the best coherence measure methods used to determine the ideal number of topics (Mimno, Wallach, Talley, Leenders & McCallum, 2011). As the number of topics increases, the umass value decreases. However, intuitive inferences can be made on the break-peak points of the umass graph (Gurcan & Cagiltay, 2022; Mimno et al., 2011). In this context, to empirically select the ideal number of topics (K), the LDA model was applied iteratively with different K values ranging from 5 to 40, and a u_mass coherence measure (c) was calculated for each K. Figure 2 shows the graph of the u_mass c value obtained for each K value between 5-40 using the u_mass semantic consistency approach. The clarity and semantic consistency of the discovered topics at these points were evaluated by the researchers by taking into consideration the important break-peaks (models with 6, 9, 15, 18, 27, and 31 topics in figure 2). It was decided that the model with 18 topics was appropriate, with a maximum consistency score (K = 18; u_mass_c=-2.077) reflecting the suitability and consistency of the topics distributions within these breakpoints.

Figure 2. Number of topics-u_mass coherence measure graph for 5-40 topics



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The significance and consistency of these topics, which are explained with representative keywords, were evaluated by two experts working in the field of PBL, apart from the researchers. After examining the consistency of the topics, the label of each topic was determined and assigned by two field experts and researchers, taking into account the descriptive keywords of the topics. After naming the topics, the percentage of each topic per document, the distribution of words in each topic and the distribution of the topics in the entire corpus were calculated. At the end of this process, 15 representative key terms with the highest frequency were selected for each of the 18 topics. As a result, trend analyzes were performed with these 18 topics discovered by LDA, taking into account the u_mass consistency metric and semantic analysis.

3. RESULTS

In this research, which aims to examine the studies on the PBL approach in terms of content and descriptiveness, answers to five research questions were sought. The findings of the research are presented within the framework of the research questions.

3.1. Distribution of PBL Studies by Years (RQ1)

In the first research question of the study, the distribution of PBL studies by years was examined. The distribution of 7289 articles included in the research by years is given in Figure 3.

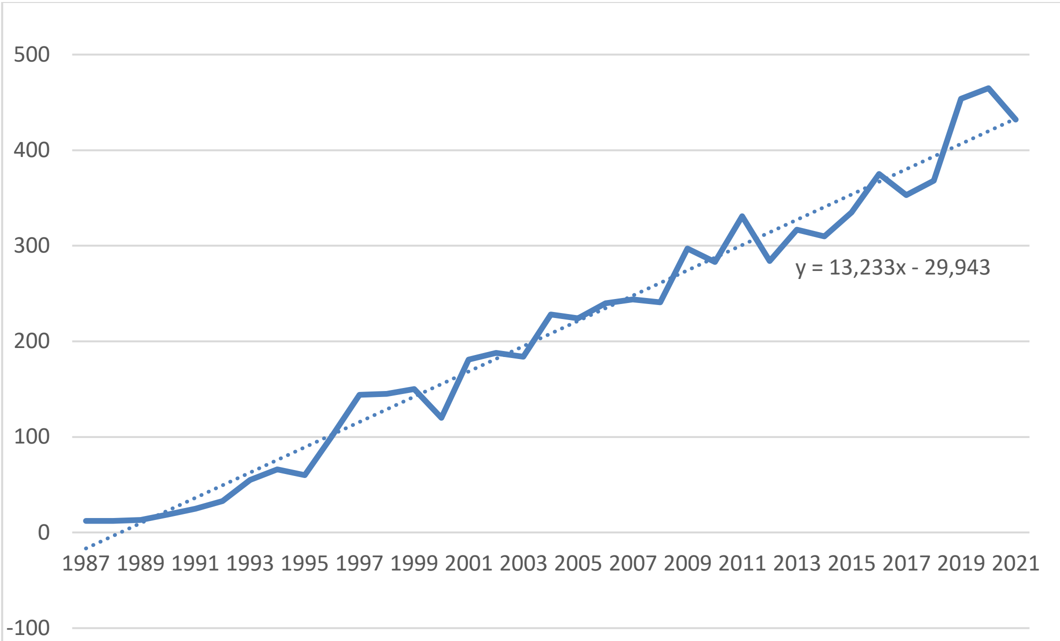

Figure 3. Distribution and slope of PBL studies by years

When Figure 3 is examined, the number of publications for 35 years in the field of PBL and the change in the number of publications by years are seen. As seen in Figure 3, PBL studies have increased linearly over the years. It can be said that it has reached the highest number of publications in recent years.

3.2. Subject Areas in PBL Studies (RQ2)

In the second research question of the study, the subject areas where PBL studies were conducted were examined. It has been observed that PBL studies are intensified especially in the subject of Social Sciences. Data on other subject areas in PBL studies are given in Figure 4.

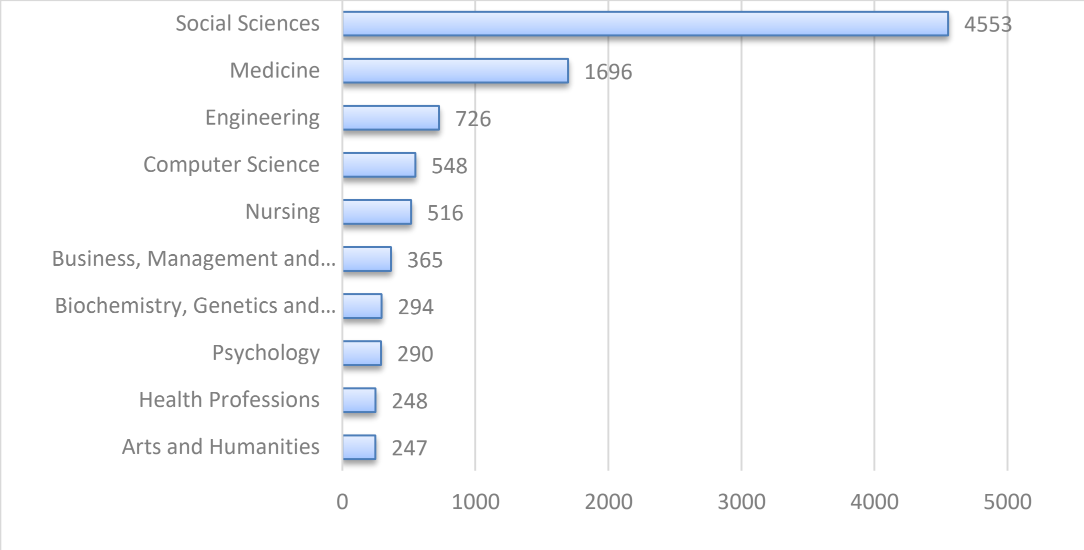

Figure 4. Subject areas in PBL studies

When Figure 4 is examined, it is seen that PBL studies stand out in the subject of Medicine (n=1696), Engineering (n=726) and Computer Science (n=548), especially in Social Sciences (n=4553). It is noteworthy that PBL studies were also carried out in studies conducted in different sub-fields of medicine such as Nursing, Psycology and Health Progessions.

3.3. Prominent Authors and Countries in PBL Studies (RQ3)

The third research question of the study is about examining the prominent authors and their countries in PBL studies. Schmidt, H.G. He is researcher who has the highest number of study in the field of PBL with 62 studies. Data on other researchers are given in Figure 5.

Figure 5. Prominent authors in PBL studies

According to Figure 5, Dolmans, D.H.J.M. with 46 studies, Van Der Vleuten, C.P.M. with 37 studies, are the authors who have conducted the highest number of the study in the field of PBL following Schmidt. When we look at the countries where studies in the field of PBL are carried out, United States was in the first rank with 1963 studies. The number of studies carried out in other countries is given in Figure 6.

Figure 6. Prominent countries in PBL studies

According to Figure 6, while the United States was in the first rank out and away with 1963 articles in the studies in the field of PBL, United Kingdom with 687 articles, Australia with 478 articles and Canada with 432 articles contributed to the studies in the field of PBL.

3.4. Prominent Topics in PBL Studies (RQ4)

The fourth research question of the study is about the prominent topics in PBL studies. These topics will provide the information to determine the research interests and trends in the field of PBL. LDA based topic modeling analysis was conducted to determine the topics studied in the field of PBL. As a result of the analysis, 18 prominent topics were determined. First 15 terms that make up each topic are listed and examined according to their intensities. In the naming stage of the topics, support was received from three field experts who worked in the field of PBL. The topics that emerged as a result of the LDA analysis, the terms that make up the topics and the volume ratios of the topics are presented in Table 1.

Table 1. Discovered topics, terms that make up the topics and volume ratios

Topics	Topic terms	Rate (%)
education curriculum	curriculum, education, teaching, practice, development, school, student, change, university, method, educational, professional, experience, nan, challenge	39.15%
teaching strategies	student, skill, solving, knowledge, teaching, strategy, ability, analysis, environment, learner, activity, task, teacher, case, writing	14.90%
critical thinking skill	student, thinking, test, skill, critical, effect, self, model, significant, solving, analysis, achievement, ability, school, method	12.29%
patient simulation	student, case, patient, simulation, clinical, pharmacy, medical, experience, scenario, facilitator, concept, knowledge, skill, interprofessional, care	8.88%
engineering education	engineering, student, project, skill, team, design, education, development, methodology, teaching, role, teamwork, model, analysis, work	6.11%
flipped classroom	student, teacher, science, teaching, classroom, method, methodology, education, model, flipped, active, development, strategy, skill, evaluation	3.51%
dental education	student, dental, perception, curriculum, method, undergraduate, questionnaire, experience, medical, self, education, perceived, response, survey, academic	3.35%
computer aided education	education, computer, database, teaching, analysis, technology, creativity, map, systematic, evidence, method, online, digital, educational, concept	2.48%
nursing education	nursing, student, education, health, nurse, care, patient, method, clinical, professional, intervention, attitude, practice, skill, program	2.44%
medical education	medical, student, clinical, curriculum, method, teaching, school, knowledge, medicine, lecture, examination, traditional, performance, education, basic	1.36%
virtual teaching	teaching, virtual, method, web, game, ethic, online, technology, evaluation, clinical, patient, training, practice, platform, ebm	1.08%
radiology education	teaching, radiology - cbl, education, method, china, analysis, , chinese, meta, student, medical, coaching, information, model, lbl	1.06%
therapy training	training, occupational, therapy, social, work, leadership, education, program, video, trainee, professional, practice, psychiatry, development, programme	1.03%
peer assessment	tutor, student, assessment, faculty, tutorial, peer, teaching, feedback, evaluation, method, medical, resident, training, self, program	0.91%
project based learning	student, design, project, system, solving, development, skill, engineering, model, environment, technology, case, information, learner, collaborative	0.51%
health care education	health, care, community, program, information, library, public, education, training, medicine, literacy, curriculum, university, veterinary, medical	0.43%
online education	education, student, online, case, medical, educational, teacher, knowledge, teaching, university, technology, development, higher, environment, experience	0.30%
clinical education	practice, education, clinical, skill, care, program, continuing, educational, intervention, module, change, professional, participant, training, physician	0.22%

It is seen in Table 1 that the most studied topic in the studies in the field of PBL is “education curriculum” with 39.15%. Together with the “education curriculum” (39.15%), “teaching strategies” (14.90%), “critical thinking skill” (12.29%) and “patient simulation” (8.88%) topics constitute almost 3/4 of the studies in the field of PBL. It has been revealed that the topics of “online education” (0.30%) and "clinical education" (0.22%) are among the least studied topics in PBL studies. Considering the general distribution of the topics, it is possible to say that the topics in the field of medicine are in the majority among 18 topics. In fact, it has been determined that more specific areas of medicine such as “dental education” (3.35%), “radiology education” (1.08%) and “therapy training” (1.03%) are frequently included in PBL studies.

3.5. Temporarily changes of prominent topics in PBL studies (RQ5)

The fifth research question of the research is about how the prominent topics in PBL studies change temporarily. As well as the prominent topics in PBL studies, the change of these topics over time is also very important for the field of PBL. In this context, PBL studies conducted in 1987-2021 were analyzed in seven five-year periods. The findings obtained as a result of the analysis are given in Table 2.

Table 2. Distribution of the number of articles on the topics by five-year periods

Topics	Periods							**Total**
	1987-1991	1992-1996	1997-2001	2002-2006	2007-2011	2012-2016	2017-2021	
	1	2	3	4	5	6	7	
Education curriculum	53	172	396	473	537	569	654	**2854**
Teaching strategies	4	29	71	115	216	281	370	**1086**
Critical thinking skill	5	15	37	98	156	218	368	**897**
Patient simulation	3	21	60	113	129	138	183	**647**
Engineering education	0	11	12	47	86	117	172	**445**
Flipped classroom	1	9	13	25	48	71	89	**256**
Dental education	6	18	35	45	45	50	45	**244**
Computer aided education	1	7	25	19	29	43	57	**181**
Nursing education	2	7	24	30	40	39	36	**178**
Medical education	3	8	20	19	27	13	9	**99**
Virtual teaching	0	2	3	15	17	20	22	**79**
Radiology education	1	4	6	15	18	14	19	**77**
Therapy training	2	5	14	18	16	11	9	**75**
Peer assessment	0	2	12	15	10	17	10	**66**
Project based learning	0	0	3	10	7	9	8	**37**
Health care education	1	4	4	3	9	2	8	**31**
Online education	0	1	3	3	3	7	5	**22**
Clinical education	0	0	2	1	3	2	8	**16**
Total	**82**	**315**	**740**	**1064**	**1396**	**1621**	**2072**	**7289**

According to Table 2, it can be said that the topic of "education curriculum" continues to increase its volume in PBL studies in every period. Especially in the period of 1997-2001, studies on the “education curriculum” increased by approximately 230% compared to the previous period. Similarly, there were significant increases in “teaching strategies” and “patient simulation” in the same period. By looking at the increase in the number of studies on the topics in the periods, the topics with the highest increase rate in each period compared to the number of publications in the previous period were determined and are presented in Figure 7.

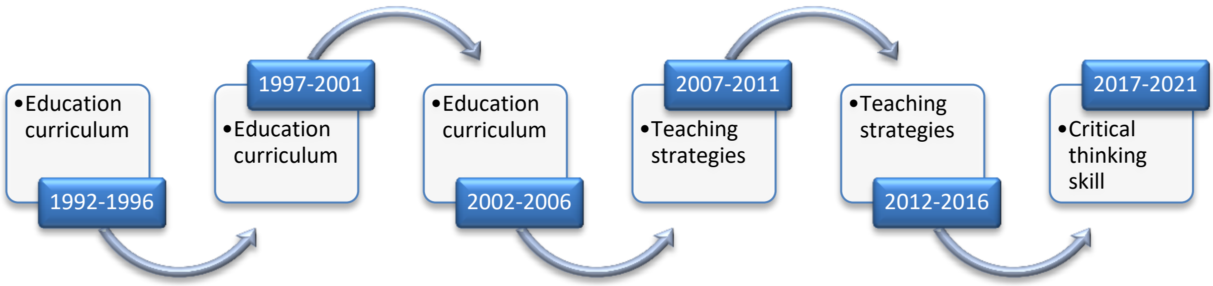

Figure 7. Topics with the highest increase in the number of researches by period

According to Figure 7, the topic of "education curriculum" between the years 1992-2006 has been the topic that increased the number of studies the most compared to the previous five-year period. Between 2007 and 2016, the topic of "teaching strategies" was the first topic to increase the number of researches compared to the previous period. In the last period, the topic of "critical thinking skill" became prominent among other topics. In order to examine the temporal changes of the prominent topics in the PBL studies more clearly, the volumes and slopes of the topics in the periods were calculated and their graphs were created. Periods are shown on the horizontal axes of the graphs, and the number of publications in that period is shown on the vertical axes. The resulting graphics are presented in Figure 8.

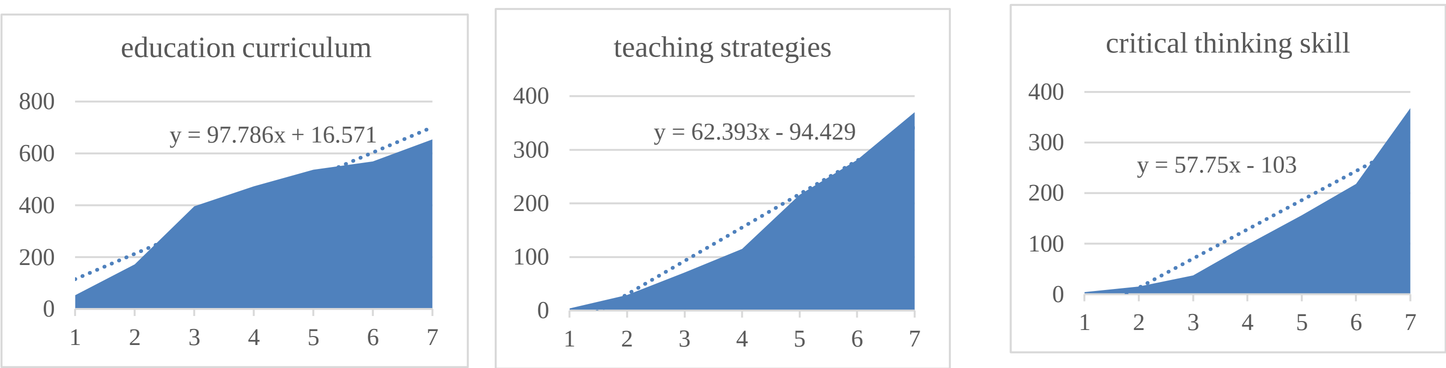

Figure 8. Volumes and slope graphs of all topics within periods

Figure 8 shows the graphs of the top three subjects according to their volume densities. When the graphics are examined, the "education curriculum" is the most voluminous topic among the topics studied in the field of PBL. In addition, "education curriculum" has become prominent as the topic with the fastest growing volume among other topics (Acc=97.78). In other words, "education curriculum" in PBL studies has been the topic that has the highest rate of increase in terms of the number of publications in five-year periods. The topics of "teaching strategies" and "critical thinking skill" also came first in terms of volume and acceleration among other topics. The volume graphs of the topics compared to other topics and their trends are presented in Figure 9. In the created graphs, the horizontal axis shows the periods, the vertical axis shows the percentages of the topic in that period. The order of the topics is organized according to the magnitude of their acceleration and the graph of the first three ranked topics is included.

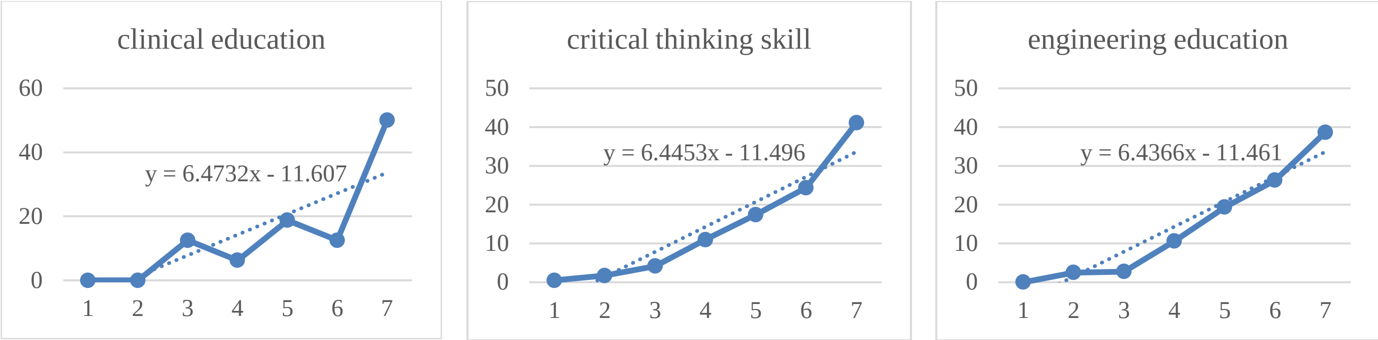

Figure 9. Percentage and acceleration graphs of each topics compared to other topics within periods

As a result of the analysis, it was seen that the topic of "clinical education" was the most accelerated topic (Acc=6.47). In addition, it was determined that the topics of "critical thinking skill, engineering education, flipped classroom, teaching strategies, virtual teaching, computer aided education, and patient simulation" were above the average acceleration. Considering the number of publications of the relevant topics in each period, the percentage rate compared to other topics was calculated. Again, a slope value (AccPTP = Percent acceleration relative to other topics in periods) was determined upon these percentages. The slope values of the topics were calculated based on the data obtained according to the results of the LDA analysis. According to the results of the analysis, while the percentage weights of 11 topics increased over time compared to other topics, the percentage weights of 7 topics decreased. The percentage distribution of all topics within the topics studied over time is given in Figure 10.

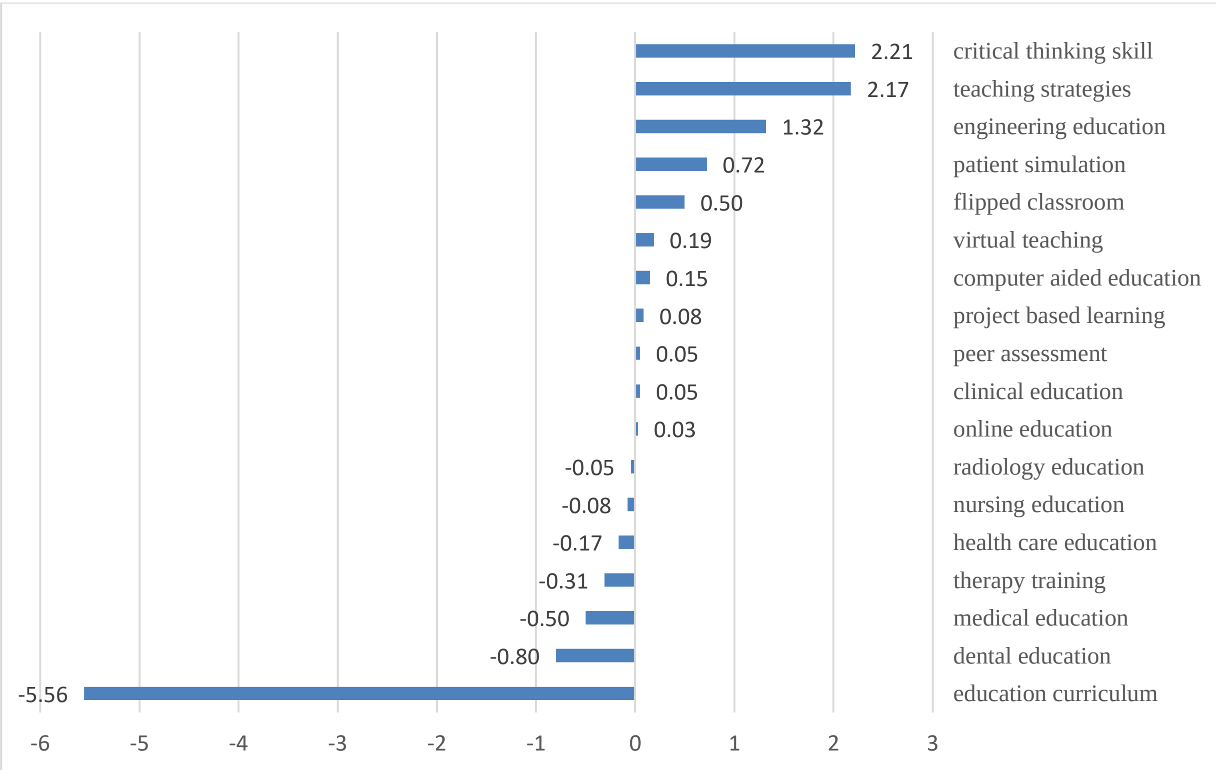

Figure 10. Acceleration values of all topics compared to other topics

According to Figure 10, it is seen that the topics of "critical thinking skill" (AccPTP = 2.21) and "teaching strategies" (AccPTP = 2.17) accelerate more than the other topics. On the other hand, the topic of "education curriculum" (AccPTP = -5.56) became the topic whose percentage weight decreased the most compared to other topics.

4. DISCUSSION AND CONCLUSIONS

In this study, it is aimed to examine the studies based on the PBL approach in terms of descriptive analysis and topic modeling based semantic content analysis. Before moving on to the results of the research, it is important to draw attention to the limitations of the research and to evaluate the results within the framework of these limitations. In this context, the LDA algorithm, which was first used for topic modeling analysis, can be expressed as one of the limitations of the study. The second limitation can be said that only the articles were selected from the study types in the selection of the studies to be analyzed. Finally, the keywords used in the database scans in the selection of the studies can be considered as a limitation of the research.

First of all, descriptive features of the studies in the field of PBL were examined within the framework of the purpose of the research and research questions. In this context, the distribution of PBL studies by years, subject areas, countries and researchers who have conducted the most research have been examined. In the examination, it was determined that the number of PBL studies continued to increase over the years. When the literature is examined, it is seen that PBL is widely used in many education levels from secondary education (Wilder, 2015) to nursing education (Ghani, Rahim, Yusoff & Hadie, 2021).

In terms of the research fields in PBL studies, “Social Sciences”, “Medicine” and “Engineering” took the top three ranks. According to the results of the study, it is possible to say that the PBL approach is used in different disciplines. Similarly, Savery (2006), Majeski and Stover (2005) define the PBL approach as an approach that can be used in different disciplines and interdisciplinary learning activities. However, Stentoft (2017) states that a comprehensive approach on how to organize PBL to support interdisciplinary learning has not yet been developed. It is thought that future studies in this context will make significant contributions to the literature. On the other hand, the prominence of different fields of study, especially in the field of medicine, such as “Nursing”, “Psycology” and “Health Progessions” is remarkable. Considering that the first applications of PBL in learning environments were made in the field of medicine (Schmidt, 1983) and the applications in other disciplines were realized after successful applications in the field of medicine, it is not surprising that the use of PBL is widespread in the sub-disciplines of medicine. In PBL studies, United States ranked first with 1963 research, while United Kingdom (n=687) ranked second and Australia (n=478) ranked third. In terms of the researchers with the highest number of study in the field of PBL, Schmidt, H.G. (n=62) and Dolmans, D.H.J.M. (n=46) become prominent. In the studies conducted by Hallinger (2021) and Zhang, Wang, Bai and Zhang (2022), the country with the highest number of studies in the field of PBL is the United States, while Schmidt, H.G. and Dolmans, D.H.J.M. in the top ranks in terms of the authors with the highest number of publications.

After examining the descriptive features of PBL studies, the topics studied in the field of PBL and their temporal changes were examined. As a result of the LDA analysis, it was determined that the studies in the field of PBL concentrated on 18 topics. Among these topics, "education curriculum" (39.15%), “teaching strategies” (14.90%) and “critical thinking skill” (12.29%) are in the top three ranks. At the same time, these three topics make up more than half of the total study field (66.34%). The fact that these topics constitute a large part of the studies in the field of PBL can be explained by the change in expectations from the learning process and education systems. In recent years, it has been observed that in many teaching levels, especially in medical education, the development of skills such as critical thinking and problem solving has been the focus point (Merisier, Larue & Boyer, 2018). Similarly, according to Al-Azri and Ratnapalan (2014) many universities and educational institutions try to use PBL as a teaching model and continue their research and development activities in this direction. Two factors can be effective in bringing these three issues to the fore: First, expectations in education systems shapes around skills such as critical thinking skills, taking responsibility for one's own learning and problem solving, which are accepted as 21st century skills. Second, educational institutions make efforts to evaluate PBL as a holistic learning model. In addition to these, it has been determined that topics such as “peer assessment”, “project based learning”, “health care education”, “online education” and “clinical education” are studied proportionally below 1%.

The results of the LDA analysis showed that the “education curriculum” continued in PBL studies by increasing the number of publications over the years. “education curriculum” stood out as the topic that increased its volume the fastest among other topics (Acc=97.78). In other words, “education curriculum” in PBL studies has been the topic that increased the number of publications the most in five-year periods. Looking at the years 1987-2021 within five-year periods, it has been determined that the "education curriculum" has increased the most in the period of 1997-2001. Hallinger (2021), in his study, examined the PBL field in five-year periods, and as a result of his analysis, it was determined that the studies and citation rates in the field of PBL increased rapidly, especially in the period 1995 and later. From this point of view, the highest increase in the "education curriculum" in 1997-2001 may be due to the increase in all topics in the field of PBL during these periods.

As a result of the analysis, it was seen that the topic of “clinical education” was the most accelerated topic (Acc=6.47). In addition, it was determined that the topics of “critical thinking skill, engineering education, flipped classroom, teaching strategies, virtual teaching, computer aided education, and patient simulation” were above the average acceleration. It was revealed that the three least accelerated topics were “medical education” (Acc=1.26), “therapy training” (Acc=1.66) and “health care education” (Acc=2.53). Clinical education is a very important link that brings together university education and professional business life, providing students with the opportunity to apply the knowledge they have acquired during their university education in the field of medicine and nursing in their natural environment (Williams, 1999). PBL is very suitable for clinical education because of the opportunities it provides for students to apply their theoretical knowledge by exposing them to real-life problems in the learning process (Tiwari et al., 2005). In this context, it is expectable situation that the use of PBL in clinical education will become more widespread than in other topics. Although the needs of clinical education and the opportunities offered by PBL largely overlap, there are still significant challenges in applying PBL to different disciplines (Brown, 2022). In addition, some problems such as crowded classrooms in fields considered suitable for PBL use, such as clinical education (Cash, Letargo, Graether & Jacobs, 2017), create significant problems in the use of PBL. In this context, in future research, identifying the problems encountered especially in the topics where PBL is widely used, and proposing solutions for these problems are important.

Acknowledgement

Due to the scope and method of the study, ethics committee permission was not required.

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Abstract

The aim of our study is to examine the psychological resilience and goal commitment levels of the students studying at the Faculty of Sport Sciences of Fırat University over various variables. In our study, descriptive scanning methods were used. A total of 330 individuals, 152 women and 178 men, studying at the Faculty of Sport Sciences of Fırat University, participated in our research on a voluntary basis. "Demographic Information", "Child and Adolescent Psychological Resilience Scale" adapted into Turkish by Arslan (2015) and "goal commitment scale" adapted into Turkish by Senel and Yıldız (2016) were used on the individuals participating in the research. SPSS package program was used for data analysis. Percentage frequencies of the given data were calculated, normal distribution tests were performed, and as a result of these controls, t test was used for those with 2 variables and analysis of variance for multiple variables. Tukey test was used to determine the differences between the groups. The significance level of the study was taken as $p<.05$. As a result, gender, age and types of sports played by students studying at the Faculty of Sports Sciences have no effect on psychological stability and goal commitment, while when we look at the income situation, individuals with high family income status at psychological stability levels are psychologically more robust, but income has no effect on goal commitment, in terms of the classes in which students study 4. it is possible to say that the psychological robustness and goal commitment levels of classroom students are higher than those of students studying in other classes.

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Research Article

Examination of Psychological Strength and Target Commitment Level of Students Faculty of Sports Sciences Province [*]

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Abstract

The aim of our study is to examine the psychological resilience and goal commitment levels of the students studying at the Faculty of Sport Sciences of Fırat University over various variables. In our study, descriptive scanning methods were used. A total of 330 individuals, 152 women and 178 men, studying at the Faculty of Sport Sciences of Fırat University, participated in our research on a voluntary basis. "Demographic Information", "Child and Adolescent Psychological Resilience Scale" adapted into Turkish by Arslan (2015) and "goal commitment scale" adapted into Turkish by Senel and Yıldız (2016) were used on the individuals participating in the research. SPSS package program was used for data analysis. Percentage frequencies of the given data were calculated, normal distribution tests were performed, and as a result of these controls, t test was used for those with 2 variables and analysis of variance for multiple variables. Tukey test was used to determine the differences between the groups. The significance level of the study was taken as p<.05. As a result, gender, age and types of sports played by students studying at the Faculty of Sports Sciences have no effect on psychological stability and goal commitment, while when we look at the income situation, individuals with high family income status at psychological stability levels are psychologically more robust, but income has no effect on goal commitment, in terms of the classes in which students study 4. it is possible to say that the psychological robustness and goal commitment levels of classroom students are higher than those of students studying in other classes.

Keywords: Sports, psychological well-being, goal commitment

1. INTRODUCTION

Psychological Stability The concept of indomitability, which began to be studied as a subject of psychology, especially in the early 1970s, has been described in various ways in the literature. The concept of psychological robustness, psychology, sociology and Biology researchers from various disciplines, such as working on a concept, and by staying positive despite challenges and risky situations is characterized by the ability to adapt to the environment (Masten, 2001). Psychological soundness refers to the process of coping positively despite all kinds of difficulties faced by a person Luthar, Cicchetti and Becker (2000). It is defined as overcoming stressful life events and adverse conditions and having positive adaptation characteristics (Fraser, Richman, & Galinsky, 1999). It is said that psychological stability is a successful and adaptive process. Hunter (2001), the fact that people live healthy lives, fulfill their developmental responsibilities at various stages of development throughout their lives, and behave according to social roles can be explained by positive, healthy personalities and self-improvement. There are various functional and non-functional behavioral

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mechanisms that individuals have developed in relation to these situations and have developed to overcome them. It is expressed as the ability to actively use these behavioral mechanisms and coordinate the struggle against the difficulties and difficulties of life in an appropriate way Bolat (2013). Looking at the results of the above studies as a whole, we can draw the following conclusions:

* Psychological soundness is effective in coping with stress.
* Social support has a positive effect on psychological well-being.
* Increased self-efficacy contributes to increased psychological soundness.
* Psychological soundness reduces risky behaviors and shows protective effects against negative situations such as loneliness, hopelessness.
* School attendance, life satisfaction and self-esteem predict psychological well-being Koçhan (2021).

Goal Commitment: The goal is a direct motivational strategy. It is a condition that shows various cognitive, emotional and behavioral reactions Kingston and Wilson (2010). The goal is the timely achievement of a certain ability, and commitment to a goal refers to the determination to achieve the goal Locke and Latham (2002). The most important result of goal commitment is said to be that it establishes a relationship between goal difficulty and performance Klein, Wesson, Hollenbeck and Alge (1999). Researchers say that people who are dedicated to achieving their goals perform better than others, proving the importance of adherence to goals. Due to differences in commitment to personal goals, two people may exhibit different attitudes towards the same goal Klein et al. (1999). It cannot be said that all people are equally committed to their personal goals (Locke & Latham, 2002). The ability to perform the desired performance after the goal has been set is also related to the level of motivation. If there is enough motivation to achieve the desired result by doing your best, it becomes easier to achieve this goal Latham (2003). It can be said that there is a relationship between performance and motivation and the determined goals in determining goals or objectives Decel (2001). To achieve a goal, it is necessary to set a goal, set a date, make a plan, visualize the goal, strive and not give up, and finally evaluate. People who actively participate in the goal setting process can think independently and take responsibility Rader (2005). On the other hand, once a goal or goals are defined, the individual will try to achieve the goal using his/her existing abilities, but when he/she realizes that it is not, he/she will make more efforts Efil (2006). As a result of separate analyzes for male and female students, students' adaptation to university was affected by psychological resilience, problem-solving skills, and seeking social help in males; It was concluded that resilience, optimism and social help seeking skills were explanatory variables in girls Yalım (2007). In their study, Karaırmak and Siviş-Çetinkaya (2009) investigated the relationship between psychological resilience, self-esteem, positive emotions and locus of control. It was concluded that self-esteem and locus of control, as cognitive processes, have effects on emotions; It has been found that both positive and negative emotions can explain resilience. In the study of Özer and Deniz (2014), consisting of university students, it was found that there was a significant positive relationship between the scores the students received from the psychological resilience scale and the scores they obtained from the sub-dimensions of the emotional intelligence scale. In order to achieve the goal, it is necessary to determine a goal, assign a date, create a plan, visualize the goal, make efforts and not give up, and finally make an evaluation.

1.1. Questions of the Study or Hypotheses

• Is there a significant difference between the psychological comfort levels of sports science faculty students and their gender?

• Is there a significant difference between the psychological comfort levels of sports sciences faculty students and their ages?

• Is there a significant difference between the psychological comfort levels of sports sciences faculty students and sports types?

• Is there a significant difference between the psychological comfort levels of sports sciences faculty students and their family income status?

• Is there a significant difference between the psychological comfort levels of sports sciences faculty students and their classes?

• Is there a significant difference between the goal commitment levels and gender of sports sciences faculty students?

• Is there a significant difference between the goal commitment levels of sports sciences faculty students and their ages?

• Is there a significant difference between the goal commitment levels of sports sciences faculty students and sports types?

• Is there a significant difference between the goal commitment levels of sports science faculty students and their family income status?

• Is there a significant difference between the goal commitment levels of sports sciences faculty students and their classes?

• Is there a significant relationship between the psychological comfort levels and goal commitment levels of sports sciences faculty students?

• Is there an effect between the psychological comfort levels and goal commitment levels of sports sciences faculty students?

2. METHOD

2.1. Research Method

The aim of our study is to expand the psychological resilience and goal resilience levels of people growing up at Fırat University Faculty of Sports Sciences through various variables. Descriptive scanning methods were used in our study.

2.2. Sample

A total of 330 people, 152 women and 178 men, studying at Fırat University Faculty of Sports Sciences, participated in our research on a voluntary basis.

2.3. Data Collection Tools

Individuals participating in the study were asked "Demographic Information" using a 12-item 5-point Likert scale ("Describes me completely (5)" to "Does not describe me at all (1)) prepared by Liebenberg, Ungar and LeBlanc (2013) and adapted into Turkish by Arslan (2015) and the Cronbach α coefficient of the scale is .91. In order to determine the target commitment levels of the participants; It was developed as 9 items by Hollenbeck, Williams, and Klein (1989), adapted as 5 items by Klein, Wesson, Hollenbeck and Wright (2001), and adapted into Turkish by Şenel and Yıldız (2016) and consists of a 5-point Likert scale with a single dimension (Goal commitment scale (1=strongly disagree, 5=strongly agree) was used. "The internal consistency coefficient of the scale was found to be .74.

2.4. Analysis of Data

SPSS package program was used to analyze the data. The percentage frequencies of the given data were calculated, normal distribution tests were performed, and as a result of these checks, t-test was used for those with 2 variables and analysis of variance was used for multiple variables. Tukey test was used to determine the differences between groups. The significance level of the study was taken as $p<.05$.

3. FINDINGS

Table 1. Table of variables for psychological resilience and goal commitment levels of faculty of sport sciences students

Groups	Variables	n	%
Gender	Female	152	46,1
	Male	178	53,9
Age	18-23	232	70,3
	24 years and older	98	29,7
Sport Type	Individual	186	56,4
	Set	144	43,6
Family Income Status	0-5250 TL	94	28,5
	5251 TL and above	236	71,5
Class	1st Class	78	23,6
	2 st Class	104	31,5
	3 st Class	84	25,5
	4 st Class	64	19,4

More than half of the students of the Faculty of Sports Sciences (53.9) are men, the majority of them are between the ages of 18-23 (232), the number of participants engaged in individual sports is higher than team sports, and when we look at the family income, 71% of them are 5251 TL and above. It is seen that there are 104 students and 2nd grade students among the students.

Table 2. Average value table of psychological resilience and goal commitment levels of faculty of sport sciences students

Scales	n	Minimum Value	Maksimum Value	Average	Std. S.
Psychological Resilience	330	1,00	3,67	2,28	,559
Goal Loyalty	330	2,20	4,20	3,43	,436

It is seen that the average minimum value of psychological resilience of the Faculty of Sport Sciences students is 1.00, the maximum value is 3.67, the general average is 2.28, the minimum value of goal commitment is 2.20, the maximum value is 4.20 and the general average is 3.43.

Table 3. t-test for psychological resilience and goal commitment levels of faculty of sport sciences students by gender

Scales	Gender	n	$\bar{x}$	ss	t	p
Psychological Resilience	Female	152	2,32	,603	1,176	,240
	Male	178	2,25	,519		
Goal Loyalty	Female	152	3,43	,453	-,137	,891
	Male	178	3,43	,421		

When we examined the psychological resilience and goal commitment levels of the Faculty of Sport Sciences students on the gender variable, no statistical difference was found between men and women as a result of the t-test (p>0,05).

Table 4. t-test for psychological resilience and goal commitment levels of faculty of sport sciences students by age

Scales	Age	n	$\bar{x}$	ss	t	p
Psychological Resilience	18-23	232	2,31	,547	1,647	,101
	24 years and older	98	2,20	,583		
Goal Loyalty	18-23	232	3,41	,478	- 1,260	,209
	24 years and older	98	3,48	,309		

When we examined the psychological resilience and goal commitment levels of the Faculty of Sport Sciences students according to the age variable, it was seen that there was no statistical difference between the ages as a result of the t test (p>0,05).

Table 5. Psychological resilience and goal commitment levels t-test of faculty of sport sciences students according to athlete license status

Scales	Sport Type	n	$\bar{x}$	ss	t	p
Psychological Resilience	Individual	186	2,31	,556	,943	,346
	Set	144	2,25	,563		
Goal Loyalty	Individual	186	3,40	,457	-1,258	,209
	Set	144	3,46	,405		

When the psychological resilience and goal commitment levels of the Faculty of Sports Sciences students are examined according to the types of sports, no statistically significant difference was found as a result of the t-test between those who are engaged in individual sports and those who are engaged in team sports (p>0,05).

Table 6. Psychological resilience and target commitment levels t-test of faculty of sport sciences students by family ıncome status

Scales	Family Income Status	n	$\bar{x}$	ss	t	p
Psychological Resilience	0-5250 TL	94	2,07	,372	-4,401	,000
	5251 TL and above	236	2,36	,599		
Goal Loyalty	0-5250 TL	94	3,42	,392	-,253	,801
	5251 TL and above	236	3,43	,452		

A statistical difference was found in the psychological resilience of the students of the Faculty of Sports Sciences according to their family income in favor of those with an income of 5251 TL and above (p < 0.05), but it was observed that there was no difference in goal commitment levels in terms of family income (p > 0.05).

Table 7. Psychological resilience and goal commitment levels of sports sciences faculty students in terms of classes anova test

	Variables	Anova test					TUKEY
Scales	**Class**	**n**	**$\bar{x}$**	**ss**	**f**	**p**	**Differences**
Psychological Resilience	1. st Class A	78	1,89	,346	28,123	,000	A-B,C,D D-A,B,C
	2. st Class B	104	2,27	,486			
	3. st Class C	84	2,37	,581			
	4. st Class D	64	2,65	,565			
	Total	330	2,28	,559			
Goal Loyalty	1. st Class A	78	3,43	,377	5,748	,001	D-A,B,C
	2. st Class B	104	3,39	,394			
	3. st Class C	84	3,34	,526			
	4. st Class D	64	3,62	,386			
	Total	330	3,43	,436			

When we examined the psychological resilience and goal commitment levels of the Faculty of Sport Sciences students according to their classes, a statistical difference was found between the classes as a result of the anova test (p<0,05). According to the results of the Tukey test performed to determine the differences between the groups, there was a significant relationship between the 1st grade students and 2nd, 3rd and 4th grade students in the psychological resilience levels of the students of the faculty of sports sciences, and a significant relationship between the 4th grade students and the 1st, 2nd and 3rd grade students. relationship was found. When we look at the level of goal commitment, a significant relationship was found between the 4th grade students and the 1,2 and 3rd grade students.

Table 8. Psychological resilience and goal commitment levels correlation test

		Psychological resilience	**Goal Loyalty**
Psychological resilience	Pearson Correlation	1	-,324**
	Sig. (2-tailed)		,000
Goal Loyalty	Pearson Correlation	-,324**	1
	Sig. (2-tailed)	,000	

***. Correlation is significant at the 0.01 level (2-tailed).*

When we look at the significant relationship between the Psychological Resilience and Goal Commitment levels of the students of the faculty of sports sciences, according to the correlation test result, it is seen that there is a negative relationship between the two variables (p <0.01).

Table 9. Psychological resilience and goal commitment levels regression test

Dependent variable: Psychological Resilience Scale

				S				
		B	**td. error**				**t**	
(Independent)		3		,			1	
Goal Commitment Scale	,716		232			6,003		000
		-		,	,324		-	
	,416		067			6,209		000

R=,324[a]; R^2=,105

F=38,556; p<0,000

When the effect between the Psychological Resilience and Goal Commitment levels of the students of the faculty of sports sciences is examined, according to the results of the regression test, it is seen that there is an effect between the two scales (p<0,05).

4. DISCUSSION and CONCLUSION

More than half of the students of the Faculty of Sports Sciences (53.9) are men, the majority of them are between the ages of 18-23 (232), the number of participants engaged in individual sports is higher than team sports, and when we look at the family income, 71% of them are 5251 TL and above. It is seen that among the students, 104 students and 2nd grade students are in the majority, and parents who are secondary school graduates are in the majority.

It is seen that the average minimum value of psychological resilience of the Faculty of Sport Sciences students is 1.00, the maximum value is 3.67, the general average is 2.28, the minimum value of goal commitment is 2.20, the maximum value is 4.20 and the general average is 3.43. Accordingly, it is seen that the psychological resilience levels and goal commitment levels of the students studying at the faculty of sports sciences are at a moderate level.

When we examined the psychological resilience and goal commitment levels of the Faculty of Sport Sciences students on the gender variable, no statistical difference was found between men and women as a result of the t-test. As a result of the analysis, it was seen that the psychological resilience and goal commitment levels of the students studying at the faculty of sports sciences did not have an effect on gender differences. When we look at the literature studies, Çekceoğlu (2019), found that psychological resilience did not have an effect on the gender variable in his study on high school students. In the study conducted by Can and Cantez (2018) on university students, no significant difference was found in terms of gender variable in the psychological resilience levels of the students. As a result of their study, Karataş and Camadan (2020), found that there was no significant difference in psychological resilience in terms of gender. In a study by Insan (2022), it is seen that there is no gender difference in the psychological resilience levels of university students. When we look at the studies that do not overlap with our study; the study of Ülker, Tümlü and Recepoğlu (2013), it is possible to say that the psychological resilience levels of women are higher than men. Again, Kılıç (2014), concluded in a study that women have higher levels of psychological resilience.

When we look at the results of the gender variable in the studies on target commitment, the ones that support our study are; Öntürk, Bingöl, Göksel, and Çağlayan (2018), in his study, it is seen that there is no difference in terms of gender in the level of target commitment of the administrative staff working at the university. There are studies in the literature that do not coincide with the results of our study. These; Çekceoğlu (2019), concluded that women have higher goal commitment levels and that there is a statistical difference in goal commitment levels between women and men. Süleymanoğulları, Dogar and Bayraktar (2021), in his study on students, the level of goal commitment in favor of women was found to be higher in individuals who were educated.

When we examined the psychological resilience and goal commitment levels of the Faculty of Sport Sciences students according to the age variable, it was seen that there was no statistical difference between the ages as a result of the t test. As a result of the analysis, it was seen that the psychological resilience and goal commitment levels of the students studying at the faculty of sports sciences did not have an effect on their age. When the literature studies are examined; it has been observed that the age of university students does not have an effect on psychological resilience Insan (2022). It was observed that the psychological resilience of the participants did not differ in terms of the age variable Güler (2021). In a study conducted by Duygun (2017), it was determined that the psychological resilience of university students did not differ according to age. As a result of a study on teachers working in private schools, it was seen that the ages of the teachers did not differ in their psychological resilience levels Gönen (2020). When we look at the studies that do not overlap with our study; In a study conducted by Cekceoglu (2019) on high school students, it was concluded that the levels of resilience differ in terms of age, and it was observed that the level of resilience of the students decreased as they got older. When we look at the studies of the target commitment level on the ages; There was no significant difference between the target loyalty scores of the participants and the age variable Cekceoglu (2019). As a result of a study conducted by Salim (2018) on individuals who do orienteering sports, no difference was found between target commitment and age. It was observed that there was no statistical difference between the ages of the students and their goal commitment scores Süleymanogulları et al. (2021). When we look at the literature studies; No statistically significant difference was found in the psychological resilience levels of individuals engaged in individual sports or team sports Bayrakdaroglu (2014). In a study conducted by Soflu, Esfahani, and Assadi (2011) it was concluded that sports types of individuals do not have an effect on their psychological resilience levels. It has been observed that the types of sports in the sports branches that students are interested in do not show a significant difference in the levels of psychological resilience Insan (2022). It has been determined that there is no significant difference in the psychological resilience levels of the athletes who are interested in team sports and individual sports Soydal-Darıcı (2019). There are studies that do not overlap with the results of our study, Nas (2019), found that the variable of sports branches has an effect on psychological resilience in a study he conducted.

Since there are no similar studies in the literature on goal commitment, it is thought to contribute to the literature.

A statistical difference was found in the psychological resilience of the Faculty of Sport Sciences students in favor of those with an income of 5251 TL and above, according to their family income status, but it is seen that there is no difference in the level of target commitment in terms of family income. According to this, it has been observed that the students of the faculty of sports sciences with high family income are more psychologically stronger, but the income status has no effect on their commitment to the goal.

In the literature studies; It has been observed that the psychological resilience of individuals with a high income level is higher than those with a medium level Varıcıer (2019). Ülker et al. (2013), in their study, found that low income level is a factor that prevents the development of psychological resilience. The psychological resilience of individuals with high income status is higher than individuals with other income status Avcı-Taskıran (2021).

It has been determined that the psychological resilience levels of students with low income levels are lower than those with high income levels Insan (2022). It has been observed that the psychological resilience of the students shows a significant difference in terms of family income status. It is seen that the psychological resilience of individuals with low family income status is higher than those with higher income status Güler (2021). Again, in a study on university students, it was found that students from low-income families had higher psychological comfort Ergün (2012). When we look at the target loyalty family income status; Differences were determined according to the family income status of the participants, it is seen that the level of target commitment is higher for students with families with high income Süleymanoğulları et al. (2021).

When we examined the psychological resilience and goal commitment levels of the Faculty of Sport Sciences students according to their classes, a statistical difference was found between the classes as a result of the Anova test. According to the results of the Tukey test performed to determine the differences between the groups, there was a significant relationship between the 1st grade students and 2nd, 3rd and 4th grade students in the psychological resilience levels of the students of the faculty of sports sciences, and a significant relationship between the 4th grade students and the 1st, 2nd and 3rd grade students. relationship was found. When we look at the level of goal commitment, a significant relationship was found between the 4th grade students and the 1,2 and 3rd grade students. As a result of the analysis made according to the class status of the students, it is seen that the students studying in the 4th grade are more robust in psychology and their level of commitment to the goal is higher. We can say that the students have come to a conclusion in their psychological relaxation due to their graduation from school, determining their future goals and planning about it. When the literature is examined, there is a statistical difference in the psychological resilience of the students studying at the university in terms of their classes.

It is thought that it will contribute to the literature when similar studies are not found as a result of the literature studies conducted at the target commitment level. In conclusion; Gender, age and the types of sports they do in the Faculty of Sport Sciences do not have an effect on their psychological resilience and goal commitment. In terms of the classes they attend, it is possible to say that the psychological resilience and goal commitment levels of the 4th grade students are higher than the students studying in other classes.

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Abstract

It is evident to everyone that the being referred to as human needs to meet many requirements in order to sustain their life. With the rapid growth of technology, even fulfilling these needs is almost dependent on the use of technology, which would not be wrong to say. The reflections of high literacy levels observed in developed societies are significant research subjects in the online environment and their effects on learning. The importance of this development and change in educational institutions, especially, cannot be underestimated. Within this scope, this study aims to examine the impact of sports science students' digital literacy levels on e-learning. The universe of the study consists of students from faculties and colleges providing sports education in Turkey, and the sample includes 922 individuals selected through a simple random sampling method. The sample group was administered the "Digital Literacy Scale" developed by Ng (2012) and adapted to Turkish by Hamutoğlu et al. (2017), as well as the "Attitude Scale towards E-learning" developed by Haznedar (2012). As a result, it is predicted that digital literacy (and its sub-dimensions) has a 32.4% effect on being inclined towards e-learning.

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Research Article

Perceptions of the Effect of Digital Literacy Levels of who Take Sports Education Students on E-Learning *

Fatih Harun TURHAN [1]

Abstract

It is evident to everyone that the being referred to as human needs to meet many requirements in order to sustain their life. With the rapid growth of technology, even fulfilling these needs is almost dependent on the use of technology, which would not be wrong to say. The reflections of high literacy levels observed in developed societies are significant research subjects in the online environment and their effects on learning. The importance of this development and change in educational institutions, especially, cannot be underestimated. Within this scope, this study aims to examine the impact of sports science students' digital literacy levels on e-learning. The universe of the study consists of students from faculties and colleges providing sports education in Turkey, and the sample includes 922 individuals selected through a simple random sampling method. The sample group was administered the "Digital Literacy Scale" developed by Ng (2012) and adapted to Turkish by Hamutoğlu et al. (2017), as well as the "Attitude Scale towards E-learning" developed by Haznedar (2012). As a result, it is predicted that digital literacy (and its sub-dimensions) has a 32.4% effect on being inclined towards e-learning.

Keywords: Digital literacy, e-learning, sport studens, physical education

1. INTRODUCTION

Today, we live and learn in a culture where the flow of information is constant, and technologies keep individuals connected 24/7. Networks create tremendous and vibrant opportunities for teaching and learning, requiring contemporary students to be literate in written, visual, and digital forms of expression (Fotunu, 2015). The internet is a tool that enables individuals in society to effectively socialize, communicate through flexible and multiple networks. Unlike traditional media, it offers users a wide range of content and services to choose from, giving rise to a new digital world. The process of adapting to technological advancements varies depending on individuals' generation and digital literacy levels (Öztürk, 2023).

Technological advancements spreading rapidly have led to significant changes in the field of education (Jones, 2010). Especially in recent years, e-learning (electronic learning) methods are considered an alternative approach to traditional learning methods (Alshammari, 2019). E-learning refers to a learning process that takes place using information and communication technologies, allowing learning to occur independent of time and place (Rosell-Aguilar, 2020). The concept of e-learning is believed to have been first used by Desmond Keegan. In his book "The Foundations of Distance Education," published in 1986, Keegan used the term "e-learning" to define distance learning conducted in electronic environments, emphasizing the inclusion of computer-based and digital technologies in distance learning processes. Sports science education, unlike other fields, requires

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students to combine theoretical knowledge with practical experience. In this context, the digital literacy levels of sports science students can play a significant role in the e-learning process.

Previous studies have highlighted many advantages associated with the implementation of e-learning technologies in university education (Raspopovic, Cvetanovic, Medan, & Ljubojevic, 2017). It is seen as effective in catering to students' individual needs or providing digital-age information resources according to instructors' requirements (Huang & Chiu, 2015). E-learning enables reaching goals with the least effort in the shortest possible time. While managing the e-learning environment, the impact of providing equal access to information regardless of users' locations, ethnic backgrounds, races, and ages is observed (Joshua, Obille, John, & Shuaibu, 2016). E-learning allows for more flexible learning methods that significantly reduce the need for travel. Through interactive video features in the classroom, it facilitates a deeper understanding of the subject matter for students (Gautam & Tiwari, 2016).

Despite the significant advantages of e-learning, students may encounter various challenges that can lead to negative outcomes. For example, Arkorful and Abaidoo (2015) pointed out in their study that e-learning can sometimes result in reduced interaction due to distance and lack of face-to-face communication. When compared to traditional teaching methods, e-learning might be less effective due to the absence of in-person interaction. Assessments in e-learning are generally conducted online, which may decrease the possibility of preventing illegal activities such as cheating and plagiarism. The most notable disadvantage of e-learning is the lack of fundamental personal interaction with teachers, as well as among students (Islam, Beer, & Slack, 2015). Lack of motivation, deviation from goals, difficulty in maintaining focus, and individuality are among other disadvantages of e-learning (Raspopovic et al., 2021).

The concept of digital literacy was first introduced by Paul Gilster. In his book titled “Digital Literacy,” published in 1997, Gilster defined and explained the term digital literacy. The book explored the effects of digital technologies in the information age and emphasized the need for literacy skills that would enable individuals to function effectively in these new technological environments. Digital literacy refers to individuals' abilities to understand, use, and evaluate digital technologies (Prensky, 2001). An individual's level of digital literacy encompasses elements such as accessing internet resources, understanding digital content, conducting data analysis, and using critical thinking skills (Fraillon, Ainley, Schulz, Friedman & Duckworth, 2020). For sports science students, developing digital literacy skills can provide more effective access to information, content creation, and sharing opportunities in the e-learning process. Today, the term “digital literacy” can be defined as the necessary technical knowledge and skills for leading a productive life, engaging in continuous learning activities for personal development, and making positive contributions to society. According to this definition, the types of literacy included in digital literacy are information literacy, visual literacy, software literacy, technology literacy, and computer literacy (Raice & Bailon, 2023).

In today’s world, the necessity of technology in the educational process is evident in all fields, making the relationship between digital literacy and e-learning inevitable. In this context, the aim of this study is to investigate the impact of sports science students' digital literacy levels on the e-learning process. This study aims to assess sports science students' abilities to use e-learning materials, access information, create and share content. Additionally, it will examine the influence of digital literacy levels on learning achievement, motivation, and satisfaction in the e-learning process.

2. METHOD

2.1. Research Design

In this study, a quantitative research method has been used. The quantitative research method aims to understand and explain reality based on objective scientific data. This method is grounded in a positivist scientific approach and a realist philosophy. According to the positivist perspective, there is a specific order in the universe, and this order can be discovered, understood, and controlled by humans. The quantitative research method aims to obtain results based on concrete observations and measurable data (Sönmez & Alacapınar, 2011).

2.2. Participants

The population of this research consists of undergraduate students enrolled in sports education programs at universities in Turkey during the 2022-2023 academic year. The sample of the study consists of 922 participants selected through a simple random sampling method.

2.3. Data Collection

As the data collection method, a survey form consisting of three sections was used. The first section of the survey includes 4 questions to gather demographic data such as gender, class, department, and daily internet usage duration. The second section of the survey includes the "Digital Literacy Scale" developed by Ng (2012) and adapted to Turkish by Hamutoğlu, Güngören, Uyanık, and Erdoğan (2017). This scale consists of a total of 4 sub-dimensions and 17 items, including attitude, technical, cognitive, and social dimensions. In the third section, the "Attitude Scale towards E-learning," developed by Haznedar (2012), was used. Data was collected through an online form using the internet. The researcher prepared an online survey form in advance and shared it with academicians from different departments (determined through simple random sampling), asking for voluntary participation from students in an online environment.

2.4. Data Analysis

In this research, normality tests were conducted to check the assumption of normality for the data obtained in the sub-dimensions of the scale. In these tests, the skewness and kurtosis values of the data were examined, and as shown in Table 1, it was determined that the skewness and kurtosis values of the scale were between +1.5 and -1.5. This indicates that the data is normally distributed. As expressed by Tabachnick and Fidell (2007), when the skewness and kurtosis values are between +1.5 and -1.5, it can be interpreted that the distribution is normal.

The scores obtained from the "Digital Literacy" scale and the "Attitude Scale towards E-learning" scale applied to the participants were analyzed using "Multivariate Analysis of Variance (MANOVA)". Additionally, the assumptions of normality were checked for the application of MANOVA, and the values obtained from the Box Test for Equality of Covariance Matrices based on the dataset were examined. In this analysis, it was determined that the p-values were greater than 0.05, indicating that the variances were equal. As a result, differences arising from the MANOVA analysis were interpreted based on post hoc tests such as LSD and Tukey. The internal consistency of the sub-dimensions of the scales was calculated, and Cronbach's Alpha coefficients ranged from 0.68 to 0.94.

3. FINDINGS

Table 1. Descriptive ınformation on participants

Vaiable	Group	N	%
Gender	Male	640	69,4
	Female	282	30,6
Grade	1. Grade	256	27,8
	2. Grade	128	13,9
	3. Grade	202	21,9
	4. Grade	336	36,4
Deparment	Teaching Education	254	27,5
	Coaching Training	234	25,4
	Sport Management	402	43,6
	Recreation Education	32	3,5
Internet Using	1 Hour A Day	34	3,7
	1-3 Hours A Day	272	29,5
	3-5 Hours A Day	366	39,7
	5 Hours and Above	250	27,1

When examining the gender distribution, it is observed that 69.4% of the participants are male and 30.6% are female. Regarding the class level distribution, it is seen that 27.8% of the participants are in the 1st grade, 13.9% in the 2nd grade, 21.9% in the 3rd grade, and 36.4% in the 4th grade. This indicates that the participants come from various class levels, representing different student groups in the study. When looking at the distribution by department, it is observed that 27.5% of the participants are from the education department, 25.4% from the sports coaching department, 43.6% from the management department, and 3.5% from the recreation department. Examining the distribution based on internet usage habits, it is found that 3.7% of the participants use the internet for 1 hour daily, 29.5% use it for 1-3 hours daily, 39.7% use it for 3-5 hours daily, and 27.1% use it for more than 5 hours daily. This indicates that the participants use the internet at different levels and durations.

Table 2. Descriptive information on the scales

Scale	Factor	N	Mean	*Ss*	Skewness	Kurtosis	C'Alpha
Digital Literacy	Attitude	922	3,74	,90	-,718	,213	,91
	Technical	922	3,73	,86	-,551	,303	,90
	Cognitive	922	3,88	,98	-,434	-,176	,75
	Social	922	3,41	,97	-,248	-,290	,68
E-Leaning	Predisposition	922	3,08	,99	-,148	-,377	,94
	Escape	922	3,43	,90	,023	-,280	,87

When examining the factors of the Digital Literacy Scale, it is observed that under the "Attitude" factor, the participants' average score is 3.74. The standard deviation for the scale scores in this factor is 0.90, the kurtosis value is -0.718, and the skewness value is 0.213. Additionally, the Cronbach's Alpha reliability coefficient for this factor is calculated as 0.91. Similarly, under the other factors of the Digital Literacy Scale, namely "Technical", "Cognitive", and "Social", the average scores are 3.73, 3.88, and 3.41, respectively. The standard deviations, kurtosis, skewness, and Cronbach's Alpha reliability coefficients for these factors are between -0.248 and 0.303, and the internal consistency coefficients are 0.90, 0.75, and 0.68, respectively. When examining the E-Learning Scale, under the "Propensity" factor, the participants' average score is 3.08. The standard deviation for the scale scores in this factor is 0.99, the kurtosis value is -0.148, and the skewness value is -0.377. The Cronbach's Alpha reliability coefficient for this factor is calculated as 0.94. Under the other factor of the E-Learning Scale, namely "Avoidance," the participants' average score is 3.43. The standard deviation, kurtosis, skewness, and Cronbach's Alpha reliability coefficient for this factor are given without specific values mentioned.

Table 3. MANOVA results of the scores of the participants according to the gender variable

Scale	Factor	Gender	N	Mean	*Ss*	F	*P*
Digital Literacy	Attitude	Male	640	3,76	,90	,337	,56
		Female	282	3,72	,92		
	Technical	Male	640	3,74	,83	1,281	,25
		Female	282	3,67	,93		
	Cognitive	Male	640	3,67	,96	3,329	,06
		Female	282	3,54	1,02		
	Social	Male	640	3,48	,98	4,667	,03*
		Female	282	3,33	,94		
E-Leaning	Predisposition	Male	640	3,21	,97	10,019	,00*
		Female	282	2,99	1,02		
	Escape	Male	640	3,01	,89	,055	,81
		Female	282	3,03	,91		

This table presents the results of the MANOVA (Multivariate Analysis of Variance) for the scores obtained from the scales according to the gender variable of the participants. When examining the “Attitude” factor of the Digital Literacy Scale, it is observed that male participants have an average score of 3.7612 and female participants have an average score of 3.7234. The MANOVA analysis revealed that the effect of gender on this factor is not statistically significant (F = 0.337, p = 0.562). In the "Technical" factor of the Digital Literacy Scale, male participants have an average score of 3.7427, and female participants have an average score of 3.6726. The MANOVA analysis indicated that the effect of gender on this factor is not statistically significant (F = 1.281, p = 0.258). For the "Cognitive" factor of the Digital Literacy Scale, male participants have an average score of 3.6781, and female participants have an average score of 3.5496. The MANOVA analysis revealed that the effect of gender on this factor is not statistically significant (F = 3.329, p = 0.068). However, for the "Social" factor of the Digital Literacy Scale, male participants have an average score of 3.4875, and female participants have an average score of 3.3369. The MANOVA analysis indicated that the effect of gender on this factor is statistically significant (F = 4.667, p = 0.031*). Moving on to the E-Learning Scale, in the "Propensity" factor, male participants have an average score of 3.2194, and female participants have an average score of 2.9950. The MANOVA analysis revealed that the effect of gender on this factor is statistically significant (F = 10.019, p = 0.002*). However, in the "Avoidance" factor of the E-Learning Scale, male participants have an average score of 3.0197, and female participants have an average score of 3.0348. The MANOVA analysis indicated that the effect of gender on this factor is not statistically significant (F = 0.055, p = 0.815).

Table 4. MANOVA results of the scores of the participants from the scales related to the class variable

Scale	Factor	Group	N	Mean	*Ss*	F	*p*
Digital Literacy	Attitude	1. Grade	256	3,68	,93	2,224	,08
		2. Grade	128	3,61	,91		
		3. Grade	202	3,80	,91		
		4. Grade	336	3,81	,87		
	Technical	1. Grade	256	3,72	,87	1,464	,22
		2. Grade	128	3,59	,84		
		3. Grade	202	3,80	,83		
		4. Grade	336	3,71	,88		
	Cognitive	1. Grade	256	3,55	,94	1,608	,18
		2. Grade	128	3,55	1,00		
		3. Grade	202	3,70	,97		
		4. Grade	336	3,69	1,00		
	Social	1. Grade [a]	256	3,36	1,00	2,878	,03* a-c b-c
		2. Grade [b]	128	3,29	,99		
		3. Grade [c]	202	3,57	,91		
		4. Grade [d]	336	3,47	,97		
E-Leaning	Predisposition	1. Grade	256	3,08	1,00	1,204	,30
		2. Grade	128	3,06	1,03		
		3. Grade	202	3,21	,96		
		4. Grade	336	3,19	,99		
	Escape	1. Grade	256	2,99	,95	,547	,65
		2. Grade	128	3,10	,83		
		3. Grade	202	2,98	,94		
		4. Grade	336	3,03	,85		

This table shows the analysis results of the scores obtained from the scales among different groups (different class levels). When examining the “Attitude” factor of the Digital Literacy Scale, it was investigated whether there is a significant difference between the averages of different class levels (1st class, 2nd class, 3rd class, 4th class). According to the results, there is no statistically significant difference among class levels in this factor (F = 2.224, p = 0.084). Similarly, for the "Technical" factor of the Digital Literacy Scale, it was examined whether there is a significant difference among different class levels. The results show that there is no statistically significant difference among class levels in this factor (F = 1.464, p = 0.223). When analyzing the "Cognitive" factor of the Digital Literacy Scale, it was also investigated whether there is a significant difference among class levels. The results indicate that there is no statistically significant difference among class levels in this factor (F = 1.608, p = 0.186). However, for the “Social” factor of the Digital Literacy Scale, a significant difference among different class levels was found (F = 2.878, p = 0.035*). When examining the "Propensity" and "Avoidance" factors of the E-Learning Scale, it is observed that there is no significant difference among different class levels in these factors. The respective p-values (p > 0.05) indicate that there is no statistically significant difference.

Table 5. MANOVA results of the scores of the participants from the scales related to the department variable

Scale	Factor	Group	N	Mean	*Ss*	F	*p*
Digital Literacy	Attitude	Teaching Education	254	3,77	,95	2,401	,06
		Coaching Training	234	3,62	1,03		
		Sport Management	402	3,79	,79		
		Recreation Education	32	3,93	,83		
	Technicial	Teaching Education	254	3,72	,84	7,174	,00* a-b b-c b-d
		Coaching Training	234	3,51	,98		
		Sport Management	402	3,82	,79		
		Recreation Education	32	3,88	,76		
	Cognitive	Teaching Education	254	3,57	,99	3,747	,01* a-c b-c
		Coaching Training	234	3,50	1,11		
		Sport Management	402	3,74	,89		
		Recreation Education	32	3,84	,91		
	Social	Teaching Education	254	3,39	1,00	3,859	,00* b-c b-d
		Coaching Training	234	3,29	1,01		
		Sport Management	402	3,53	,92		
		Recreation Education	32	3,68	1,04		
E-Learning	Predisposition	Teaching Education	254	3,13	1,04	2,640	,05
		Coaching Training	234	3,09	1,08		
		Sport Management	402	3,15	,92		
		Recreation Education	32	3,61	,83		
	Escape	Teaching Education	254	2,95	,98	1,262	,286
		Coaching Training	234	3,09	,91		
		Sport Management	402	3,03	,81		
		Recreation Education	32	2,87	1,03		

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This table presents the analysis results of the scores obtained from the scales among different groups (e.g., teaching, coaching, management, recreation). When examining the "Attitude" factor of the Digital Literacy Scale, it was investigated whether there is a significant difference in score averages among different groups. The results show that there is no statistically significant difference among groups in this factor (F = 2.401, p = 0.066). Similarly, for the “Technical” factor of the Digital Literacy Scale, it was examined whether there is a significant difference in score averages among different groups. The results indicate that there is a statistically significant difference among groups in this factor (F = 7.174, p = 0.000*). This difference occurred between groups a-b, b-c, and b-d. When analyzing the “Cognitive” factor of the Digital Literacy Scale, it was also investigated whether there is a significant difference among different groups. The results show that there is a statistically significant difference among groups in this factor (F=3.747, p = 0.011*). This difference occurred between groups a-c and b-c. Similarly, for the “Social” factor of the Digital Literacy Scale, a significant difference among different groups was found (F=3.859, p = 0.009*). This difference occurred between groups b-c and b-d. When examining the “Propensity” and “Avoidance” factors of the E-Learning

Scale, it was investigated whether there is a significant difference among different groups. The respective p-values ($p > 0.05$) indicate that there is no statistically significant difference among the groups.

Table 6. MANOVA results of the scores of the participants from the scales regarding the internet usage duration

Scale	Factor	Group	N	Mean	*Ss*	F	*p*
Digjital Literacy	Attitude	1 Hour A Day [a]	34	2,63	1,29	32,829	,00* a-b a-c a-d b-c b-d c-d
		1-3 Hours A Day [b]	272	3,59	,84		
		3-5 Hours A Day [c]	366	3,75	,86		
		5 Hours and Above [d]	250	4,06	,81		
	Tecnicial	1 Hour A Day [a]	34	2,73	1,17	20,657	00* a-b a-c a-d b-d c-d
		1-3 Hours A Day [b]	272	3,64	,80		
		3-5 Hours A Day [c]	366	3,74	,85		
		5 Hours and Above [d]	250	3,90	,79		
	Cognitive	1 Hour A Day [a]	34	2,97	1,27	10,976	,00* a-b a-c a-d b-d c-d
		1-3 Hours A Day [b]	272	3,51	,91		
		3-5 Hours A Day [c]	366	3,65	,96		
		5 Hours and Above [d]	250	3,85	,98		
	Social	1 Hour A Day [a]	34	3,00	1,37	3,544	,01* a-b a-c a-d b-d
		1-3 Hours A Day [b]	272	3,40	,87		
		3-5 Hours A Day [c]	366	3,43	,96		
		5 Hours and Above [d]	250	3,55	1,01		
E-Learning	Predisposition	1 Hour A Day	34	3,07	1,21	2,095	,09
		1-3 Hours A Day	272	3,15	,94		
		3-5 Hours A Day	366	3,07	1,04		
		5 Hours And Above	250	3,27	,94		
	Escape	1 Hour A Day	34	2,75	1,11	1,582	,19
		1-3 Hours A Day	272	3,03	,84		
		3-5 Hours A Day	366	2,99	,90		
		5 Hours And Above	250	3,08	,92		

This table presents the analysis results of the scores obtained from the scales (“Attitude”, “Technical”, “Cognitive”, “Social”, “E-Learning Propensity”, and “Avoidance”) among different groups (“1 Hour Daily”, “1-3 Hours Daily”, “3-5 Hours Daily”, “Over 5 Hours Daily”). In the "Attitude" factor of the Digital Literacy Scale, a significant difference among groups was found ($F = 32.829$, $p=0.000$). For the "Technical" factor, a significant difference among groups was also observed ($F=20.657$, $p = 0.000$). Participants who allocate 1 hour daily have lower technical scores compared to other groups. Similarly, for the "Cognitive" factor, a significant difference among groups was determined ($F=10.976$, $p=0.000$). Participants who allocate 1 hour daily have lower cognitive scores compared to other groups. Regarding the “Social” factor, a significant difference among groups was observed ($F = 3.544$, $p=0.014$). Participants who allocate 1 hour daily have higher social scores compared to other groups. However, there was no significant difference among groups for the “E-Learning Propensity” and “Avoidance” factors ($p > 0.05$).

Table 7. Regression analysis results showing the effect of participants' digital literacy on susceptibility to e-learning

		B	*Ss*	β	t	*p*
Digital Literacy	Constant	,978	,126	-	7,757	,00
	Attitude	,196	,048	,179	4,062	,00*
	Technical	-,222	,054	-,193	-4,122	,00*
	Cognitive	,426	,041	,422	10,436	,00*
	Social	,208	,041	,204	5,128	,00*
	R2= 0,324					
	F(111,548)=0,000					

Dependent Variable *: Susceptibility to E-Learning*
Independent Variable *: Digital Literacy*

The constant term shows a positive effect with a value of 0.978. This indicates that when other independent variables are held constant, there is an effect on the dependent variable. The "Attitude" factor has a positive effect on the dependent variable with a value of 0.196. This means that an increase in the "Attitude" factor positively influences the dependent variable (β = 0.179, p = 0.000). On the other hand, the "Technical" factor has a negative effect on the dependent variable with a value of -0.222. In other words, an increase in the "Technical" factor negatively affects the dependent variable (β = -0.193, p = 0.000). The "Cognitive" factor has a positive effect on the dependent variable with a value of 0.426. This indicates that an increase in the "Cognitive" factor positively influences the dependent variable (β = 0.422, p = 0.000). Similarly, the "Social" factor has a positive effect on the dependent variable with a value of 0.208. This means that an increase in the "Social" factor positively affects the dependent variable (β = 0.204, p = 0.000). The R-squared value is calculated as 0.324, indicating that 32.4% of the dependent variable's variance is explained. In other words, the "E-Learning Propensity" sub-dimension of Digital Literacy (its sub-dimensions) has an effect of 32.4%. The F-statistic shows that the model is significantly explained ($F_{(111,548)}$ = p = 0.000).

Table 8. Results of regression analysis showing the effect of participants' digital literacy on e-learning avoidance

		B	*Ss*	β	t	*p*
Digital Literacy	Constant	2,607	,135	-	19,354	,000
	Attitude	-,067	,051	-,068	-1,303	,19
	Technical	,059	,058	,056	1,018	,30
	Cognitive	-,137	,044	-,150	-3,141	,00*
	Social	,276	,043	,300	6,375	,00*
	R2= 0,055					
	F(14,392)=0,000					

Dependent Variable *: Escape to E-Learning*
Independent Variable *: Digital Literacy*

The “Attitude” factor does not have a significant effect on the sub-dimension of "E-Learning Avoidance" (β = -0.067, p = 0.193). This indicates that the attitudinal factor is not significant in determining the sub-dimension of e-learning avoidance. Similarly, the “Technical” factor does not have a significant effect on the sub-dimension of “E-Learning Avoidance” (β = 0.059, p = 0.309). This means that the “Technical” factor is not significant in determining e-learning avoidance. However, it is observed that the “Cognitive” factor has a significant effect on the sub-dimension of “E-Learning Avoidance” (β = -0.137, p = 0.002*). This suggests that the cognitive factor can influence the tendency to avoid e-learning. Likewise, the "Social" factor has a significant effect on the sub-dimension of “E-Learning Avoidance” (β = 0.276, p = 0.000*). This indicates that the Social factor can influence the tendency to avoid e-learning. The R-squared value indicates that the variables used explain 5.5% of the total variance. The F-statistic shows that the regression model is generally significant ($F_{(14,392)}$= p = 0.000*).

4. DISCUSSION and CONCLUSION

Research has shown that income, socio-economic status, employment, education, and gender are among the most influential determinants affecting access to and usage of information and communication technologies in all seventeen African countries (Qazi, et al., 2022). In this section, the results related to gender and social demographic characteristics such as class, department, and daily internet usage are discussed.

According to the results of the MANOVA based on the scores of the participants according to the "gender" variable, a significant difference was observed in the "Social" sub-dimension of the "Digital Literacy Scale" in favor of males. This suggests that the more widespread use of digital technologies among males may lead to higher social competence in this area for males. In a study by Karakuş and Ocak (2019) measuring the digital literacy of teacher candidates, they found significant differences in favor of males only in the "ability to use applications" sub-dimension. In another study by Göldağ and Kanat (2018) examining the digital literacy levels of students in fine arts education, they found significant differences in favor of males in all sub-dimensions except for the cognitive sub-dimension. Similarly, Göldağ (2021) examined the digital literacy levels of university students and found significant differences in favor of males based on the gender variable. In a study by Gökbulut (2021) conducted on teachers in the national education system, they found significant differences in favor of males in the "technical" and "cognitive" sub-dimensions of digital literacy levels. However, when we examine the results in the literature compared to our study, it can be seen that there is no significant difference between digital literacy and the gender variable (Aksoy, Karabay & Aksoy, 2021; Bay, 2021; Kozan & Özek, 2019; Şahin, 2021). Regarding the "E-Learning" scale, a significant difference in favor of males was observed only in the "propensity" sub-dimension. In a study by Şahin (2021) examining the e-learning levels of religious culture and ethics teacher candidates, they found significant differences in favor of males in both sub-dimensions.

According to the results of the MANOVA based on the scores of the participants according to the "class" variable, a significant difference was observed in the "Social" sub-dimension of the "Digital Literacy Scale" in favor of 3rd-grade students compared to 1st and 2nd-grade students. In a study by Kozan and Özek (2019) examining the digital literacy levels of teacher candidates in educational sciences programs, they found no significant difference based on the class variable. However, Göldağ and Kanat (2018) conducted a study examining the digital literacy levels of students in fine arts education and found significant differences in the attitude and cognitive sub-dimensions based on the class variable. In another study by Bay (2021) investigating the digital literacy levels of preschool teacher candidates, they found no significant difference based on the class variable. Regarding the "E-Learning" scale, no significant difference was observed based on the class variable. However, Şahin (2021) examined the e-learning levels of religious culture and ethics teacher candidates and found a significant difference in favor of 4th-grade students compared to 1st-grade students in the "propensity for e-learning" sub-dimension.

According to the results of the MANOVA based on the scores of the participants according to the "department" variable, significant differences were observed in the "technical" sub-dimension of the "Digital Literacy Scale" in favor of coaching, in the "cognitive" sub-dimension in favor of management, and in the "social" sub-dimension in favor of coaching. In a study by Karakuş and Ocak (2019) examining the digital literacy of teacher candidates, they found significant differences between departments in all sub-dimensions. Similarly, Göldağ and Kanat (2018) conducted a study examining the digital literacy levels of students in fine arts education and found a significant difference in the social sub-dimension based on the department variable. However, regarding the "E-Learning" scale, no significant difference was observed based on the department variable.

According to the results of the MANOVA based on the scores of the participants according to the "daily internet usage durations" variable, significant differences were observed in all sub-dimensions of the "Digital Literacy Scale". In a study by Aksoy et al. (2021) examining the digital literacy levels of teachers, they could not find any significant difference between digital literacy and the variable of daily internet usage duration. Similarly, Kozan and Özek (2019) conducted a study examining the digital literacy levels of pre-service teachers in educational technology and found no significant difference in terms of the variable of computer usage durations. Göldağ and Kanat (2018) examined the digital literacy levels of students in fine arts education in terms of internet usage duration and found no significant difference in any sub-dimension. However, in the same study, they observed significant differences between computer usage durations and digital literacy in all sub-dimensions. As for the "E-Learning" scale, no significant difference was observed based on the variable of "daily internet usage durations". It is not expected that non-learning-related internet usage durations would have an impact on e-learning.

The impact of digital literacy on the "E-Learning Readiness" sub-dimension has been examined, and it was predicted to have a 32.4% effect. Considering that digital literacy and e-learning concepts are closely related to each other, it can be said that this result is lower than expected. In another sub-dimension, the "E-Learning Avoidance" sub-dimension, the impact of digital literacy was examined, and it was predicted to have a 5% effect. The fact that this effect is inversely proportional and low can be interpreted as a positive outcome. In other words, it can be stated that as the level of digital literacy increases, the avoidance of e-learning decreases. As a result, we see that the level of digital literacy has an effect on e-learning. Without underestimating the importance of this effect we found on students receiving sports education, in their future plans; digital literacy courses should be given as compulsory, and it is recommended to prepare and integrate technology-based education programs in sports practice courses.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Karabuk University with the decision dated 19/06/2023 and numbered 2023/05-36.

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Conceptualization, literature review, methodology, implementation, data analysis, translation, and writing.

Abstract

The objective of this study was to explore preschool teachers' experiences with bullying behaviors in the classroom, their strategies for managing such behaviors, and to provide recommendations for addressing peer bullying in the classroom. Key findings from the research include: A high percentage (90.3%) of teachers reported encountering peer bullying in their classrooms. The most frequently observed types of bullying were verbal (65.6%), followed by physical (16.9%), and psychological (17.4%) bullying. Female students tended to engage more in psychological peer bullying, whereas male students were more inclined toward physical bullying. The incidence of physical and verbal bullying increased as children grew older.One of the primary approaches employed by teachers in dealing with bullying was changing classroom management practices and promoting empathy among students.Implementing a values education program within classroom activities was suggested as a way to enhance the effectiveness of anti-bullying efforts. These findings highlight the importance of addressing peer bullying in early childhood education and fostering positive classroom environments that promote empathy and values education. The study also emphasizes the need for teacher training and support to effectively manage and prevent bullying behaviors among young children.

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Research Article

Peer Bullying Experiences and Management Strategies of Preschool Teachers*

Derya KAYIRAN [1]

Abstract

The objective of this study was to explore preschool teachers' experiences with bullying behaviors in the classroom, their strategies for managing such behaviors, and to provide recommendations for addressing peer bullying in the classroom. Key findings from the research include: A high percentage (90.3%) of teachers reported encountering peer bullying in their classrooms. The most frequently observed types of bullying were verbal (65.6%), followed by physical (16.9%), and psychological (17.4%) bullying. Female students tended to engage more in psychological peer bullying, whereas male students were more inclined toward physical bullying. The incidence of physical and verbal bullying increased as children grew older.One of the primary approaches employed by teachers in dealing with bullying was changing classroom management practices and promoting empathy among students.Implementing a values education program within classroom activities was suggested as a way to enhance the effectiveness of anti-bullying efforts. These findings highlight the importance of addressing peer bullying in early childhood education and fostering positive classroom environments that promote empathy and values education. The study also emphasizes the need for teacher training and support to effectively manage and prevent bullying behaviors among young children.

Keywords: Peer bullying, preschool education, teacher, educational program, values education

1. INTRODUCTION

Socialization commences in the early years of life through interactions with the family and environment. As early as the end of the first year of infancy, children begin to engage with their peers through activities like sharing and conflicts. Positive or negative experiences encountered during the socialization process in childhood can leave a lasting impact on a child's future interactions with peers (Hay, Caplan & Nash, 2009).

The first scientifically recognized research on peer bullying was conducted by Dan Olweus in 1970 (Olweus, 1980). Prior to this research, bullying was often regarded as a natural part of the developmental process (Finnegan, Hodges & Perry, 1998). Various studies have consistently highlighted bullying as a prevalent and significant problem in today's world (Çarkıt & Bacanlı, 2020; Gündoğdu & Yaşar, 2021).

Peer bullying can be defined as the intentional infliction of pain and distress by the aggressor on the victim, often deriving pleasure from it (Finnegan et al., 1998). It can also be characterized as the persistent, systematic, and deliberate harassment or disruption of a more dominant individual or group by a less powerful individual or group. To qualify as bullying, a behavior must be purposeful, ongoing, and involve an imbalance of power between the perpetrator and the targeted individuals, distinguishing it from mere aggression (Perren, 2000).

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The preschool period is an educational phase during which children engage in increased interaction with their peers, fostering valuable social experiences. Preschool education institutions provide environments that facilitate and enhance this socialization process (Bakkaloğlu, Eryılmaz & Sapsağlam, 2019; Darga, 2021). It is well-established that positive interactions with peers during the preschool years significantly contribute to children's social and emotional development (Mendez, 2002). Behaviors that can be classified as peer bullying may first surface during the preschool period as children initiate peer relationships (Hanish, Ryan, Martin & Fabes, 2005)

Bullying in preschool educational institutions can have a ripple effect on the entire class, with children potentially reinforcing each other's bullying behaviors (Peren, 2000). During this period, it's evident that peer bullying has become a common aspect of children's lives, and they may find themselves taking on roles such as the bully, victim, or bystander in the face of peer bullying (Alsaker & Gutzwiller-Helfenfinger, 2009). It is observed that children who engage in or are subjected to peer bullying at a young age may continue this behavior into their future lives (Gillies-Rezo & Bosacki, 2003). From this perspective, peer bullying is regarded as a troubling social issue (Gültekin-Akduman, 2012). It is crucial to address peer bullying during the early years of preschool education. Implementing preventative measures against peer bullying in the early stages of a child's life can be effective in mitigating bullying behaviors that might persist in later years (Koyutürk-Koçer & Gültekin-Akduman, 2016). Research on peer bullying in the literature primarily focuses on primary education, high school, and university periods. It is evident that the preschool period is comparatively underrepresented in terms of peer bullying studies (Gültekin-Akduman, 2012). Peer bullying, which typically begins to manifest around the ages of 4-6 in early childhood, differs from the bullying behaviors observed in children during their primary or high school years in terms of aggression (Monks, Smith & Swettenham, 2005). Given our current age and the impact of visual and digital media on our lives, it can be argued that children are exposed to more violence than in the past. Considering that peer bullying during the preschool years can influence a child's future behavior, it is essential to conduct in-depth investigations into peer bullying during the preschool period to prevent it effectively.

When reviewing the relevant literature, it becomes evident that the majority of studies on peer bullying are primarily conducted at the primary education level, with fewer studies focusing on peer bullying during the preschool period compared to other stages (Özözen-Danacı & Çetin, 2019). This research aims to examine peer bullying in the preschool period and provide insights into potential preventive measures and intervention strategies for the future. Additionally, it seeks to serve as a foundation for a preschool education program designed to instill values in children and help prevent bullying.

1.1 Research Questions

The study's objective was to investigate preschool teachers' experiences regarding bullying behaviors within their classrooms and to explore their strategies for managing such behaviors. Additionally, the study aimed to provide recommendations for addressing peer bullying in the classroom. The research sought to address the following questions:

1. What are the most common forms of bullying observed among preschool students?
2. What are the attitudes of preschool teachers towards bullying, and what types of management strategies do they employ?

2. METHOD

2.1. Research Model

The research is conducted as a cross-sectional descriptive study. To gather information regarding teachers' experiences and strategies for handling peer bullying, a questionnaire technique was employed. Data were collected through face-to-face interviews, with interview forms including questions related to the teachers' socio-demographic characteristics and their experiences with and management of peer bullying.

2.2. Participants

The research was conducted among preschool teachers employed in preschool education institutions situated in the city center of Southern Turkey. The study aimed to encompass the entire population, and no sampling method was used. Data were collected from a convenience sample of 195 preschool teachers who work with children aged 36 to 72 months. All teachers who volunteered to participate were included in the study.

2.3. Limitations

This study involved a limited number of preschool teachers who volunteered to participate. There is a total of 385 preschool teachers in the city center of Southern Turkey, and approximately half of them, or 195 teachers, were included in the study.

2.4 Instruments

The "Questionnaire Form" used in this study was developed by the researcher as the primary data collection tool. In constructing the interview form, the initial step involved conducting a thorough review of relevant literature (Çarkıt & Bacanlı, 2021; Tanrıkulu, 2020). Following this literature review, draft questionnaire items were created. These draft items then underwent a content validity assessment, which included feedback from 10 experts. Subsequently, the internal validity of the questionnaire questions was determined and confirmed.

To assess the internal validity of the questionnaire items, a preliminary pilot study was carried out by interviewing 15 preschool teachers working in a district that was not part of the main research scope. During this pilot study, the questions were evaluated in terms of their feasibility, comprehensibility, and clarity. The questionnaire received its final form after considering the expert opinions and the outcomes of the pilot study.

The interview form covers various aspects, including the teachers' gender, age, educational background, the age group they teach, class size, their experiences with peer bullying behaviors in the classroom, and the strategies they employ to manage such bullying incidents.

2.5. Data Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0, and the results were presented as percentages. When comparing data, categorical data were analyzed using chi-square analysis. Significance levels were determined at a 95% confidence interval with a 5% margin of error, denoted as $p<0.05$.

2.6. Procedure

The research received ethical approval from the Kahramanmaraş Sütçü İmam University Social Sciences Ethics Committee on 03/12/2020 Date (Reference Number: 46422). Furthermore, written consent was obtained from the participating teachers, confirming their willingness to take part in the research in compliance with the principles outlined in the Declaration of Helsinki. The data for the research were gathered through semi-structured interviews with teachers during the fall semester of 2021, specifically between November 1 and December 1.

3. FINDINGS

The socio-demographic characteristics of the teachers included in the study and their encounters with peer bullying are shown in Table 1.

Table 1. Comparison status of encountering with peer bullying and some variables

Variables	Status of encountering peer bullying No n(%)*	Yes n(%)*	Total n(%)**	X^2/p***
Teachers' Gender				
Women	17(9.7)	158(97.3)	175(89.7)	0.967/0.607
Men	2(10.0)	18(90.0)	20(10.3)	
Teachers' Age				
20-24 years	12(9.4)	114(90.6)	126(65.1)	2.136/0.546
25-29 years	5(14.3)	30(85.7)	35(17.9)	
30-35 years	0(0.0)	12(100.0)	12(6.2)	
35 years and above	2(9.5)	19(90.5)	21(10.8)	
Teachers' Education				
Associate degree	12(9.2)	109(90.8)	121(62.1)	0.043/0.979
Bachelor Degree	6(9.9)	59(90.1)	65(33.3)	
Masters degree	1(11.1)	8(88.9)	9(4.6)	
Working experience				
0-5 Years	16(10.4)	138(89.6)	154(79.0)	0.359/0.836
6-9 Years	1(6.7)	14(93.3)	15 (7.7)	
10 Years and above	2(7.7)	24(92.3)	26(13.3)	
Working age group				
3	1(2.9)	34(97.1)	35(17.9)	3.978/0.264
4	3(9.4)	29((90.6)	32(16.4)	
5	7(9.1)	70(90.9)	77(39.5)	
6	8(15.7)	43(84.3)	51(26.2)	
Class size				
Less than 20	8(5.6)	136(94.4)	144(73.8)	**10.995/0.004**
21-30	7(21.2)	26(78.8)	33(16.9)	
31 and above	4(22.2)	14(77.8)	18(9.2)	
Type of Bullying Encountered/Witnessed				
Psychological (Indirect)	4(11.8)	30(88.2)	34(17.4)	0.562/0.755
Verbal	11(8.6)	117(91.4)	128(65.6)	
Physically	4(12.1)	29(87.9)	33(16.9)	
Need for In-Service Training in Coping with Bullying				
Yes	17(10.2)	150(89.8)	167(85.6)	0.251/0.616
No	2(7.1)	26(92.9)	28(14.8)	
Total	**19(9.7)**	**176(90.3)**	**195(100.0)**	

*Row percent, ** Column Percent, *** Chi Square test

In the research, the majority of the participating teachers were female, making up 89.7% of the sample, while 10.3% were male. A significant proportion of teachers fell within the 20-24 age group and held an associate degree. Approximately 79% of the teachers had a professional experience ranging from 0 to 5 years, with 39.5% of them having served for 5 years or more.

When it comes to peer bullying, a high percentage of teachers, 90.3%, reported encountering such behavior. Concerning the types of bullying frequently witnessed, it was observed that 65.6% of teachers reported instances of verbal bullying, 16.9% experienced physical bullying, and 17.4% encountered psychological bullying.

Table 2. Comparison peer bullying types and some variables

Variables	Types of Bullying			Total n(%)	X^2/p*
Student Gender	**Psychological n(%)**	**Physically n(%)**	**Verbal n(%)**		
Female Students	136(69.7)	11(5.6)	48(24.6)	195(100.0)	**13.915/0.008**
Male Students	11(5.6)	160(82.1)	24(12.3)	195(100.0)	**12.793/0.012**
Student Age					
3 years	0(0.0)	5(3.9)	4(12.1)	9(4.6)	**16.912/0.010**
4 years	6(17.6)	38(29.7)	3(9.1)	47(24.1)	
5 years	18(52.9)	38(29.7)	12(36.4)	68(34.9)	
6 years	10(29.4)	47(36.7)	14(42.4)	71(36.4)	
Teachers'Attitude towards bullying					
Speaking with family	2(5.9)	15(11.7)	3(9.1)	20(10.3)	3.494/0.744
Reporting to the school administration and guidance service	2(5.9)	14(10.9)	3(9.1)	19(9.7)	
Changing Classroom Management System	19(55.9)	56(43.8)	13(39.4)	88(45.1)	
To Build Empathy	11(32.4)	43(33.6)	14(42.4)	68(34.9)	
Peer Bullying Feature					
Bullying with the intent to harm	19(55.9)	24(18.8)	15(45.5)	58(29.7)	**23.357/0.000**
Chronic bullying	3(8.8)	23(18.0)	6(18.2)	32(16.4)	
Power imbalance bullying	12(35.3)	77.1(63.3)	12(36.4)	105(53.8)	
Effective Method to Prevent Peer Bullying					
Education for Families	10(29.4)	24(18.8)	3(9.1)	37(19.0)	**13.869/0.031**
Psychological Counseling Practices at School	1(2.9)	13(10.2)	0(0.0)	14(7.2)	
In-Service Training	2(5.9)	3(2.3)	2(6.1)	7(3.6)	
Classroom Activities	21(61.8)	88(68.8)	28(84.8)	137(70.3)	
Status of Teachers' Competency					
Never	4(11.8)	11(8.6)	4(12.1)	19(9.7)	2.874/0.942
Rarely	10(29.4)	31(24.2)	9(24.2)	50(25.6)	
Sometimes	16(47.1)	58(45.3)	15(45.5)	89(45.6)	
Usually	3(8.8)	24(18.8)	4(12.1)	31(15.9)	
Always	1(2.9)	4(3.1)	1(3.0)	6(3.1)	

Chi-Square test, p<0.05

The findings suggest that female students tend to use psychological bullying more frequently, while male students tend to engage in physical bullying. Moreover, as students grow older, they are more inclined to resort to physical and verbal bullying.

Regarding teachers' primary attitudes towards bullying, it appears that they are focused on modifying classroom management practices and fostering empathy among students as possible solutions. More than half of the students involved in bullying activities had the intention of causing harm.

Additionally, the research highlighted that nearly one-third of the teachers do not feel adequately competent when faced with bullying incidents. This underlines the need for further support and training to help teachers effectively address and manage such situations.

Table 3. Manage strategies of teachers against peer bullying

Strategies	n	%
Problem should be resolve by administration	185	80.5
No opinion	10	19.5
Total	195	100.0

According to the teachers' perspectives on developing and implementing strategies to address peer bullying, nearly all of them (out of a total of 185) emphasized that it is essential for the school administration to play a role in resolving the issue. Furthermore, they indicated that both the child engaged in bullying and their family should be directed to the psychological counseling and guidance unit for support and intervention. There were 10 participants who did not express a specific opinion on this matter (Table 3).

4. DISCUSSION and CONCLUSION

In the study, the incidence of encountering peer bullying was compared with various variables. It was found that classrooms with fewer than 20 students had a higher incidence of peer bullying ($p<0.05$). The number of adults in a classroom, which includes the classroom teacher and teaching assistants, could potentially influence the relationship between class size and preschool bullying. In Turkey, crowded classrooms with more than 20 students typically have one preschool teacher and one teaching assistant. These crowded classrooms tend to have a higher number of teachers, and increased adult supervision can potentially reduce the risk of bullying incidents in such settings. It's important to note that in the literature, some studies have reported no significant relationship between class size and bullying (Scheithauer, Hayer, Petermann & Jugert, 2006).

Regarding other variables such as age, gender, education level, years of working experience, working age group, type of bullying, and the need for in-service training to address bullying, no significant correlations were found (Table 1). However, in another study, it was reported that a higher incidence of bullying incidents was associated with preschool teachers' higher educational levels (Tanrıkulu, 2020). This suggests that the relationship between educational level and bullying incidents may vary across different studies and contexts.

Based on the research findings, it appears that female students are more likely to engage in psychological peer bullying, while male students are more inclined toward physical bullying during the preschool period. This aligns with previous research (Gillies-Rezo & Bosacki, 2003) which has shown that physical bullying is more common in boys than in girls. Additionally, girls tend to prefer engaging in verbal and psychological forms of aggression more frequently than boys do. These findings are consistent with the broader literature on the gendered patterns of bullying behavior.

Furthermore, the research findings indicate that as students age, they tend to engage more in verbal and physical bullying rather than psychological bullying. This trend aligns with the findings from Akduman's study conducted in 2012, which suggested that preschool children often experience conflicts related to sharing toys, establishing games, and defining roles during play, which can lead to peer bullying. According to Akduman (2012), children in such situations predominantly exhibit physical peer bullying behaviors like kicking, hitting, pinching, and punching, but they also resort to verbal peer bullying behaviors such as threats, teasing, name-calling, and insults. Akduman's study also noted that physical peer bullying is most commonly encountered in the 3-4 and 5-6 age groups during the preschool period. Therefore, it can be inferred that the findings from the current research are consistent with the previous study's results, reinforcing the idea that the nature of peer bullying behavior evolves with age in preschool children.

The research findings indicate that one of the primary attitudes teachers have regarding bullying is to modify classroom management strategies and foster empathy among students. This aligns with the conclusions drawn by Çarkıt and Bacanlı (2020), who found in their study that preschool teachers regarded empathy as one of the most effective approaches in preventing peer bullying within the school environment. Similarly, Atış-Akyol, Yıldız and Akman (2018) stated that the most common attitude among preschool teachers when dealing with peer bullying is to meet with the students' families, counselors, and school administration to address the issue. These findings underscore the importance of promoting empathy and implementing effective strategies in managing and preventing peer bullying in preschool settings.

The research findings indicate that more than half of the students involved in bullying do so with the intent to cause harm. This aligns with the findings of McGinnis and Goldstein (2003), who suggested in their study that students may engage in peer bullying to achieve personal desires, demonstrate their power to others, or seek attention. Furthermore, Özdemir (2014) noted in his study that children often exhibit aggressive behaviors and engage in actions aimed at asserting dominance within their peer groups. These findings shed light on the motivations and behaviors of students involved in peer bullying, highlighting the multifaceted nature of this issue.

In the present research, the participating preschool teachers indicated that the most effective methods for addressing peer bullying are in-class activities and family education. These findings are consistent with the conclusions reached by Çarkıt and Bacanlı (2020), who also studied preschool teachers' perspectives on peer bullying and found that the most effective method, according to teachers, is to provide training for students' families as a preventive measure. Similarly, Atış-Akyol, Yıldız, and Akman (2018) found in their study on peer bullying that the most commonly used practice by teachers to counter peer bullying is classroom interventions. These results emphasize the importance of a multi-faceted approach involving both classroom activities and family engagement in addressing and preventing peer bullying.

The research findings highlight that almost one-third of the teachers do not feel competent when faced with bullying situations. This aligns with the observations made by Mercan (2020), who noted in their study that teachers often lack the necessary coping skills to address peer bullying, and they may not possess a clear understanding of how to effectively manage such situations. Teachers may not be well-versed in strategies for handling peer bullying, and they might not allocate sufficient attention to implementing anti-bullying practices. On the other hand, according to Rodkin and Hodges (2003), teachers may not always play a significant role in peer relationships. Additionally, Özdemir (2014) found in their study that aggressive behaviors related to peer bullying tend to be more intense during unstructured and routine activity times, when teacher control and supervision are reduced. These insights emphasize the need for teacher training and support in addressing peer bullying effectively, especially during times when teacher supervision is limited.

The study conducted by Gündoğdu and Yaşar (2021) demonstrated that teachers' behaviors towards peer bullying have an indirect impact on peer bullying by influencing the power dynamics among children. Teachers' use of constructive language and positive interaction styles in their relationships with students can serve as a positive example for children. It underscores the importance of teachers and families being aware that they are constantly seen as role models in their interactions with children. These findings underscore the significance of fostering positive teacher-student relationships and providing a supportive, non-coercive classroom environment to address and mitigate peer bullying effectively.

Based on the literature review and the evaluation of the current research results, it becomes evident that teachers may not have sufficient training and resources to effectively address and control peer bullying (Tanrıkulu, 2020). While the Ministry of National Education of Turkey (MoNE) provides training for guidance counselors regarding peer bullying, it appears that this effort may not be sufficient (MoNE, 2021). Focusing solely on counselors and neglecting other educational branches may not fully address the issue of peer bullying. Therefore, it is believed that implementing an education program that involves preschool teachers, students, and their families is essential, particularly considering the crucial role of the preschool period in human development. Furthermore, a study with 538 participants has shown that prosocial behaviors are negatively associated with bullying and that prosocial behaviors play a significant role in reducing school bullying (Fu, Li, Shen, Zhu, Zhang, Liu & Zhang, 2023). Also it is stated that values education plays a significant role in the social and emotional development of children (İnan, 2011). Developing a program that incorporates values and prosocial behaviors such as empathy, friendship, love, respect, and sharing in classroom activities can enhance the effectiveness of anti-bullying efforts and reduce bullying behaviors among students. In addition, adopting an official anti-bullying policy and implementing regulations can be beneficial in preventing peer bullying. These policies and regulations can create a framework for addressing and preventing bullying within educational institutions. It is evident that preschool teachers often lack confidence in dealing with peer bullying, and they emphasize the importance of family education and programs for families. To enhance the effectiveness of education and prevention efforts, creating an educational program that involves families, teachers, and children is recommended.

Preschool teachers frequently stress the importance of promoting empathy in addressing peer bullying. Developing a values education program for preschool, which incorporates the value of empathy along with the 10 core values defined by the Ministry of National Education, such as love, respect, friendship, self-control, patience, and helpfulness, can be a valuable approach in combating peer bullying during the preschool years. In addition, it's worth noting that academic research on peer bullying has predominantly focused on primary and high school years, with relatively less attention given to the preschool period. There's a need for increased research on peer bullying in the preschool period, as it can provide valuable insights into addressing this issue and inform both national and international studies in the future. Expanding research in this area can contribute to a more comprehensive understanding of peer bullying across different age groups.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Kahramanmaraş Sütçü İmam University with the decision dated 03/12/2020 and numbered 46422

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Abstract

The purpose of this study is to disclose the practices of parents regarding the development of mathematical skills of their preschool children in their home environment during the Covid-19 pandemic. The research uses an explanatory case study as one of the types of case studies included in qualitative research methods. The sample selection of the research uses criterion sampling as one of the purposeful sampling types. In line with this, the study group consisted of 30 parents. The data of the research were collected using the interview technique. The data were obtained by using a semi-structured interview form developed by the researchers. The study concluded that parents perceive early math skills as daily life skills rather than a part of math skills and their knowledge about early math skills is inadequate. In the study, it was observed that during the pandemic period, preschool teachers generally did not make suggestions to support early math skills to parents, while parents used workbooks to support children's early math skills at home during the pandemic period, they made their children do addition and subtraction operations and made them count numbers. Based on the findings obtained at the end of the research, it is recommended to organize supportive training to increase parents' knowledge about early math skills and about methods for teaching these skills.

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Research Article

The Mathematics Process in Home Environments of Preschool Children in the COVID-19 Pandemic: Views of Parents *

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Abstract

The purpose of this study is to disclose the practices of parents regarding the development of mathematical skills of their preschool children in their home environment during the Covid-19 pandemic. The research uses an explanatory case study as one of the types of case studies included in qualitative research methods. The sample selection of the research uses criterion sampling as one of the purposeful sampling types. In line with this, the study group consisted of 30 parents. The data of the research were collected using the interview technique. The data were obtained by using a semi-structured interview form developed by the researchers. The study concluded that parents perceive early math skills as daily life skills rather than a part of math skills and their knowledge about early math skills is inadequate. In the study, it was observed that during the pandemic period, preschool teachers generally did not make suggestions to support early math skills to parents, while parents used workbooks to support children's early math skills at home during the pandemic period, they made their children do addition and subtraction operations and made them count numbers. Based on the findings obtained at the end of the research, it is recommended to organize supportive training to increase parents' knowledge about early math skills and about methods for teaching these skills.

Keywords: Early mathematic skills, view of the parent, Covid-19 pandemic

1. INTRODUCTION

The Covid-19 pandemic, which began in China in 2019 and soon became a global epidemic, has affected many areas of life in a negative way (TEDMEM, 2022). During the pandemic period, 1,326,123 children in the preschool period were affected by the interruption of education activities in Turkey (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020). The research results on this topic show that preschool children are missing the opportunity to learn mathematics and to study in social environments during the Covid-19 pandemic (Stites, Sonneschein & Galczyk, 2021). Educational activities started to be carried out through distance education on March 23 of 2020, in formal education institutions affiliated with the Ministry of National Education (MoNE, 2020). Based on this, as the time spent at home by children increased, the responsibility of parents in their children's education in the home environment increased (Brossard, Cardoso, Kamei, Mishra, Mizunoya, & Reuge, 2020) and parents had a critical position in children's access to education (Logan, Ogurlu, Garbe & Cook, 2021). In the long term, parental involvement in learning processes is important for children to become successful (Hapsari, Sugito, Fauziah, 2020), independent, productive and responsible individuals (Cousins & Mickelson, 2011).

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The formal and informal experiences with mathematical content during early childhood support children to learn mathematical information. These learnings take place in environments where the child interacts such as school and home (Lefevre, Skwarchuk, Smith-Chant, Fast, Kamawar & Bisanz, 2009). In addition to the activities performed by teachers, the development of the mathematical skills of children can be achieved through the support of parents (Karakuzu & Koçyiğit, 2016). Mathematical skills include one-to-one matching, perceiving and counting numbers, ordering, classification, comparison, geometry, spatial perception, connections such as part-whole relations, measuring, graphing, and performing mathematical operations. (Charlesworth & Lind, 2007). Early math skills such as pairing, grouping, and sequencing play a role in the individual's understanding of life (Yıldırım-Hacıibrahimoğlu, 2019), but they also predict long-term academic skills and readiness for primary school (Huntsinger, Jose & Luo, 2016). At this point, parents play an important role. The beliefs of parents about their children's development, learning, and the roles they assume, affect children's interactions with math activities (Sonnenschein, Metzger & Thompson 2016; Sonnenschein, Stites & Dowling, 2021). These activities which include mathematical content carried out by parents also predict children's arithmetic performance (Skwarchuk, Sowinski & Lefevre, 2014). It is seen that mathematics is taught formally and informally in studies examining the interactions of parents with their children including mathematical content (Levefre, et al., 2009). To increase children's arithmetic skills, parents' direct and explicit instruction on number, quantity, or arithmetic is defined as formal activities. Arithmetic activities are defined as informal arithmetic activities where the main purpose is not to teach about numbers, quantity, or arithmetic, but activities such as playing games on the scoreboard, making measurements in art, and kitchen activities (Skwarchuk, Sowinski & Lefevre, 2014).

Review of studies on the views of parents on the distance education process during the covid-19 pandemic, indicated that parents' do instructional activities on mathematics (Stites, Sonneschein & Galczyk, 2021). Haktanır (2021), in his study, which examined the parents' levels of support for skills such as mathematics and readiness to literacy in the home environment, concluded that parents' support levels for these activities were moderate. It is important to reveal the support of early mathematics skills, which is important to support in the early period, in the home environment during the pandemic period, how much and how mathematics is included in the process, in terms of guiding teachers who shed light on parents and parents in the pandemic. Thus, with the present results, there will be a guide to support early mathematic skills in the home environment in the future.

- The current study which aimed at revealing the processes related to the development of children's mathematical skills in the home environment of parents who had children in the preschool period during the Covid-19 pandemic, addressed the following research questions: How do parents define early mathematics skills?
- What do skills like matching, ordering, classification, and grouping mean to parents?
- What kind of math-related materials do children play with within their home environment?
- Do parents include mathematics in their conversations?
- What mathematical activities do parents do with their children?
- What are the mathematical skills that should be acquired in the preschool period according to the parents?
- During the pandemic period, what is the role of teachers in supporting children's early math skills according to parents' views?
- Do parents need support to develop their children's early mathematics skills?

2. METHOD

2.1. Research Model

This study is designed as an explanatory case study, which is one of the case study types included in qualitative research methods, and criterion sampling was determined from the purposeful sampling types in the sample selection in this study.

2.2. Study Group

The sampling criterion was, "having a child aged between 3 and 6 years old, who attended preschool education during the pandemic period". Accordingly, the study group consists of 30 parents. Qualitative research can also be conducted with purposefully selected small samples, sometimes even using a single sample (Patton, 2014). Of the 30 parents included in the study group, 8 of them live in Istanbul, 8 in Sivas, 7 in Denizli, 2 in Ankara, 1 in Samsun, 1 in Kayseri, 1 in Aydın, 1 in Izmir, and 1 in Kırşehir. Of the parents, 3 are primary school graduates, 5 are high school graduates, 3 hold associate degree, 16 hold undergraduate, and 3 hold graduate degree. Looking at the professions of the parents, 12 of them are housewives, 7 of them are teachers, 7 of them are civil servants (4 university employees, 2 police officers, 1 expert), 2 are engineers, 1 is a lecturer and 1 is a banker. 21 of the parents have 2 children, 5 of them have 1 child, 3 of them have 3 children and 1 of them has 4 children. The children of 24 parents go to public school, and 6 of them go to private school. Considering the distribution of children according to their ages, it was seen that 4 of them were aged between 36-48 months, 8 of them were aged between 49-60 months and 18 of them were aged between 61-72 months.

2.3. Data Collection Tool

2.3.1. Semi-structured interview form of the parents on the mathematics process of the preschool children in the home environment in the covid-19 period 659

The data in the study were collected using the "Semi-structured Interview Form of the Parents on the Mathematics Process of the Preschool Children in the Home Environment in the Covid-19 Period" developed by the researchers. After the feedback from three experts, the questions "What do the matching, sorting, classification, and grouping skills mean to you? and What kind of materials (other than toys) does your child play with at home?" were added. Pilot interviews were conducted with three parents to understand whether the form, which was prepared in line with expert opinions, was understandable and whether the questions were functional. The clarity of the questions and whether the answers included answers to the questions were examined by both researchers and an expert. After it was concluded that the questions provided the desired data, the main data collection process started.

2.4. Data Collection Process

In the interviews, the same questions were asked to all participants in the same order (Corbetta, 2003). The researchers stated to the interviewees that the interviews would be used only for this research and that no personal information would be included in the interviews and that they would be used by giving codes. The interviews lasted approximately 20 minutes. Interviews were conducted using telephone and online platforms (Zoom, Skype) due to the pandemic period. The number of participants was deemed sufficient after it was seen that data saturation was achieved and the answers were repeated. The interviews were converted into written documents and were stored by giving codes such as "P1, P2, P3, …, P30". The form consists of two sections. In the first part, which includes demographic information, answers are sought for questions about educational status, occupation, place of residence, number of children, children's ages, children's gender, and the age of the child receiving preschool education. In the second part, there are ten interview questions such as "How do you define early math skills? What skills do you say when you say early math skills? How did you spend time at home with your child during the pandemic period? What kind of study/activities did you do about math with your child at home during the pandemic? What kind of activities did your teacher do to improve your child's math skills at home during the pandemic period? Do you need any support to improve your child's math skills during the pandemic period?".

2.5. Data Analysis

The content analysis technique suggested by Mayring (2004) was used to create codes and categories in the examination of written documents in the research, and the data were analyzed using the MAXQDA Analytics Pro 2018 (18.2.5) program. In content analysis, the process must be organized with a communication model, and regularity, central themes, validity, and reliability criteria must be provided. In this context, in order to make inductive categorization, first, the interviews were transcribed, the codes were created from the written texts, then the codes were combined under categories by paying attention to the meaning context, and the themes were created. 20% of the answers that were transcribed were sent to an expert in preschool education to increase the reliability of the coding of the data. In this way, multiple coding was done (Barbour, 2001). In line with expert opinion, the theme of skill areas that should be supported according to parents was divided into three categories: operations, early math skills, and numbers.

Lincoln and Guba's (1986) credibility, consistency, transferability, and confirmability stages were used. The literature has been reviewed and references are given to related studies. Opinions of three field experts were taken during the creation of the form. In addition, an expert in the field was consulted in the analysis of the data. The interviews were made on a voluntary basis, and the participants were ensured the confidentiality of the data. Written documents were stored by giving codes as "P1, P2, P3, …, P30". See appendix 1 to get a clearer picture of the research and data analysis process.

3. FINDINGS

Based on the findings obtained at the end of the study, many parents have been found to think of numbers/counting, addition, and subtraction as early mathematics skills. In addition, it has been determined that parents describe matching, sorting, classification, and grouping skills as life skills. It was concluded that the majority of the parents participating in the study did not need any support for the development of children's mathematical skills during the pandemic period.

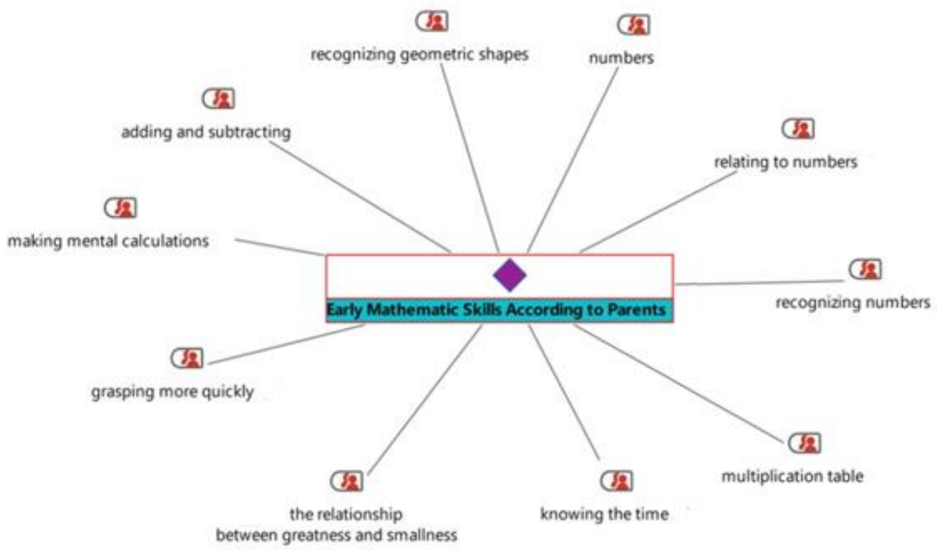

Figure 2. Early mathematic skills according to parents

In Figure 2, the codes

for recognizing numbers, relating to numbers, numbers, recognizing geometric shapes, adding and subtracting, making mental calculations, grasping more quickly, the relationship between greatness and smallness, knowing the time, and multiplication table were created in Figure 2 regarding the theme of early mathematics skills. Some of the parents' views that mediated the creation of the codes are given below:

P3: *"Knowing the numbers, I mean so. Knowing how many there are, knowing the time, I mean recognizing the numbers. For me that is all."*

P6: *"Counting can be related to greater/smaller relation. This of course can be a greater/smaller relationship between objects, either in number or visually. It can be simple addition, operation, or four operations skills. Addition, subtracting, reducing of something, or increasing. They might be such things like that. Perhaps not 3-dimensional objects, but to be able to recognize a 2-dimensional square, rectangle, or geometric shapes. These might be included."*

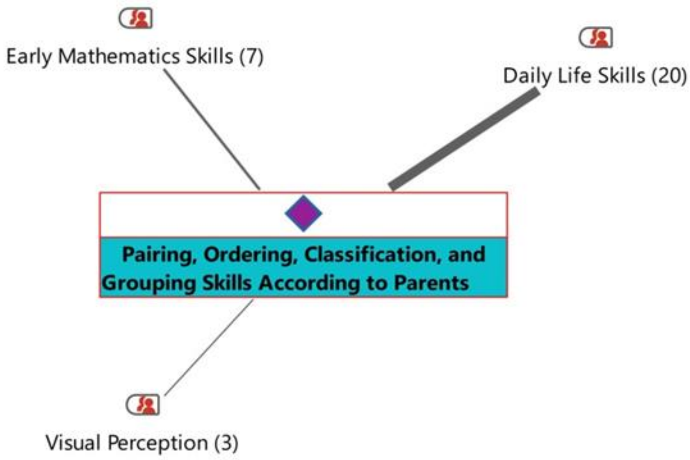

Figure 3. Pairing, ordering, classification, and grouping skills according to parents

In Figure 3, according to the views of the parents, the categories of Daily Life Skills, Early Mathematics Skills, and Visual Perception were created regarding the theme of matching, ordering, and grouping skills. Examples of parent's views that form the basis for the creation of these categories are given below:

P6: "It is great that you said that. These are also actual mathematical skills. Of course, I couldn't portray it when I said it all of a sudden. I think that these are also mathematical skills."

P18: "I think of visual perception and daily life skills. He must perceive what he sees so that he can match and classify them. For this reason, these skills seem to me first as visual perception. I can also say things that make me think that it is a daily life skill, such as looking around to find the other socks at home, or my son's playgroup being divided into two groups and playing in the street while he is playing."

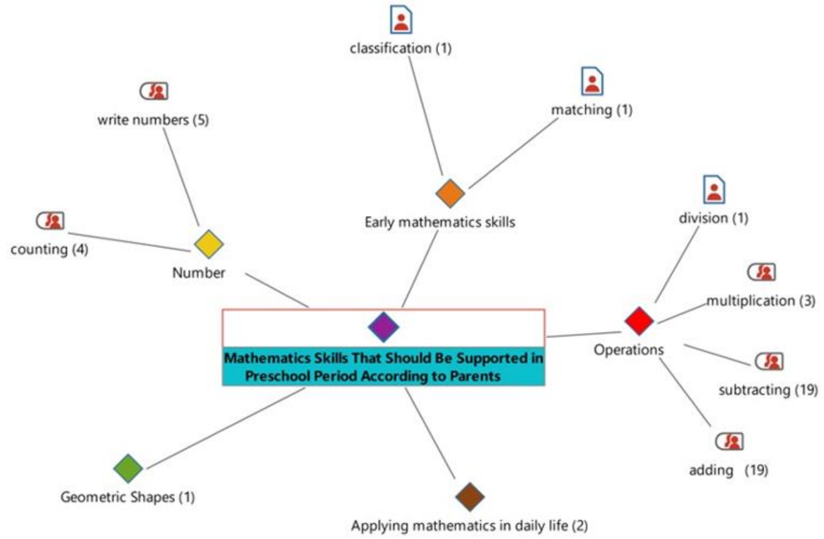

Figure 4. Mathematics skills that should be supported in preschool period according to parents

In Figure 4, the categories of Operations, Early Mathematics Skills, Numbers, Geometric Shapes, and Applying Mathematics in Daily Life were created related to the theme of mathematical skills that should be supported according to the parents. The codes of addition, subtraction, multiplication, and division were used in the creation of the operation category.

P18: *"He needs to learn numbers especially well, to be able to do things like counting by fives, and counting in simple ways. I think that they should learn operations such as addition and subtraction, and making subtraction using their fingers. He also uses mostly addition and subtraction in daily life. In order to be able to do this, he needs to know the numbers very well."*

P28: *"Well, like I said, he needs to make visual matchings. If he is going to buy 5 pens for his friends he should be able to buy 5 pens without counting them in his mind. He should know its number and take it without seeing anything concrete. I think he should do things like addition, subtraction, and matching to meet his daily needs."*

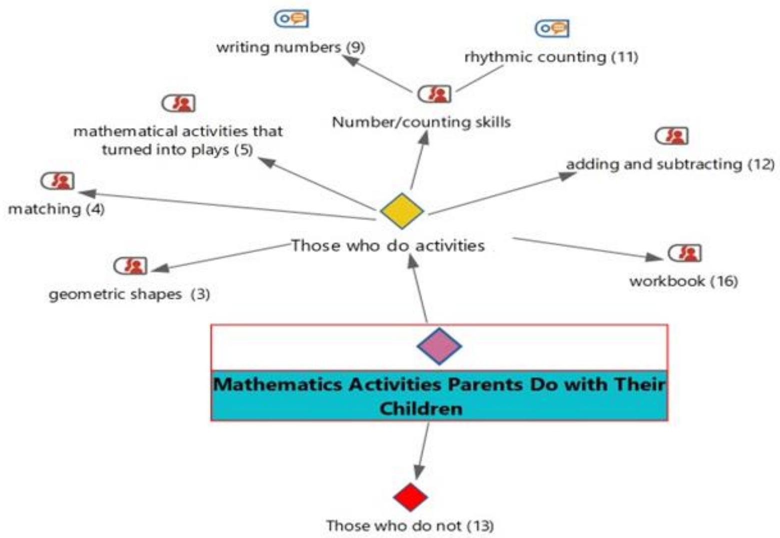

Figure 5. Mathematics activities parents do with their children

When Figure 5 is examined, two categories, "Those who do activities" and " Those who do not", were created regarding the theme of mathematical activities done with children. In the creation of the “Those who do activities” category, codes of number/counting skills, mathematical activities that turned into plays, matching, and geometric shapes were utilized to create “ activities done ” category.

> P12: “*For example, we played with balls. We played with balls the most. I'll tell you that. It's called marbles, you know, you line up marbles, you throw them. How many did you collect from the right head, from the left head here? How many marbles each of us have left? Everyone put four, or three each. Like how much everyone has. How many marbles each of us have left after the last play is over? Like that way you know. For example, this is mathematics, you know, a mathematical play… We also had a game with hippopotamuses. It was about the one who gets the most marbles. Like that.”*

> P19: *“His father bought a homework book. Generally, we use that. There are activities to be done, things like which tree has more apples in it. Also, the workbook guides us about exactly what we need to work on. Otherwise, if it were up to me, I would consider practicing things like memorizing numbers, writing numbers, or adding and subtracting.”*

> *I bought some fun math kits. Toys related to math are being sold. The numbers are like plus and minus. So that you can see it. She shows her comprehension of numbers by saying things like an apple and a duck. Then there was the matching such as matching the number two with the box with two pencils. Then there was the collection. This time we are adding, I mean we are putting them together. It's like bringing three toys with two toys and counting.*

> P27: *“He mostly played with his siblings, now that I have an 8-month-old child. . That's why I would be lying if I said that I played. His father also came home tired as his father often went to work.”*

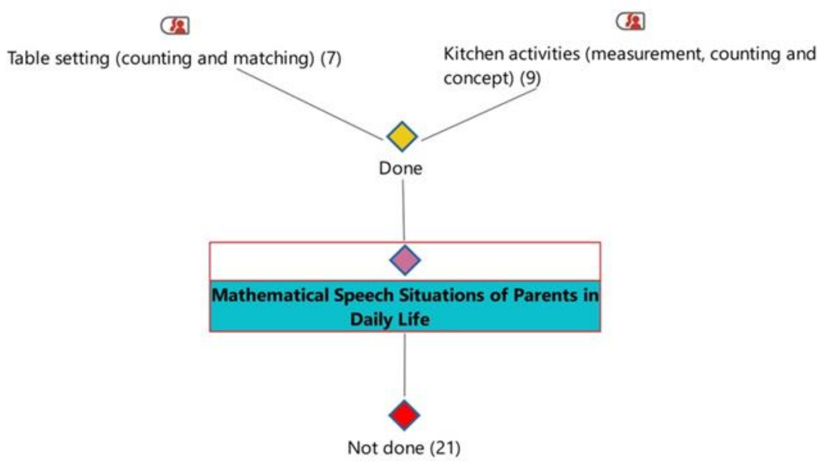

Figure 6. Mathematical speech situations of parents in daily life

In Figure 6, categories such as activities are done and not done and were determined regarding the theme of mathematical speaking in daily life. Codes for kitchen activities and table setting were created for the category of doing.

> *P20: “I do not know how much it can be regarded as conversation on mathematics but when I'm making a cake, I give my daughter commands like give me three eggs, and also tell her the process by saying: “we put a glass of milk, a teaspoon of baking soda”; just like writing a recipe..”*

P23: "Especially when setting up the table, my daughter puts forks and spoons according to where we will sit. He puts smaller cutlery on the place where her brother and herself will sit. Rather than counting like one, two, or three, when taking it out of the drawer, she takes it to the table by matching it by saying it is my mother's spoon and it is my father's spoon.

P24: I set the table myself in case a plate or something breaks; I have never asked such a thing from my child until now. I don't know why but when making cakes, I also prepare everything, I just give him a piece of dough, she shapes it the way she likes and cooks and eats. Since I'm very meticulous, I don't let my daughter get close in case a hair or something else falls in, but now that you asked me about that; I think maybe I could make her realize what numbers and quantities do in daily life."

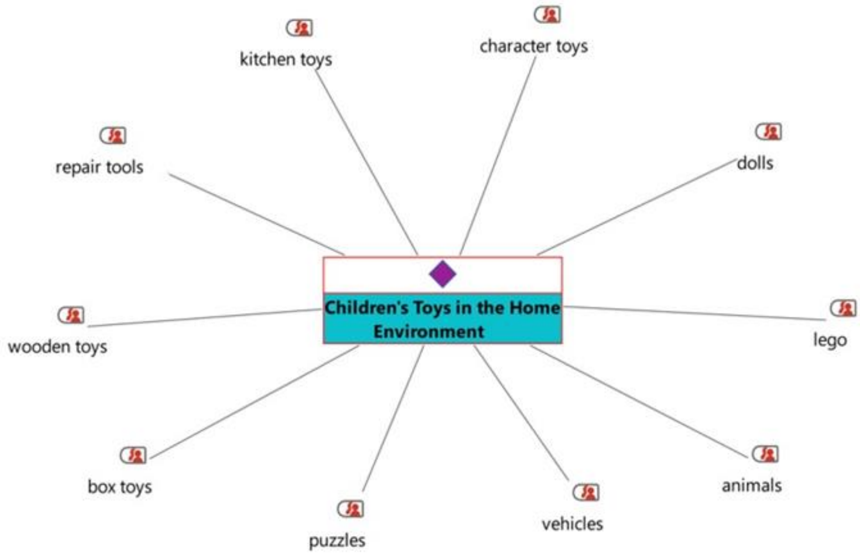

Figure 7. Children's toys in the home environment

664

When Figure 7 is examined, codes for lego, dolls, character toys, box toys, kitchen toys, wooden toys, board games, puzzles, vehicles, and animals were created according to the parents' views on the theme of the child's toys.

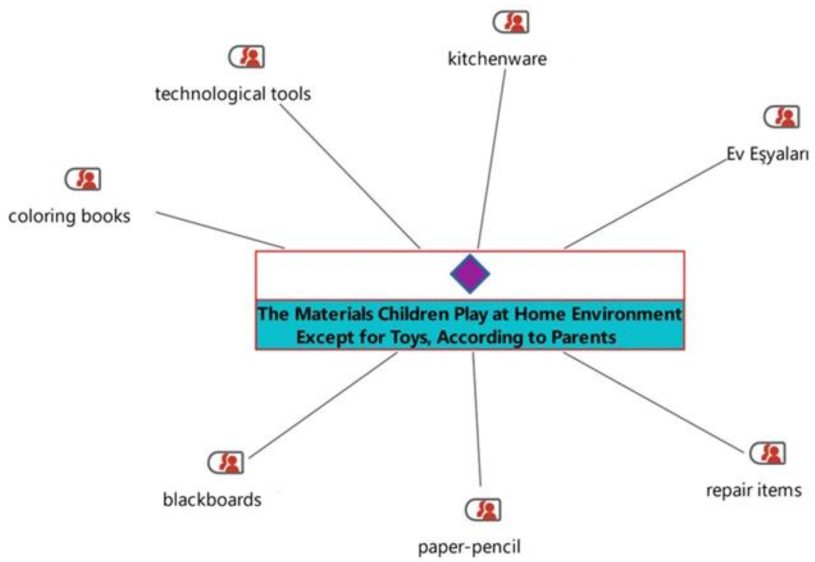

Figure 8. The materials children play at home environment except for toys, according to parents

When Figure 8 is examined, codes for household items, kitchenware, technological tools, coloring books, blackboards, paper pencils, and repair items have been created related to the theme of materials that children play with other than toys. Sample parent views on the creation of codes are given below:

> P2: *"Robot, electrical stuff. Battery-powered stuff in the house. He usually plays with battery-powered devices, and mostly with batteries. When we go to the toy store or the market, he looks for the batteries. He likes to open the inside of the toys afterward. He doesn't like Legos. He does not like to do something in accordance with a directive, he gets bored. He doesn't like to paint or do that kind of stuff. But the screwdriver, then the hammer, then the little electronic things, the things I use at home, he knows these. He can play for a long time with such things, or a simple toy made of wood, or he likes to make them. Like that…… He plays with things other than the toys... He doesn't play much with the toys, he either plays with the things in this house or in the cabinets or at work, he takes out the screwdrivers, he takes out the small screwdrivers and opens the toys then change the batteries. For example, we plant flowers, and he likes to play with soil. He mostly likes to spend time outside."*

> P12: "*My son plays lego the most. He's doing jigsaw puzzles. He is mostly interested in two things. Other than that, he doesn't have much to do with sports. He mostly doesn't play with balls. He doesn't ride the bike much. Usually, he is at his desk. He paints, draws something; collects and subtracts things. My son invents things. He connects, unties, and glues the items in the house. He invents all the time… As I said, for example, when the toilet paper runs out, he makes binoculars out of a toilet paper roll, then makes a microphone. For example, when you run out of something at home, you buy something from the market. In our house, no item's box can be thrown away. I secretly throw them away. He's always trying to invent something like that with them. He's making a trap, he's making a space shuttle, he's making an imaginary thing, you know, making a teleportation machine. I mean, he does stuff like that."*

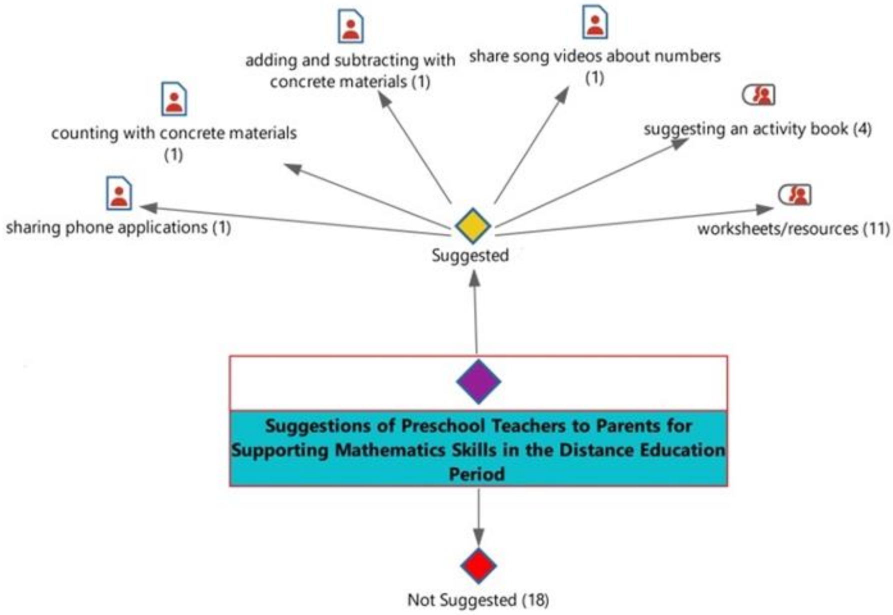

Figure 9. Suggestions of preschool teachers to parents for supporting mathematics skills in the distance education period

When Figure 9 is examined, the theme of teacher suggestions for supporting math skills is divided into categories as Suggested and Not Suggested. Suggested category was created from the codes of sharing worksheets/resources, suggesting an activity book, song videos about numbers, adding and subtracting with concrete materials, counting with concrete materials, and sharing phone applications.

> P19: *"Of course he suggested. We were doing live lessons in the evening, the teacher was asking, there was a wheel of fortune, for example, he was teaching a play like jumping on one foot 5 times. There were suggestions like giving us printouts and coloring six apples. We completed them."*

> P28: "*The teacher did not provide any support. He finished his lesson and turned the computer off.*"

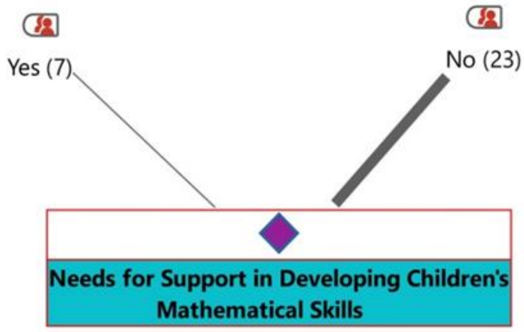

Figure 10. Needs for support in developing mathematical skills

> P7: "*Of course it is possible. After all, no matter how much we know about that age group in educational sciences, I don't know as much as experts who deal with that age group. Of course, I think it would be much better if there was someone who directed me or told me to buy and use certain materials. I mean, I just tried to do as far as I know about educational sciences. I was reading about these things, but if an expert told me to do this directly, take this and apply this, it would be much better, and would be much more planned. So I would like that, yes.*"

> P30: *"Of course I needed support. Since I am in music education, I did not have a full grasp of what was going on in the preschool period. I had no idea what was taught. In fact, we do not know exactly what topics are in mathematics, how teaching should be, or what and how we will teach. Since the teacher did not inform us during this period, I tried to learn something by searching on the internet during this period."*

4. DISCUSSION and CONCLUSION

The study shows that parents knowledge about early mathematical skill include numbers, knowledge of operations, geometric shapes, the concept of greater / smaller, grasping, and clock. Similarly, in their study, Kılıç and Özcan (2020) found that parents did not mention the importance of matching, ordering, classification, and comparison skills among early mathematics skills. In their study, Thippana, Elliott, Gehman, Libertus, and Libertus (2020), who examined conversations of children including numbers with parents in math activities and non-math-related activities, reported that parents performed math-related activities with their children and they were more likely to use number words in math activities.

Parents consider matching, ordering, classification, and grouping skills, which are under the early mathematics skills, predominantly as daily life skills. Similarly, in their study, Kılıç and Özcan (2020), it was revealed that parents regard matching, sorting, classification, and grouping skills, which are under early mathematics skills, predominantly as daily life skills. Also, in the study of Öçal (2019), parents emphasize that mathematics is important in children's daily lives. Within this respect, it can be concluded that parents are aware of the importance of mathematics in early childhood in children's development.

It was observed that children play with a variety of toys such as legos, dolls, character toys, box toys, kitchen toys, wooden toys, board games, puzzles, toy vehicles, and animals. It was determined that they made sequences with wooden toys and played board games that supported mathematical skills such as counting. The findings also indicated that they studied of numbers and math operations on the blackboard, which can be regarded as one of the non-toy materials children spend time with. Kitchen utensils and furniture at home are important elements that contribute to the development of children's early math skills (Blevins Knabe & Musun Miller, 1996). Kılıç and Özcan (2020) stated in their research that parents expressed that the materials they thought supported children's early math skills were puzzles, legos, and wooden toys. Majority of the parents stated that they do not think their home environment as a supportive element in the development of children's early math skills. In the study by Mutaf Yıldız, Sasanguie, De Smedt, and Reynvoet (2018), it was concluded that parents made more mathematical conversations when playing with lego and reading books than children, and children had more mathematical conversations while playing with lego compared to reading books. Within this respect, it can be concluded that children use mathematical expressions more in their daily activities.

The study concluded that most parents ignored mathematical speech in daily life. However, the findings highlighted that as a part of responsibilities parents gave to their children at home, they made mathematical conversations involving numbers and half/full concepts such as "Let's add 2 eggs, half a glass of flour, one package of oil" in the kitchen activities of counting and matching in preparing the table. Ergel and Aydoğan (2021) determined in their research that parents stated that children's early mathematical skills were supported by mathematical conversations in activities such as table preparation, cooking, laundry/dishwashing, cleaning, and shopping. Parents included mathematical conversations with children while playing games, shopping, and cooking with them, and these had positive effects on the development of children's mathematical skills (LeFevre et al., 2009; Ramani & Siegler, 2008).

It has been observed that almost half of the parents who make up the study group did not do activities related to mathematics with their children during the pandemic period, while the parents who did the activities mainly completed activities with their children in activity books, did addition-subtraction operations verbally or with concrete materials, and activities that support number/counting skills. Stites, Sonneschein, and Galczyk (2021) stated that parents provide inadequate amount of learning experiences in the field of mathematics to their children in the home environment. Similarly, Fatmawati, Herman, and Kisno (2021), in their research concluded that during the pandemic period, parents did not provide the necessary guidance to children in teaching mathematics activities, and they had difficulties in it. In the research conducted by Kılıç and Özcan (2020), parents stated that they think that numbers, addition and subtraction are used in preschool mathematics teaching. In other studies, creating opportunities to support mathematical skills through doing activities with children related to daily life, and creating mathematical conversations resulted in positive outcomes for children (Jay, Rose & Simmons, 2018; Sonnenschein et al., 2012). In the study conducted by Ergel and Aydoğan (2021), it was concluded that parents mostly played games to support children's early math skills, and then they did art activities and daily life-kitchen activities. In the study conducted by Zippert and Rittle Johnson (2020), it was seen that parents with children in the preschool period supported their children's arithmetic, spatial and pattern skills to a certain extent, and among these skills, they focused on supporting arithmetic skills the most.

Parents think that recognizing numbers, writing, and counting, especially addition and subtraction skillsshould be supported in the preschool period. Similarly, in his study Ocal (2019) found that parents perceive early maths skills as numbers and operations. Ramani et al. (2015) found that children's basic knowledge of numbers has improved more than other maths skills because parents mostly study numbers at home. In their study, Blevins Knabe, Austin, Musun Miller, Eddy, and Jones (2000) concluded that mothers usually do activities at home with their children related to early math skills such as counting objects and talking about the order of events during the day.

It has been stated that more than half of the teachers of the children of the parents who constituted the study group did not make suggestions for activities during the pandemic period and that the teachers who made suggestions mostly shared worksheets/resources. In the research conducted by Karademir (2021), it was concluded that the parents with high socioeconomic status received support from the teachers during the pandemic period, but the families at the lower socioeconomic level could not communicate well with the teachers due to various reasons, thus causing the families to feel hopeless and anxious about the future of their children. On the other hand, Demir and Özdaş (2020) found that teachers were in contact with students and parents during the distance education period, they carried out distance education in cooperation with parents, and they conducted activities, gave assignments, and played games through various communication channels and follow-up the learning process. In addition, the problems related to communication such as the loss of communication of the teachers, the insensitivity of the parents, the inability to reach the parents, the inability to receive feedback from the given studies, and the inability to reach all students are the other results they obtained from the research. Preschool teachers should share more with parents about early math skills, and parents should be more open to learning at the point of gaining these skills.

Based on the findings obtained at the end of the study, the majority of parents did not need any support in developing their children's mathematical skills during the pandemic period. Similarly, Akkaya and Polat (2022), in a study examining the relationship between parents' math literacy self-efficacy and math anxiety, concluded that parents whose children are in the first grade of primary school have high math self-efficacy and do not need support. In the study by Cannon and Ginsburg (2008), parents state that it is not necessary for children to acquire mathematical skills in the preschool period. In addition, when the activities carried out by the parents were examined, it was determined that they spared little time for mathematics activities, and the activities they did were mostly activities related to the language development of the children. In his research, Panaoura (2021) determined that the competence of parents in doing activities with their children was low during the Covid-19 pandemic. Sonnenschein et al. (2012) concluded in their study that the reason why parents give less place to mathematics activities is that they have little knowledge to support their children's mathematics skills. Parents' comments on early math skills and skills that should be supported in the preschool period reveals that parents are not aware of their lack of knowledge. In the research by Ergel and Aydoğan (2021), parents indicated that they were aware of their responsibilities in helping children acquire mathematical skills, but their current knowledge was insufficient in terms of teaching mathematical skills and therefore they need support. In their study, Ölmez, Özkan, Bilgin, and Veziroğlu Çelik (2019), who studied parents whose children received preschool education, concluded that although parents consider it important to provide early mathematics education, their knowledge level about the content of early mathematics education was not sufficient. Haktanır (2021) examined the level of support parents gave for mathematics and literacy preparation skills at home and found that parents supported these activities at a moderate level. It is important that parents who have children in the preschool period are provided with a supportive training on early mathematics skills and how these skills can be taught to children as early as possible.

Parents' participation in children's learning processes not only increases academic achievement, but also positively affects processes such as behavioral development and social adaptation (Sapurgan & Sapurgan, 2014). In this direction:

- Training programs on early mathematics skills and methods for teaching these skills can be organized for parents.
- An educational program for developing parents' skills of teaching early mathematics skills to their children can be developed and the effectiveness of this program can be evaluated.
- Policy makers can provide training to families on early mathematics skills.
- With education systems such as EBA, a platform can be created that includes suggestions for activities and materials that parents can do at home regarding mathematics in early childhood.

Limitations

The study group is limited to 30 parents whose children aged between 3 and 6 attended preschool education during the pandemic period.

Ethics Committee Decision

The study, the researchers applied for ethical permission from Sivas Cumhuriyet University Scientific Research and Publication Ethics Social and Human Sciences Board, and an ethical approval was received (E-60263016-050.06.04-91547).

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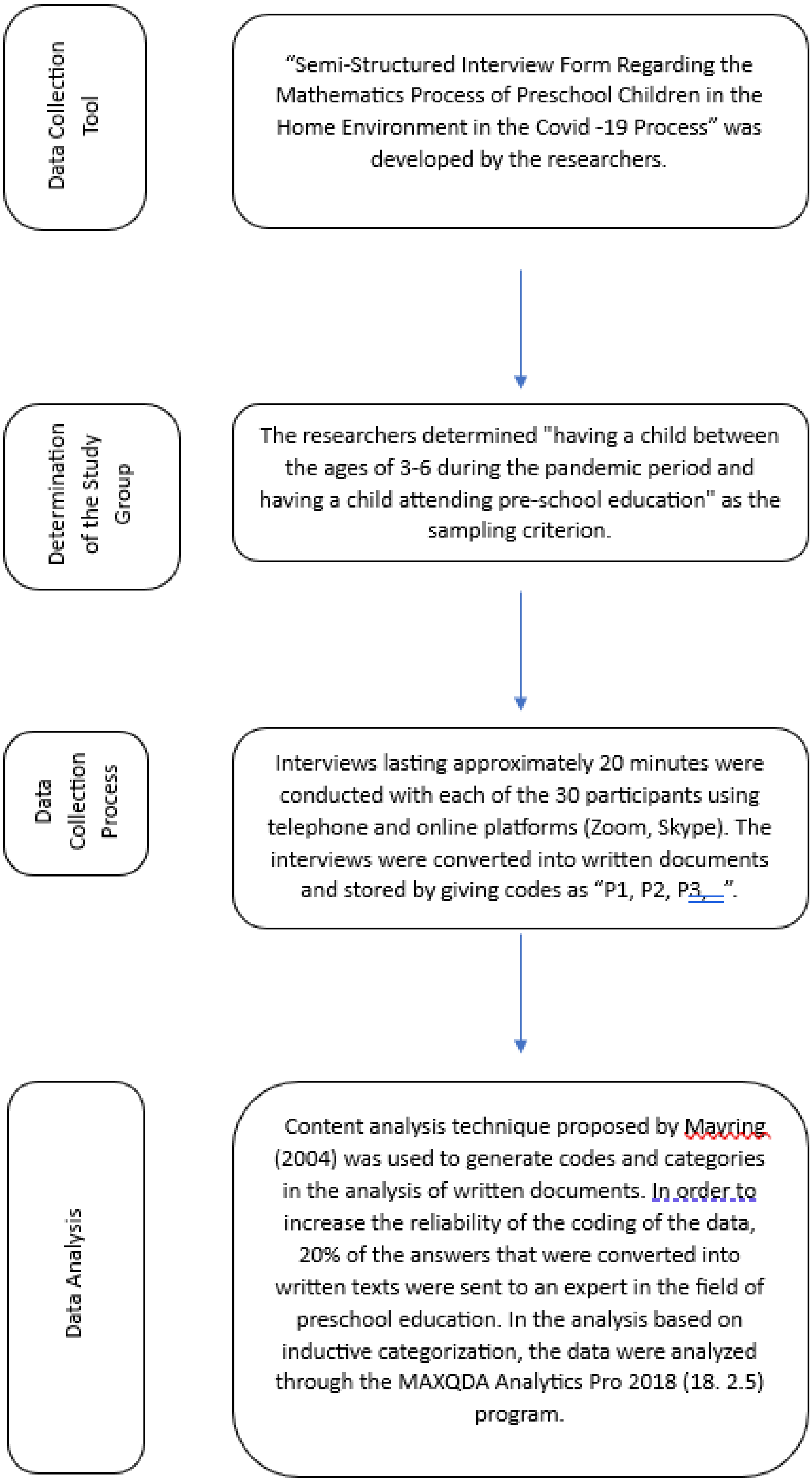
Appendix. Research process (PRISMA)



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Abstract

This research will describe the interaction of learning and gender approaches to the critical thinking skills of Science Elementary School students. This study used a quasi-experimental design method using a 2 x 2 factorial research design and saturated samples. Data were collected using the essay questions given at the beginning and end of the treatment. Test the hypothesis using Two way ANOVA. This study resulted in differences in critical thinking skills among students who were given treatment with video-based IBL approach in science learning is higher than conventional. Critical thinking skills among the group of female students outnumbered male students. There is no interaction effect of the video-based inquiry-based learning (IBL) strategy and gender on critical thinking skills. In the group of female students, the critical thinking ability of students who were given a video-based IBL approach was higher than conventional. In the group of male students, students who received a video-based IBL approach demonstrated greater critical thinking skills than conventional students. In the group of students who were given a video-based IBL approach, female students outperformed male students in critical thinking abilities. Male students have a stronger critical thinking capacity than female students in the group of students given the standard approach.

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Research Article

Video-Based IBL and Conventional Approaches to Critical Thinking Skills in Terms of Gender *

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Abstract

This research will describe the interaction of learning and gender approaches to the critical thinking skills of Science Elementary School students. This study used a quasi-experimental design method using a 2 x 2 factorial research design and saturated samples. Data were collected using the essay questions given at the beginning and end of the treatment. Test the hypothesis using Two way ANOVA. This study resulted in differences in critical thinking skills among students who were given treatment with video-based IBL approach in science learning is higher than conventional. Critical thinking skills among the group of female students outnumbered male students. There is no interaction effect of the video-based inquiry-based learning (IBL) strategy and gender on critical thinking skills. In the group of female students, the critical thinking ability of students who were given a video-based IBL approach was higher than conventional. In the group of male students, students who received a video-based IBL approach demonstrated greater critical thinking skills than conventional students. In the group of students who were given a video-based IBL approach, female students outperformed male students in critical thinking abilities. Male students have a stronger critical thinking capacity than female students in the group of students given the standard approach.

Keywords: Critical thinking, inquiry based learning, conventional, gender

1. INTRODUCTION

The drawback for weak critical thinkers can be divided especially in two categories; First they are generally more likely to score poorly when compared to high critical thinkers. Secondly generally they have less motivation in improving their critical way of thinking in a positive direction (Stockdale, 2003). But what cannot be denied is that one of the causes of unmotivation of students in improving critical thinking is that teachers are very often the main source of all information so that Students lack the chance to engage in learning activity, students become passive, because students are rarely given the opportunity to convey their arguments against solving existing problems (Bustami, Syafruddin, & Afriani, 2018). The statement describes that what happens in schools is that the learning process is dominated by teachers and students only receive teacher orders. It is clearly not trying to change from active teachers to active students, of course, will make the development of students' analytical abilities will not progress in a positive direction in terms of improving critical thinking skills.

A person must become proficient in more advanced information as the development of science and technology increasing. To achieve this requires critical, logical, and acceptable thinking (Siregar,

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Mujib, Hasratuddin, & Karnasih, 2020). According to (Sari & Winda, 2019) critical thinking, thinking creativity is very necessary in order to be capable of competing in life in the 21st century. Critical thinking is one that needs to be learned from an early age (Fisher, 2009). Indraswati, Marhayani, Sutisna, Widodo, and Maulyda, (2020) explained that one thing that becomes a high-level thinking point to focus on in 21st century learning is the skill to be able to think critically. In another research article submitted by (Susilowati, Relmasira, & Hardini, 2018) and (Utami, Koeswati, & Giarti, 2019) critical thinking is needed for learners to be capable of competing in real society. Some previous opinions can be concluded that it is very important to teach critical thinking and should start from elementary school. This is important because it will be used in real life.

This statement is also reinforced by the opinion expressed in the article which states that critical thinking capacity still needs to be improved Dwi Ferdiani, Yudiono, and Murniasih, (2019) states that critical thinking of high-class elementary school children is found to be still low. Likewise, the results of PISA in 2018, Indonesia's value for critical thinking is lower than the OECD mean, especially in reading, science, and mathematics (OECD, 2018). However, if students since primary education is given an education that is able to develop critical thinking skills, it will have a real impact in a positive direction in the lives of students at a later stage (Richardson, 2016). Some of the findings of the preceding study is that primary school critical thinking abilities children need to be improved and should have started since elementary school.

In addition to the importance of efforts to enhance critical thinking abilities, there are several factors that can affect students' ability to think critically, one of which is gender. According to a research article stated that the IBL approach can eliminate the gender gap and can improve interest and learning outcomes (Khalaf & Zin, 2018). Likewise, the findings stated that inquiry learning in samples taken in Beijing reported an increase in student learning activities and that a sample of Dutch students in some lessons liked inquiry activities (Huang, Doorman, & van Joolingen, 2021).

Critical thinking is a skill to make essay questions so that it can be seen the depth of the student's ability to make questions and classify arguments, define and capture the content of a general concept. Critical thinking is a way of thinking where when someone has a goal in his mind then he wants to know how to achieve it and question what is right, what is wrong, what is believed, and what is rejected. Critical thinking is a powerful and much-needed thinking (Facione, 2011). Critical thinking is mind control, which develops high thinking skills and can help control propaganda, analyze arguments and be aware when there is intentional deception and be able to consider the truth of the source of information and be able to think about the best decision (Halpern, 2013).

According to Wiyoko, (2019) critical thinking skills must be trained starting from elementary school. Thinking skills from the very beginning became the best basis for his further schooling. A critical thinker can influence the effectiveness of learning as well as the speed of learning, and the ability to learn (Heong, Othman, Yunos, Kiong, Hassan, Bin & Mohamad, 2011).

The opinions above can be concluded that, critical thinking is a way of thinking that is able to control the mindset in order being able to think clearly, and be able to analyze arguments and not easily propagated, and have goals and be able to think how to achieve them. One of these goals can be achieved by providing essay questions as often as possible to be able to pour ideas or thoughts in solving them.

1.1. Aim of Study

The results are expected to provide additional knowledge and scientific insight not only for the field of basic education, but also for researchers and academics engaged in all fields of education in general.

2. METHOD

2.1. Research Model

This research is a quantitative research with quasi experiment method. Quasi experiment is an experiment in which the treatment can not be fully controlled by a researcher (Laursen, Hassi, Kogan, & Weston, 2014). Experimental research is research in which a researcher manipulates subjects to be treated or not, and controls the treatment fully and compares the results between different treatments (Hasnunidah, 2017).

2.2. Participants

The target population was taken as a saturated sample consisting of two classes, Class A and Class B. Next, Class A was designated as the experimental class, whereas Class B was designated as the control class. The number of Class A students is 27 people consisting of 13 female and 14 male students. The number of students in Class B is 27 people, comprised of 13 male and 14 female. The research design that will be applied is treatment design by level 2x2 factorial. Sample research is an indispensable sampling, where one is unlikely to examine the entire population (Gowda, Komal, Sanjay, Mishra, Kumar, & Math, 2019). Part of the population is a source in research data collection where the population is part of the characteristics of the population (Etikan, 2016).

2.3. Analysis of Data

SPSS package program was used to analyze the data. The percentage frequencies of the given data were calculated, normal distribution tests were performed, and as a result of these checks, t-test was used for those with 2 variables and analysis of variance was used for multiple variables. Tukey test was used to determine the differences between groups.

3. FINDINGS

Interaction of inquiry based learning (IBL) and gender approaches to critical thinking skills using two way Anova analysis. Further shown is a table of descriptive statistics two way ANOVA.

Table 1. Descriptive statistics of IBL and gender interactions

Dependent Variable: Critical Thinking Ability Results

Pendekatan Pembelajaran	Jenis Kelamin	Mean	Std. Deviation	N
Video-based IBL	Male	71.0921	14.74155	14
	Female	81.1246	10.09803	13
	Total	75.9226	13.48386	27
Conventional	Male	32.7613	10.53734	16
	Female	38.5618	20.92211	11
	Total	35.1244	15.51947	27
Total	Male	50.6490	23.08982	30
	Female	61.6167	26.69885	24
	Total	55.5235	25.12609	54

The table above shows descriptive statistics of 30 male students and 28 female students, as well as video-based IBL and conventional approach classes. In the table above, it can be seen the difference in the average grades of male and female students, both video-based IBL classes and conventional classes. Further examination of the normality test, the results of the test are shown in the table below.

Table 2. Normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig
Standard residual for critical thinking results	.068	54	.200*	.950	54	.026

*. This is the actual significance's lower bound.

[a]. *Liliefors Significance Correction*

The table above shows the standardized residual value of Kolmogorov Smirnov Sig. 0.200. means the data is normal, because the value of Sig. 0.200 > 0.050. Because the two-way anova condition is that the data is normal and homogeneous, the next analysis is a homogeneous test. The table below shows the results of homogeneous tests.

Table 3. Homogeneous test

Dependent Variable: Critical Thinking Results Test			
F	df1	df2	Sig.
1.135	3	50	.344

Homogeneous test results show the value of Sig. 0.344 > 0.050, this value clearly state that the data is homogeneous. The basis of decision making is that if the level of relevance is higher than 0.05, this indicates that the data is homogeneous and vice versa, if the significance value is less than 0.05, the data is not homogeneous. The following investigation will look at the relationship between video-based IBL and gender on critical thinking skills. The chart below shows how this exam uses two-way anova to determine whether IBL and gender interact on critical thinking abilities.

Table 4. Two way Anova test

Test of Between-Subjects Effects						
Dependent Variable: Critical Thinking Results Test						
Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Corrected Model	23368.385[a]	3	7789.462	38.594	.000	.698
Intercept	165594.948	1	165594.948	820.460	.000	.943
Approach	21685.356	1	21685.356	107.443	.000	.682
Gender	830.742	1	830.742	4.116	.048	.076
Gender Approach *	59.348	1	59.348	.294	.590	.006
Error	10091.594	50	201.832			
Total	199934.478	54				
Corrected Total	33459.979	53				

[a]. *R squared = .698 (Adjusted R squared = .680)*

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The two way anova table uses the basis of decision makers, if the significance value is lower than 0.05, then there is a difference or interaction and if the significance value is greater than 0.05, then there is no difference or interaction between the video-based IBL learning approach and gender (male and female) towards critical thinking. The table above shows the video-based IBL approach and conventional learning approaches obtained Sig values. 0.000 < 0.05 means that critical thinking abilities differ between video-based IBL lessons and conventional classes. Furthermore, for male and female gender obtained the value of Sig. 0.048< 0.05 shows male and female have different critical thinking abilities. The value of interaction between video-based IBL learning approaches obtained Sig value. 0.590 > 0.05 means that on critical thinking skills, there is no connection between video-based IBL and gender. Furthermore, we will see the mean value based on video-based IBL learning approach and conventional learning approach in the table below.

Table 5. Video-based IBL approach and conventional approach

Dependent Variable: Critical Thinking Results Test				
Learning Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Video-based IBL	76.108	2.736	70.613	81.604
Conventional	35.662	2.782	30.073	41.250

The table above shows the results of critical thinking skills of video-based and conventional IBL approaches. Obtained mean based on video-based IBL learning approach is 76.108 and mean conventional approach is 35.6. The video-based IBL learning approach is much higher in the average worth of critical thinking abilities when compared to conventional classes. Further below are shown the average values by gender.

Table 6. Difference in mean by gender

Dependent Variable: Critical Thinking Results Test				
Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	51.927	2.600	46.705	57.148
Female	59.843	2.910	53.998	65.688

The findings of critical thinking skills are shown in the table above. The average score based on male gender was 51,927 and the average score based on female gender was 59,843. On average, male and female students differ from one another. The average value of emale pupils have a stronger critical thinking capacity than male students, it means that the critical thinking ability of female is greater on average than male students.

The next analysis is the difference in the ability to think critically about gender separately seen from video-based IBL learning approaches and conventional learning approaches. The results of these differences are presented in the table below.

Table 7. Learning approach and gender

	Dependent Variable: Critical Thinking Results Test				
Learning Approach	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Video-based IBL	Male	71.092	3.797	63.466	78.718
	Female	81.125	3.940	73.210	89.039
Conventional	Male	32.761	3.552	25.627	39.895
	Female	38.562	4.283	29.958	47.165

The table above shows that in the video-based IBL learning approach, the average critical thinking ability of male is 71,092 and the average critical thinking ability of female is 81,125. While in the conventional learning approach the average critical thinking ability of male obtained 32.761 and the average critical thinking ability of female obtained 38.562.

The findings of the male students hypothesis test on the difference in improving critical thinking skills in the group of students who applied the video-based IBL model with conventional shown below.

Table 8. Independent sample test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Diffeerence	95% Condence Interval of the Difference	
									Lower	Upper
Ngain Persen	Assumption of equal variances	1.789	.192	8.262	28	.000	38.25964	4.63077	28.77395	47.74534
	The assumption of equal variances is not made			8.080	23.221	.000	38.25964	4.73517	28.46935	48.04994

The hypothesis testing of the male group above was preceded by a normal test and a homogeneous test. Normal test results and homogeneous test data are normal and homogeneous. Sig Value. 0.192 > 0.05 at Ngain percent equal variances assumed shows homogeneous data. Further analysis of hypothesis testing as seen in the table above. The T-test table above shows the results of the t-test for mean equality on equal variances is assumed Sig. (2-tailed) 0,000. Decision-making provisions if the acquisition value < 0.050 there is a difference and if > 0.050 there is no difference. Based on Sig value acquisition. (2-tailed) 0.000 < 0.050 concluded that there are considerable distinctions. in critical thinking ability of the male group between the use of video-based IBL learning approach and the use of conventional learning approaches. On average, male get a score of 71 and female 32.7 so there are clear differences between the two treatment groups.

The results of the hypothesis test of the female students on the difference in the growth of critical thinking abilities in the group of students who applied the IBL model with conventional can be seen below.

Table 9. Independent sample test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Condence Interval of the Difference	
									Lower	Upper
Ngain Persen	Assumption of equal variances	.154	.698	10.943	26	.000	46.9131	4.28707	38.10091	55.72532
	The assumption of equal variances is not made			11.100	25.947	.000	46.9131	4.22659	38.22438	55.60185

Hypothesis testing has met the requirements of normal and homogeneous data. Homogeneous test results seen in Ngain percent assumption of equal variances in Levene's Test for equality of variances Sig. 0,698. This significance value > 0.050 then the data is homogeneous. The mean of equal variations assumed t-test for equality of means Sig. (2-tailed) 0.000. Significance value (2-tailed) 0.000 < 0.050 then there is a substantial distinction between the experimental class female students with conventional class female students in improving critical thinking abilities in science learning grade V primary school. On average, male students scored 81 and female students scored 38.5. On average, the disparities between the two groups were significant.

The results of the hypothesis test group of students who were given a video-based IBL approach demonstrated that female students' critical thinking abilities were superior to male. The findings are shown in the table below.

Table 10. Results of t-test group of male and female students on video-based IBL approach

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Condence Interval of the Difference	
									Lower	Upper
Critical Thinking Skill	Assumption of equal variances	1.429	.243	2.063	25	.050	10.1039	4.89750	20.19050	.01730
	The assumption of equal variances is not made			2.092	23.088	.048	10.1039	4.83005	20.09352	.11428

Due to the value of Sig. (2-tailled) 0.050 = 0.050, then to take a decision on the significance of the Sig value. (2-tailled) should be smaller than 0.05. The decision-making must compare T_{count} with T_{table}. The table above shows T_{count} (2.063) and T_{table} (2.059), provided that If $T_{count} > T_{table}$, then reject H_o and accept H_1 means there is a significant difference and if $T_{count} < T_{table}$ there is no significant difference. Because the results obtained T_{count} (2,063) > T_{table} (2,059), concluded reject H_o and accept H_1 means that there is a substantial distinction between the critical thinking skills of female and male students on video-based IBL approach. On average, female students scored 81 and male students scored 71.

The results of the hypothesis test group of students given the conventional approach critical thinking ability of male students is greater than that female. The results of this hypothesis test are not proven because the male mean is 32,761 and the female mean is 38,562. Based on the results of the mean obtained by female slightly higher than male, it was concluded accept H_o and reject H_1 means it is not proven that in the conventional approach of critical thinking skills of male are higher than female.

4. DISCUSSION and CONCLUSION

The value of interaction between approach and gender based on t-test obtained Sig value. 0.590 > 0.05 means that there is no association between method and gender to critical thinking skills. This result is supported by research findings that states gender differences are not found, which is significant to the critical thinking ability posttest scores (Baker, Rudd, & Pomeroy, 2001; Bustami et al., 2018). Reinforced by the findings of research results in journals stating that male and female are not statistically distinct. from one another in applying critical thinking skills (Nurrahmah, 2015). A similar opinion is also conveyed by Mayers that there is a similarity in male and female critical thinking abilities (Myers & Dyer, 2006).

Significance value (2-tailed) 0.000 < 0.050 female with IBL and conventional and Sig values. (2-tailed) 0.000 < 0.050 male with IBL and conventional determined that there is a substantial influence between the critical thinking abilities of female with video-based IBL approach and female students using conventional approaches, as well as male students with video-based IBL approach and male students with conventional approach. The IBL approach is able to have an impact on improving critical thinking abilities in Science learning for grade V primary school students. These results are supported by similar studies that using IBL can provide a substantial impact on critical thinking abilities between video media inquiry approach and conventional approach significantly (Duran & Dökme, 2016). Similarly, the study conducted by Friedel et al., (2008), the results of his research found that inquiry can help pupils develop their critical thinking abilities. This is because the video-assisted IBL approach at every step presents students to think critically, students learn fully independently and groups and teachers only as facilitators in the process.

Male and female critical thinking differences on the video-based IBL approach obtained t_{count} (2,063) > t_{table} (2,059), it means that there is a huge gap between female and male pupils' critical thinking abilities on the IBL approach. This data is evidenced by the average value of female obtain a value of 81 and male obtain a value of 71 means that female students have a greater growth in male students' critical thinking abilities. The findings of this study support previous research by Manahal that found disparities between critical thinking abilities of men and women (Manahal, 2011). In addition, gender affects students critical thinking skills. The female gender also prefers to read and is more happy to discuss, being one of the causes of the higher critical thinking ability of the female gender while the male gender prefers practical, working on what they see, working quickly without analyzing. This statement is in line with the results of an article that women are better at learning by prioritizing language while boys prefer practical direct learning (Syahruddin-Amin, 2018). Therefore, the use of IBL which uses a lot of language in the sense that it will make a lot of use of good communication with teachers, fellow students or in response to discussions and presentations.

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Abstract

The aim of the study is to investigate the effects of using GeoGebra in teaching functions on mathematical language development and self-efficacy perceptions of tenth grade students. The study, which used the action research method, changes in participants' language structures were examined with the worksheets, mathematical language questions, researcher's logs and participant's logs; participants' self-efficacy perceptions were also examined with the self-efficacy perception scale. The ability of the participants to switch between the sub-dimensions of mathematical language was observed. The research showed that GeoGebra-Assisted Education improved the participants' perceptions of mathematical self-efficacy and positively affected their mathematical language skills. Since the effective use of mathematical language is an important component of mathematics lessons, the results present important findings.

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Research Article

GeoGebra Software on the Mathematical Language Developments and Self-Efficacy Perceptions of Students*

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Abstract

The aim of the study is to investigate the effects of using GeoGebra in teaching functions on mathematical language development and self-efficacy perceptions of tenth grade students. The study, which used the action research method, changes in participants' language structures were examined with the worksheets, mathematical language questions, researcher's logs and participant's logs; participants' self-efficacy perceptions were also examined with the self-efficacy perception scale. The ability of the participants to switch between the sub-dimensions of mathematical language was observed. The research showed that GeoGebra-Assisted Education improved the participants' perceptions of mathematical self-efficacy and positively affected their mathematical language skills. Since the effective use of mathematical language is an important component of mathematics lessons, the results present important findings.

Keywords: : Mathematical language, self-efficacy perceptions, geogebra, action research

1. INTRODUCTION

Mathematical educators have long conducted research on the role of language in mathematical teaching (Austin & Howson 1979; Pimm 1987, Wilhelm, Büchter, Gürsoy, & Benholz, 2018). Language that enables individuals to communicate and that carries a certain systematic structure plays an effective role in structuring and understanding mathematics (Arguen, Yazgan Sağ, & Gülkılık, 2010). This universal structure that contains mathematical concepts, symbols, and grammar in its unique structure and enables communication is called mathematical language (Bali, 2003). Mathematical language is a skill that should be developed by using mathematical concepts, symbols, operations, and problems that enable students to use mathematical thinking skills in the process of structuring mathematics (Akarsu, 2019; Canbazoğlu & Tarım 2019). Studies have shown that students' mathematical language skills have a great impact on their success in mathematics (Barwel, 2018; Xu, Lafay, & Douglas, 2022). Therefore, mathematical language needs to be promoted with new instructional approaches (Haag, 2013; Marshman, 2015; Prediger, 2019).

One of the fundamental elements for the acquisition of concepts and knowledge about mathematics and for the development of mathematical thinking is the correct use of the language of the subject. For conceptual learning to occur, teachers are expected to design classroom activities to support students' mathematical language development (Yeşildere, 2007). Language use plays an important role in students' understanding of the concepts presented. It is very important that the concepts used by the teacher in mathematics class have the same meaning for the students. The terms

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and concepts used in mathematics are sometimes not familiar to students; if these concepts and terms are not used with the correct content, they may have different meanings (Çalıkoğlu-Bali, 2002). The technical language that teachers do not use correctly leads to unhealthy communication over time and creates problems in constructing mathematical concepts in the long run (Emre, Yazgan Sağ, Gülkılık, & Arguen, 201; Yeşildere, 2007). For this reason, it is necessary to communicate in accordance with mathematical principles and information in mathematics classes. Students who use mathematical language effectively can correctly switch between symbols, verbal expressions, and graphs (Çakmak, 2013). The ability to use mathematical language effectively is the correct use of mathematical symbols and sub-dimensions of mathematical language when using a mathematical concept. For students, this transition between sub-dimensions is usually not easy (Güner, 2012). During instruction, teachers should prepare appropriate environments where students can share, express, and justify their ideas using mathematical language to establish a relationship between concepts (Ministry of National Education (MoNE), 2018). National Council of Teachers of Mathematics [NCTM] (2001) stated that technology is a necessary element for teaching mathematics and enriches learning. Using technology in the classroom helps students acquire skills such as critical thinking, problem solving, and creative thinking (Saavedra & Opfer, 2012). GeoGebra was developed in 2001 as a master's thesis by Markus Hohenwarter at the University of Salzburg, Austria (Hohenwarter & Preiner, 2007). GeoGebra is a dynamic open-source mathematics software that combines geometry, algebra, and statistics and can be easily used today at any level of mathematics education (Hohenwarter & Lavicza, 2007). GeoGebra helps students understand mathematical relationships by allowing them to see diagrams in two and three dimensions. GeoGebra allows students to examine the reflections of changes in equations on figures and graphs (Gökçe & Güner, 2022). Students can develop a positive perspective and sense of self-efficacy toward mathematics by encouraging them to actively participate in class and use different representational systems through technology-enhanced mathematics instruction (Köysüren & Uzel, 2018). Self-efficacy is one of the most important concepts in social learning theory, which represents the need for a sense of confidence that individuals can effectively use their abilities to successfully perform certain tasks (Bandura, 1997). Self-efficacy refers to an individual's conclusion and personal belief that he or she will succeed or fail at a particular task, rather than his or her actual abilities (Thumb & Barzel, 2021). A low perception of self-efficacy is also evident in students who are unsuccessful in mathematics class (Kohen, Amram, Dagan, & Miranda, 2022). Individuals with positive self-efficacy perceptions persist in their decisions without giving up in the face of difficult situations, whereas individuals with negative self-efficacy perceptions abandon their actions because they become distressed after negative experiences (Can & Gündüz, 2021). At the same time, research on self-efficacy in mathematics education shows that there is a positive relationship between students' mathematics achievement and mathematics self-efficacy (Cheema & Poulou, 2021). Studies on self-efficacy have found a significant relationship between mathematics achievement and self-efficacy.

Function is one of the concepts that form the foundation of mathematics and plays a key role in expressing many concepts and making connections between concepts (Bayturan, 2011). The reasons for students' difficulties in understanding the object of function, different representations of function and transitions between representations, notations about function, symbolic writings, inverse function, and resultant functions are discussed (Kul, 2020). GeoGebra provides the ability to convert mathematical expressions into each other, solve equations and statistical calculations, represent functions in two or three dimensions, and perform graphical operations (Hohenwarter & Jones, 2007). Dynamic Geometry software allows mathematical concepts to be explored and interpreted in a variety of ways, such as dynamic multiple representations and mathematical modelling. For this reason, GeoGebra was preferred for teaching functions in this study. The purpose of this study is to investigate the effects of using GeoGebra in teaching functions on tenth grade students' mathematical language development and perceptions of self-efficacy. The research was examined within the framework of the following research questions.

RQ1. How do 10th grade students' perceptions of self-efficacy change before and after using GeoGebra to teach functions?

RQ2. How do 10th grade students' mathematical language structures formed during the application process involving the use of GeoGebra in teaching about functions?

1.1. Theoretical Framework

Mathematical language was examined in several sub-dimensions, and the difficulties students have in using the language were examined in detail. Pirie in his studies treated mathematical language in 6 dimensions (Pirie, 1998). These sub-dimensions are: symbolic language, colloquial language, mathematical verbal language, non-verbal language, visual language and semi-mathematical language. Marzano (2004) explained the elements of the language of mathematics. These elements are: informal explanations, repetition of the situation by students in their own words, pictures, diagrams, and drawings, continuous improvement of knowledge, thinking about the meanings of concepts, playful activities (Riccomini, Smith, Hughes, & Fries, 2015). Pimm (1987), who considers mathematics as a language, includes the sub-dimensions of mathematical language; the language spoken by the students, the language spoken by the students and the teacher in the classroom, the written language, the written language used by the students and the teacher were determined as the syntax of mathematics. Goslin (2016) studied mathematical language by dividing it into 4 subgroups: spoken language, written language, symbolic language, and mimic language. Baykul (2009) accepted mathematical communication as a necessary structure to express mathematical ideas and treated it in four sub-dimensions. These are: expressing mathematical ideas with representations such as concrete models, figures, diagrams, and tables; expressing ideas about mathematics and problems orally and in writing; connecting daily language with mathematical language and symbols; being aware of the importance of speaking, writing, discussing, and reading about mathematics.

In the study, 4 sub-dimensions of mathematical language were created based on the studies. The sub-dimensions mentioned in the study were created by the researchers after reviewing the literature on the subject. The sub-dimensions are: 1. Verbal language, 2. Symbolic language 3. Visual language, 4. Problem posing with everyday situation. In this study, the effects of using GeoGebra on the development of mathematical language in the classroom on the topic of functions, the sub-dimensions of mathematical language and the design of mathematical language structures when switching between sub-dimensions were investigated.

2. METHOD

Under this heading, information about the research model, study group, data collection, and data analysis are presented.

2.1. Research Model

This study was designed using the action research method. In this study, the action research model was chosen because the second researcher has a teaching role.

2.2. Participants

The sample of the study consists of 10th grade students of a high school in a province of the Central Anatolian region of Turkey. There are 20 participants in the study. The participants were selected using the purposive sampling method in accordance with the purpose of the problem. None of the participants have prior knowledge about GeoGebra and its functions. The participants are not in a school that admits students after exams, and according to the language questions on applied mathematics, all of them have low achievement in mathematics.

2.3. Data Collection Tools

The data collection instruments used in this study were the Mathematics Self-Efficacy Perception Scale, worksheets, video recordings, researcher logs, participant logs, and clinical interviews. Attempts were made to address the weaknesses of each measurement tool by using different data collection instruments that were reported throughout the study. Consistency of data was checked by comparing the data obtained. The mathematical language test prepared by the researchers was also used with the students in the study. In the study, a pilot application was conducted before the actual application to obtain information about the application. The pilot application was conducted with students who were at the same level as the participants in the original application. During the first semester of the 2020-2021 academic year, data collection was scheduled to occur during the 6-week period allotted for the functions topic in the curriculum, which lasted 8 weeks due to interruptions caused by distance learning.

2.3.1. Self-efficacy perception scale against mathematics

The mathematical self-efficacy perception scale developed by Umay (2001) consists of 14 items. The Cronbach alpha reliability coefficient of the scale was calculated to be 0.823 for the pre-test and 0.840 for the post-test. The scale consists of 8 positive and 6 negative items.

2.3.2. Participant logs

Participant logs; they allow the evaluation of the data obtained from the students' thoughts (Atasoy, 2012). Photographs of the logs were taken at the end of each activity, and the logs were collected when the students came to school in January for the written process. Detailed explanations were given since this will be the first time that the participants will make such a request. The goal is to determine the opinions of the participants based on their own expressions

2.3.3. Clinical interview

The clinical interview is a technique that aims to reveal students' thinking styles. In this research, considering distance learning, the times when students could be isolated from distracting situations and in a quiet environment were conducted via Zoom. Academic achievement level was considered in the selection of participants for the clinical interview. A total of six individuals with good, average, and poor performance were selected for the clinical interviews. The academic grade point average of two students with good level is above 80, the average of three students with medium level is between 60-80, and the average of students with poor level is between 40-60. The interviews were recorded and code names were assigned to the students in the interview samples. Among the students in the range, the students to be interviewed were randomly selected.

2.3.4. Worksheets

The researcher has prepared worksheets suitable for any acquisition to teach the topic of functions. Two worksheets were prepared for the pilot application and six worksheets for the main application. The worksheets were prepared with the inclusion of expert opinions to cover all the achievements of the topic of functions in the tenth grade according to the weeks. The participants followed the instructions on the worksheet throughout the application and answered the corresponding questions using GeoGebra software. The necessary arrangements were made with the opinions of a math teacher and a math education specialist.

The question related to verbal language in the first week of GeoGebra applications is given below.

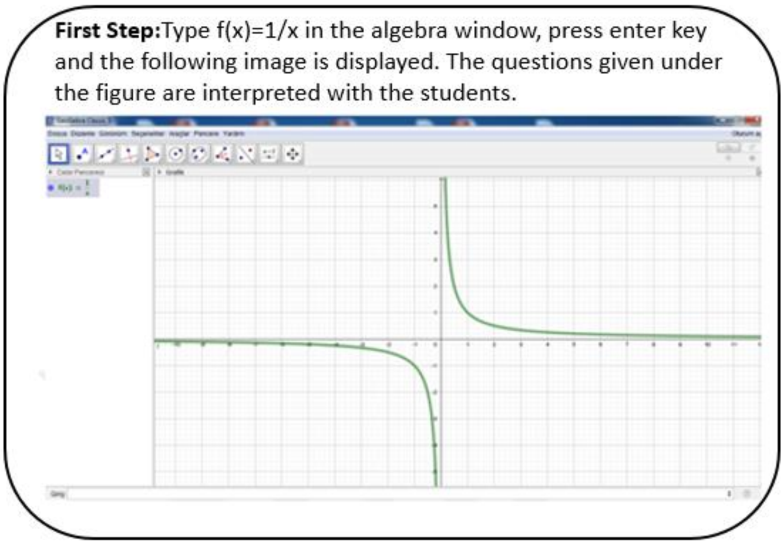


Figure. 1 The first step of application in the first week

The question about graph interpretation in the third week of GeoGebra applications is given below.

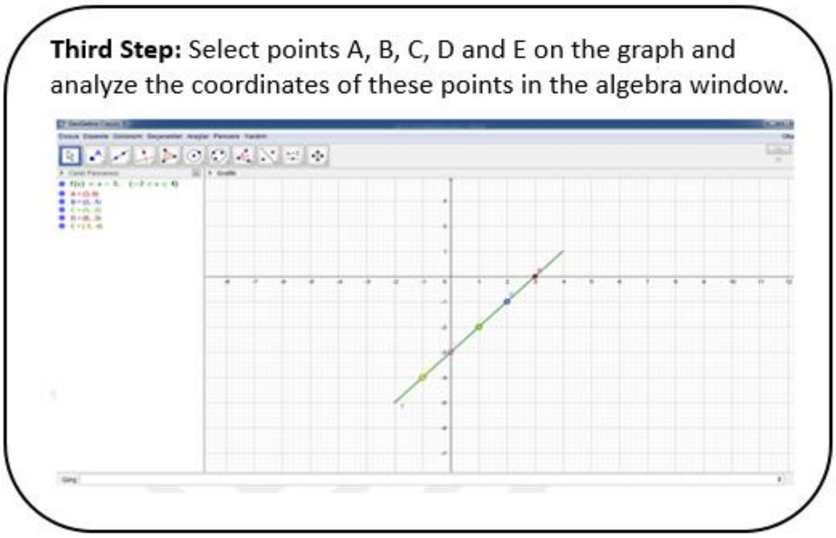


Figure. 2 The third step of application in the third week

2.3.5. Researcher logs

The researcher’s log is the notebook used to record the researcher’s observations and thoughts throughout the investigation. The researcher may also use a recording device (Johnson, 2015). The researcher’s log, which is commonly used in qualitative research, is used to examine behaviors and phenomena in a particular setting in depth. In this study twenty 10th grade students were observed during activities and detailed notes were taken of students’ verbal expressions, changes in those expressions, abuse, questions asked, changes in mathematical language, and any items deemed important by the researchers. Since the observers were directly involved with the participants, they observed as full participants and, after their observations, recorded the items they considered important and decided what to observe at the beginning of the study.

2.3.6. Mathematical language test

The mathematical language test, which is one of the data collection instruments of the study, was used as a pre-test and post-test. For each sub-dimension identified in this test, four times as many questions were elaborated, which were evaluated by two experts (mathematics educators), and it was decided to include the common items in the mathematical language test. The mathematical language test was used for qualitative analysis. In the mathematical language test: 8 questions of daily verbal language sub-dimension, 5 questions of verbal explanation of symbolic expressions, 4 questions of verbal explanation of graphs; in the visual language dimension, there are 6 questions belonging to the graphical design sub-dimension, 5 questions belonging to the graphical interpretation dimension, 2 questions belonging to the symbolic language dimension and 3 questions belonging to the problem posing sub-dimension.

2.4. Data Analysis

In the research, the analyzes were carried out within the framework of the dimensions discussed in the theoretical framework. During the process in which the worksheets were used, the content analysis method was used to study the qualitative data, observing the change in the mathematical language structure of the participants. In content analysis, words in the text are grouped into code structures according to certain rules. In this way, data with similar structure are grouped under certain concepts and themes to make them more understandable. Data obtained from observations and interviews are analyzed (Büyüköztürk, 2020). In the content analysis of the study, participants were coded as P1, P2..., and these codes were used throughout the analysis. The obtained data were analyzed in two ways: retrospective and prospective. In prospective analysis, each application is analyzed and guides the next application. Retrospective analysis was done by analyzing all data at the end of the study. Based on this data, changes in the implementation process were made as appropriate. The extent to which the study's action plan was implemented was determined in the committee meetings that took place with the participation of two experts in mathematics education after each lesson. The study collected data through the self-efficacy scale, worksheets, researcher logs, participant logs, clinical interviews, and audio and video recordings. Although one of these instruments, the self-efficacy scale, is a quantitative research instrument used for data collection, it was used for data diversity in this study. Analysis of the self-efficacy perception scale data in comparison to mathematics was conducted using the SPSS 20.0 program. Normality of the data was determined using the "Kolmogorov-Smirnov" and "Shapiro-Wilk" tests. Although the results of the pre-test and post-test meet the assumption of normality according to the results of the Kolmogorov-Smirnov and Shapiro-Wilk tests, the Wilcoxon Signed Rank Test was used to analyze whether the results differ before and after the application, since the sample size is less than 30. The assumptions of the test are met because the dependent variable is at least one variable of the rank scale and two repeated measures belong to the same group.

2.5. Validity and Reliability

In this study, the following validity and reliability measures were taken. The opinions of experts and teachers were obtained in the development of the measurement instruments. The study detailed the participants, the environment, the data collection instruments, and the application process. Immediately after the clinical interviews, the statements were transcribed without modification. These data were read to and confirmed by the respective participants. In analysing the worksheets, direct quotes, video recordings, and statements in the researcher's and participants' transcripts were transcribed unaltered. The consistency of the data obtained from the research was checked. All clinical interviews were recorded.

3. RESULTS

The findings obtained from the research are discussed under separate headings to answer the research questions. Analysis and interpretations of the data obtained with the data collection tools, using methods and techniques in line with the purpose of the research, are included. The results were reflected in the form of tables, analyzed and interpreted through codes.

3.1. Students' Self-Efficacy Perceptions

In this section, Wilcoxon signed-rank test results on whether students' scores on the mathematics self-efficacy perception scale differ before and after the application are included. The pre-test and post-test scores of the students participating in the study from the mathematics self-efficacy perception scale are given in Table 1.

Table 1. Wilcoxon signed-rank test results regarding the mathematics self-efficacy perception scale before and after the application *

Post test-Pre test		Rank Average	Rank Sum	z	p
Negative Rank	3	7,33	22.00	2.959	.003
Pozitive Rank	16	10,50	168.00		
Eşit	3	-	-		

* Based on negative ranks

According to the test results given in Table 1, it is seen that there is a significant difference between the pre-test and post-test scores of the students participating in the study from the mathematics self-efficacy perception scale ($p<0.01$). When the rank totals of the difference scores are taken into account, it is seen that this observed difference is in favor of positive ranks and post-test scores. According to these results, it was observed that the GeoGebra-supported training applied in teaching the subject of functions had a significant effect on developing students' mathematical self-efficacy perceptions.

3.2. Students' Mathematical Language

In the second research question it was investigated that "*How are the mathematical language structures of 10th grade students formed during the application process in which the use of GeoGebra is included in the teaching of the subject of functions?*". This structure was examined under the sub-dimensions.

3.2.1. Verbal language sub-dimension

Verbal language is the written or verbal explanations that are used in daily language, sometimes by adding the terminology specific to the language of mathematics (Eroğlu & Deniz, 2020). Mathematical language; in addition to the unique expressions of mathematics, it also includes the words used in daily communication, this part of the mathematical language is named as verbal language (Aydın & Yeşilyurt, 2007). The verbal language findings are given under the sub-headings of daily language, verbal explanation of symbolic expression, verbal explanation of graphics.

Daily Language

While the students had difficulty in expressing their thoughts in the first weeks, they did not avoid using some definitions and terms in the following weeks. At the same time, the daily life examples they gave related to the question were mostly compatible with the question. In these respects, the developments of the participants in their daily language use were determined. The reflections of this development process in different applications are exemplified below.

For example, in worksheet 1 applied in the 1st week; The participants were asked to create the graphic of f(x)=1/x in GeoGebra, (see Figure 3). Then, the question was interpreted together with the participants.

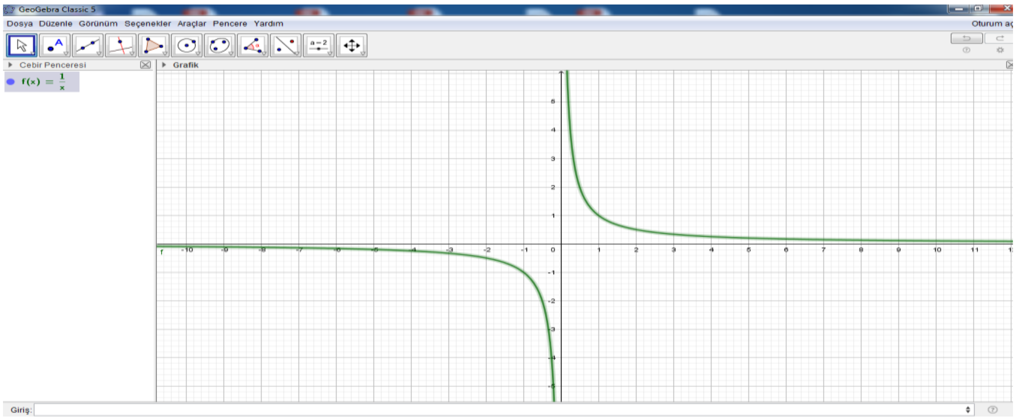


Figure. 3 The graphic of the verbal language sub-dimension in Worksheet-1

The participants were asked how the *function moves along the x-axis*, and the codes of the answers given by the participants using the daily language structure are presented in Table 2.

Table 2. Codes for daily language use in the first question

Codes	Participants
Fallen to zero	P1, P20
It vanished	P3, P12
It has two pieces	P9, P15
Took a break	P10

According to Table 2, it was determined that almost all of the students used expressions such as figure-line instead of the word graphic. It has been seen that they use the words down, go down, go without mentioning the positive part of the x axis, the negative part or the regions in the coordinate system. This showed that the students could not use the correct definitions and terms in their verbal expressions or they did not prefer to use these words at all. The student statement obtained from the video recordings supporting this finding is given below.

"The figure has come down. The first piece also went down, the second piece went down and to the side." (P3)

On the other hand, in worksheet 6, the development in daily language can be followed. When you examine the operations applied to the variable in the functions given as f(x)= 2x+1, g(x)=(x-1)/2 the answers given by the participants to the question of what do you think about these operations are examined, and the code structures are presented in Table 3.

Table 3. Codes for the question in worksheet 6 in the sub-dimension of daily language use

Codes	Participants
The same procedures were done	P1
Reverse transactions have been made	P15, P10
Transactions were performed in reverse order	P8, P19, P12

When the table 3 is examined, although one of the participants said that the same operations were performed, most of the participants noticed the operations applied to the variable during the activity. Therefore, it can be said that the participants were able to interpret the graph verbally.

Verbal Explanation of Symbolic Expression

In the process of verbally explaining the symbolic expression, the answers of the participants were examined for 6 weeks and little improvement was observed during the weeks. The reflections of this situation in different applications of the process are exemplified below.

The code structures obtained by examining the answers given to the questions "if $x_1 \neq x_2$,then $f(x_1) \neq f(x_2)$ "in the context of the verbal explanation of the symbolic expression which was discussed in worksheet 2, are presented in Table 4.

Table 4. Participant codes of the second question in the verbal explanation of symbolic expression

Codes	Participants
x_1 is not equal to x_2	P3, P12, P18
I do not know	P6, P12, P15

For example, when the code structures of Table 4 were examined in worksheet 2 applied in Week 1, it was seen that the participants were insufficient to explain the expression "if $x_1 \neq x_2$,then $f(x_1) \neq f(x_2)$".

Participants mostly avoided answering. The majority of the participants said that this statement "if $x_1 \neq x_2$,then $f(x_1) \neq f(x_2)$"did not mean anything. They have deficiencies in verbally expressing a symbolic expression. Examples from the researcher's logs explaining this situation are presented below.

…

P7: x_1 and x_2 are not equal.

R: What do you think about " $f(x_1) \neq f(x_2)$ " the rest of the statement?

P7: I don't know

R: What could " $f(x_1)$ " mean?

P7: It can be a function of x_1.

…

According to worksheet 3, when the question regarding the verbal explanation of symbolic expressions was examined, it was observed that the participants had difficulties in verbally explaining the symbolic expression.

The answer given to the question in worksheet 3, when A→B f(x)=2x-1, the symbolic expression f(A) = B was asked to be explained verbally and the answers was examined in the context of verbal explanation of the symbolic expression and the code structures obtained are presented in Table 5.

Table 5. Participant codes of the third question in the verbal explanation of symbolic expression sub-dimension

Codes	Participants
Set A is equal to set B	P1
f(A) is the same as B	P2, P13
The image set is set B	P19

When the code structures of Table 5 were examined, it was seen that the participants had a lot of difficulty in verbally explaining the symbolic expression. Similar to the second week, many students avoided answering or frequently used expressions such as I can't explain. In the answers of the participants, the word equality was mostly used, but it could not be explained what the equal sets mean.

Verbal explanation of graphics

Considering the verbal interpretation of the graphics, while the participants had difficulty in interpreting the graphics in the first weeks in the implementation process, the improvement in the interpretation of the graphics was determined in the following weeks. The reflections of this development process in different implementations are exemplified in this heading. For example, in the worksheet 1 applied in the 1st week, the examples of the situations in which the participants interpreted the graphics verbally are given below.

In Worksheet 1, the answers given in the frame of the question "If the graph is defined considering the conditions of being a function, is it a function graph?" in Figure 1 were examined in the context of verbal interpretation of the graph. The example expressions in the answers that the participants expressed verbally in the graphics are given in Table 6.

Table 6. Participants' sample expressions of the second question in the verbal interpretation of graphics sub-dimension

Sample Expressions	Participants
It is not, because it is in two parts	P4, P14
It is not, it does not pass through the zero point	P3, P15
It's not, the first piece is going down, the other piece is going towards zero.	P19

When the sample expressions in Table 6 were examined, although the participants knew the definition of the function, they failed to interpret the graph verbally. They mostly saw the graph's non-continuity as a problem. In addition, while interpreting the graph, they interpreted the domain and value set without taking into account. There are serious problems in the verbal interpretation of the graph. An example of this situation taken from the video recording is given below.

"It is not a function graph because it is in two parts." (K2)

In Worksheet 5 applied in the fifth week, a positive change is observed in the verbal interpretation of the graphics by the participants.

The answers given within the framework of the question "For the graph of the function $f(x) = x^2+3$, where is the symmetry axis of the graph and what does this mean?", which was discussed in Worksheet 5, the answers were examined in the context of verbal interpretation of the graph. The code structures of the sentences used by the participants while expressing the graphics verbally are given in Table 7.

Table 7. Participant codes of the sixth question in the verbal interpretation of graphics sub-dimension

Codes	Participants
center/y/y axis	P8, P5, P13, P19
I don't know	P17, P16

When the code structures of Table 7 are examined, it is seen that the participants generally say the symmetry axis of the graph correctly. It was observed that the number of mathematical terms used increased. There are two participants who answered I don't know, and one participant said they could not answer. Although there were answers such as the right one going up, the participants correctly sensed the axis of symmetry and answered. In these respects, it can be said that there is a positive change in the verbal interpretation of the graph.

3.2.2. Visual language sub-dimension

Verbal expressions and symbols are not sufficient to understand abstract concepts. For this reason, visual expressions that enable data to be classified and made concrete are also used (Van De

Walle, Karp, & Bay-Williams; 2014). Elements of visual language; graphs, tables, diagrams, schema, models. Examples of situations where the participants created function graphs and interpreted function graphs are given below.

Creating a Function Graph

While the frequency of incorrect, erroneous, or empty responses to questions about creating a function graph was significant in the initial weeks of the change, more accurate responses to the questions about creating a function graph were provided in the weeks that followed. Below are some examples of how this development approach is reflected in various applications.

For instance, the first week's worksheet 1 requested the participants to "What is f (2) according to the function graph?" By posing the query, their responses were looked over, and the code structures were provided in Table 8.

Table 8. Participant codes of the first question in the graphing sub-dimension

Codes	Participants
f (2) = 2	P1, P20
We can't know	P3, P12
It's a match	P9, P15
Wrong answers like 0.3	P10, P16, P8

When the data in Table 8 is examined, the answers to the question that "What is f (2) according to the function graph?", it was seen that more than half of the answers given by the participants to the question "We can't know". The participants also gave the answer "it is a match" by making use of their knowledge in the function definition, but they could not answer the question of which number matched which number or what kind of a match was made. Two of the participants stated that the number 2 would match 2 and they explained the reason by saying "every number matches itself". Some students gave wrong answers by saying any number. None of the participants have the knowledge to tell the coordinate of the point on the graph, which is necessary to create a function graph, that is, they do not have the necessary information to create a graph. An example of this situation, taken from the researchers' log, is presented below.

…

P3: The number 2 matches 2 because it is a match.

R: Why does it match 2?

P3: Because every number must match in matching.

R: So why does the number 2 match 2?

P3: I don't know.

…

In worksheet 5, the progress in the process of creating a function graph can be followed. When the question in worksheet 6 below is examined, it can be observed that the participants have the necessary information to create a function graph.

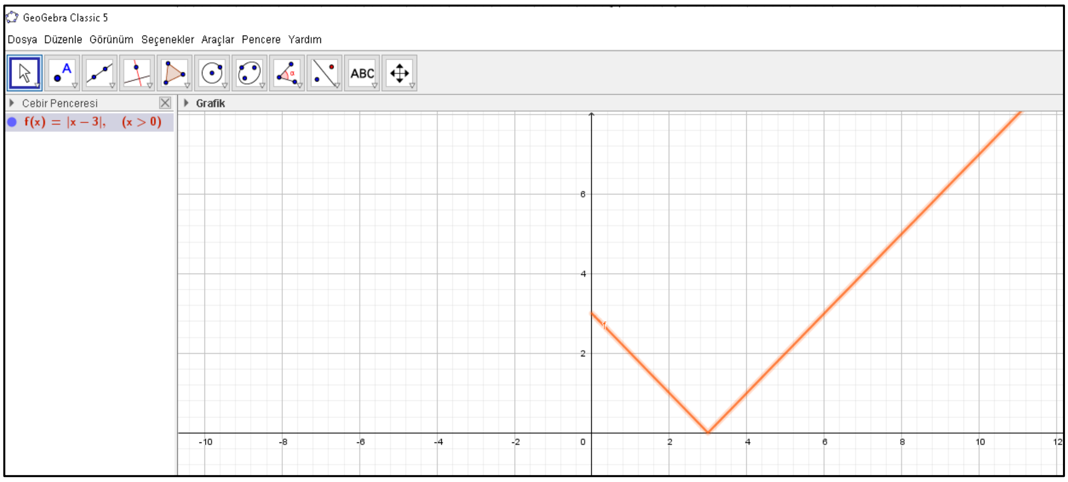


Figure. 4 Worksheet-5's graph for the subdimension of graphic creation

Within the framework of the question "Change the domain appropriately so that the given graph belongs to the even function" based on the graph that take place in Figure 4, the answers given by the students were examined in the context of creating graphics. The codes of the answers given by the participants are given in Table 9.

Table 9. Participant codes for the ninth question in the sub-dimension of chart creation

Codes	Participants
The graph should also be on the left	P16, P8
Other side of x/ x axis	P21, P10
Domain set	P4
All numbers	P18

According to the code structures of table 9, some of the participants gave non-significant answers by saying the domain or some numbers. The majority of them sensed that negative real numbers should be included in the domain, since the graphs of even functions should be symmetrical about the y-axis. It was observed that there was an increase in the number of terms used by the participants in their answers. Although they cannot express this situation appropriately, it can be said that they understand the necessary condition for the creation of an even function graph.

Interpreting Function Graphs

While the majority of queries regarding the creation of a function graph were irrelevant, incorrect, and left unanswered in the initial weeks, they were more receptive to interpreting the function graphs in the ensuing weeks and provided more accurate responses to the questions in question. The participants' progress in drawing a function graph was tracked throughout the study. Below are some examples of how this development approach is reflected in various applications.

For example, in Worksheet 2 applied in the second week, students are asked to create a graph of f(x)= x-3 (Figure 5) in the GeoGebra. Then, the questions about Figure 5 are interpreted together with the participants.

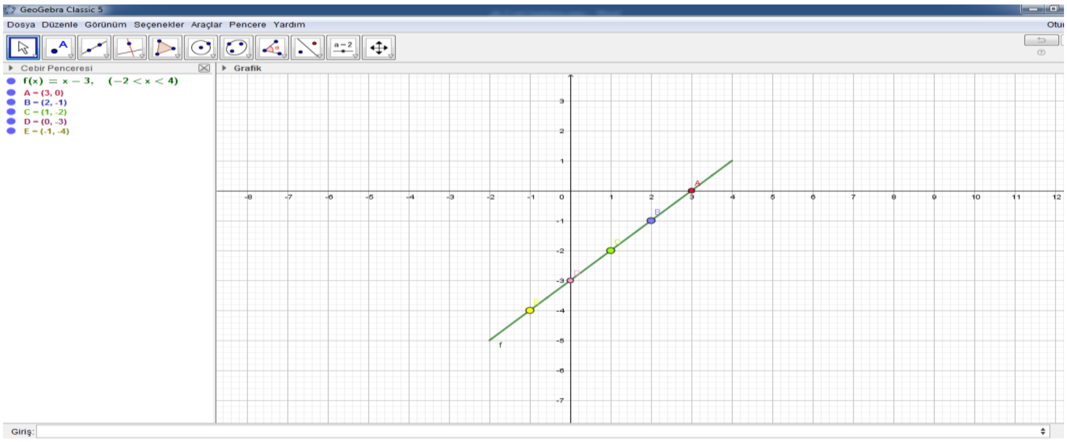


Figure. 5 The graph belonging to the worksheet-1 in graph interpretation sub-dimension

"What could be the value of *f(4)*?" according to the graph in Figure 5. Within the framework of the question, the answers given by the students were examined in the context of graphic interpretation. The answers given by the participants to this question were examined and the code structures are presented in Table 10.

Table 10. Codes for the second question of the function graph interpretation

Codes	Participants
There is a point above	P4, P13
Goes in order	P2, P11

According to the data in Table 10, the participants could not predict what the other point should be. Although a few of the participants showed their location on the screen, no one could say the coordinate of the point. The other participants gave answers as "just go up, go up". According to these data, the participants cannot interpret the graph. In worksheet 5, the development of the interpretation of the graphics can be followed. Examining the question in worksheet 5 below, it was concluded that the majority of the participants interpreted the graph correctly. Belonging to worksheet 5, "How can one interpret the slopes of inverse functions?" The question was asked to the participants and their answers were examined within the framework of the graphic interpretation sub-dimension. The answers given by the participants to this question were examined and the code structures were presented in Table 11.

Table 11. Codes for the eighth question of the function graph interpretation

Codes	Participants
Slopes are the same	P1
Slopes are opposite of each other	P3, P12, P15
Slopes are opposite of each other with respect to multiplication	P9, P15

According to Table 11, although P1, one of the students with low academic achievement, thought that there was no difference between the slopes, the other participants concluded that the slopes of inverse functions are inverses of each other according to the multiplication operation. The participants were mostly able to interpret the graph about the slope correctly.

3.2.3. Symbolic language sub-dimension

Symbolic language is one of the most used forms of mathematical language in mathematics (Emre, Yazgan-Sağ, Gülkılık, & Argün, 2017). Students should be able to make sense of what symbols mean, and should not see mathematical symbols as meaningless shapes that everyone perceives differently (Boz, 2008). Symbolic language is expressing a mathematical expression through mathematical symbols that everyone attributes the same meaning (Pirie, 1998). Examples of situations where participants use symbolic language are given below. In this study, practices related to symbolic language were the most difficult part of the participants and developed more slowly than the other sub-dimensions. The reflections of this process in different applications are exemplified below.

The following dialogue was held with the participant P18 for the question, "Do you think there is a change in transferring the expressions given verbally in the activities to symbolic language? Could you explain this change?" which was included in the clinical interview questions.

…

P18: "I understand what you write, but I can't write like that."

R: "How can you not write like that?"

P18: "Using such signs"

R: "Do you think there was a change in using symbolic language during the activities?"

P18: "I understand what you write, but I can't write it"

…

For example, in Worksheet 3, the answers given by the participants to the question "Write the domain and image set of the function that is written and graphed in the algebra window of the GeoGebra screen using symbolic language" were examined and the code structures are presented in Table 12.

Table 12. Codes for the third question of using symbolic language

Codes	Participants
R	P2, P14
All Numbers	P16, P3
Natural Numbers	P17
Domain	P2
X axis	P5

According to Table 12, some of the participants said that they did not understand what is meant by the domain of a function, and then gave the domain set, x-axis answers. Then, it was discussed again about what is meant by domain set, value and image set. The participant named P17 stated that the numbers in the domain are 0 and positive numbers on the x-axis of the graph and stated these as natural numbers. Although most of the participants gave completely wrong answers, a few came close to the correct answer. An appropriate example of this situation, taken from the researcher's log, is given below.

…

P5: When I say domain set, x-axis comes to mind, domain set is related to the x-axis.

R: Let's look at the graph together, which numbers on the x-axis do you think are in the domain?

P5: There are infinite numbers on the x-axis, they are all in the domain of the function.

R: Well, let's look at the graph again, can you tell which number -3 on the x-axis matches?

P5: If we choose a point from GeoGebra, it doesn't work. No numbers matched.

…

In the answers given for the question in worksheet 4, it is seen that it is difficult for the participants to use symbolic language in the following weeks. This example is given below. The graph of (2,4)→(2,4) f(x)=x, ie unit function, is plotted on GeoGebra's algebra screen (Figure 6). Then, the questions about the graph in Figure 6 were interpreted together with the participants.

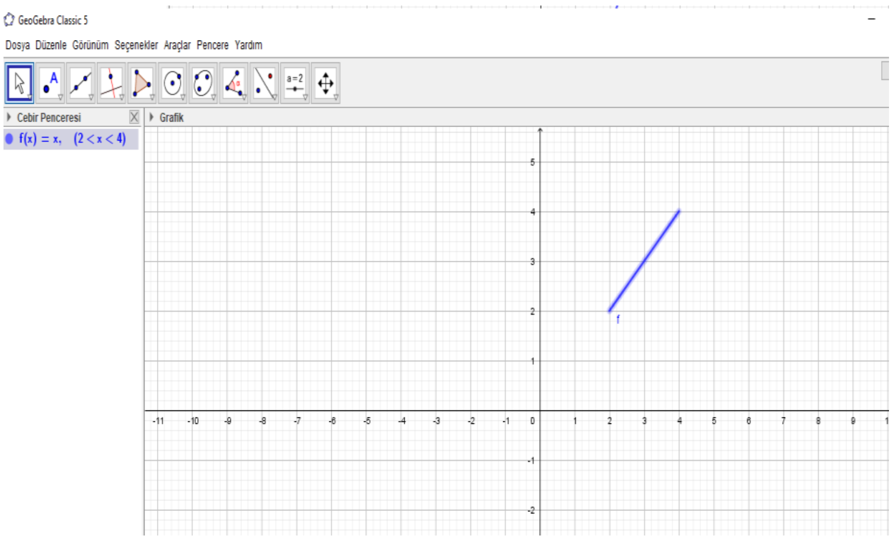


Figure. 6 Worksheet-1 graphic of symbolic language sub-dimension

For the graph in Figure 6, "Write the number range of the appropriate value set so that the graph of the specified function can be onto" The answers given by the participants to the question were examined in the context of symbolic language. The answers given by the participants to this question were examined and the code structures are presented in Table 13.

Table 13. Codes for the fifth question of using symbolic language

Codes	Participants
All Numbers	P5
X axis	P7
2 and 4	P11
(2,4)	P14, P17

According to the data in Table 13, although the majority of the participants were able to explain the onto function using everyday language and give appropriate examples from daily life, when they were asked to write down a set of values symbolically for the definition of the onto function of the graph, they mostly gave non-significant answers such as the x-axis and y-axis. Most of the participants gave the answers 2 and 4, (2,4). When asked what the parenthesis in the given answer meant, they could not answer. This situation shows that the participants are insufficient in using symbolic language. An appropriate example of this situation, taken from the researcher's log, is given below.

This situation shows that the participants are inadequate in using symbolic language.

…

R: "Which numbers do you mean by (2,4)."

P17: "The numbers between 2 and 4."

R: "Well, can you give examples of numbers in the range you specified?"

P17: "Three, but other numbers are also possible. Real numbers are also possible."

R: "So, should the numbers 2 and 4 be included in the definition set?"

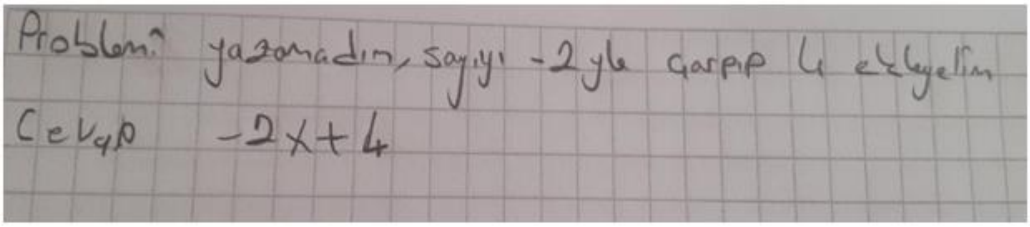
P17: "They should be included, we had these topics last year."

…

3.2.4. Problem posing sub-dimension

Problem posing can be expressed as a process that includes creating meaningful mathematical problems related to concrete situations with individual comments (Özdişçi & Katrancı, 2020). With problem posing, the ability to express mathematical situations in writing and verbally is gained, and students are enabled to discover mathematical situations (Akay, Soybaş, & Argün, 2006). An example of the participants' problem posing situations is given below.

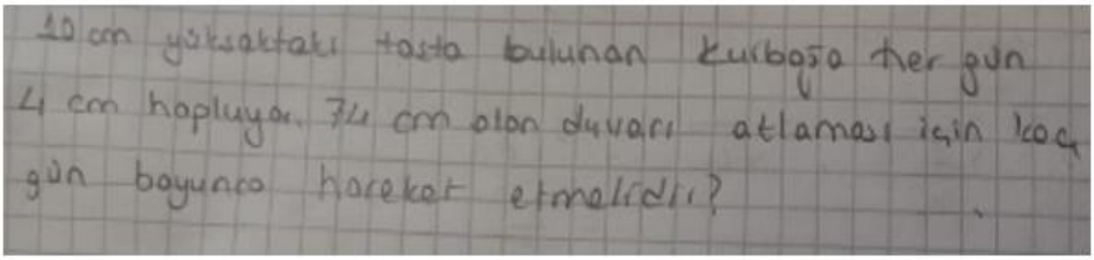
During the Problem Posing application process, the participants often left the problem posing sections blank or tried to compose relatively complex problem sentences related to daily life situations in the following weeks, while they were quite short. For these reasons, progress has been detected in the problem posing process. The reflections of this development process in different applications are exemplified below.



I couldn't write the problem however multiply the number by -2 and add 4
Answer -2x+4

Figure. 7 Structured problem posing example of participant coded P11

On Worksheet 5, "Write a problem statement for the inverse of a function, identifying appropriate definitions and sets of images." The question was asked to the participants and the sample of the participant is given below. 697



The frog, which is found on a stone 10 cm high, jumps 4 cm every day. For how many days must it move in order to pass the 74 cm wall?

Figure 8. Structured problem posing example of participant P5

In the researcher logs, it was noted that the participants tried to create problem sentences for structured and semi-structured problem sentences, but they tended to ask a question with simple sentences. It was observed that the participants tried to include mathematical terms while constructing problem sentences and tried to construct more complex sentences.

4. DISCUSSION and CONCLUSION

The study investigated how the use of GeoGebra in teaching functions affects students' mathematical language development and perceptions of self-efficacy. In the section examining how participants' self-efficacy perceptions change before and after the instructional process, there is a significant difference between the pre-test and post-test scores of the students participating in the study on the mathematical self-efficacy perception scale. Looking at the rank sums of the difference scores, it was found that this difference was in favor of the positive ranks and posttest scores. According to these results, the applied GeoGebra-based training had a significant effect on the development of students' mathematical self-efficacy perception. Orçanlı (2016), in his study investigating the effects of computer-based geometry instruction on students' perceptions of geometry self-efficacy, found a significant difference before and after the application. These results show similarities that the method of computer-assisted geometry instruction used in teaching geometry has a significant effect on students' self-efficacy. Balcı-Şeker and Erdoğan (2014) concluded in their research that GeoGebra-supported mathematics instruction causes a significant difference in terms of self-efficacy in the experimental and control groups. This result is consistent with the research findings. In studies investigating the relationship between different subjects of mathematics and computer-assisted instruction with self-efficacy, or more specifically, the relationship between GeoGebra-assisted mathematics instruction and self-efficacy in the literature, it is found that GeoGebra-assisted instruction has a significant effect on improving students' mathematical self-efficacy perceptions, as in this study.

During the GeoGebra lesson on functions, participants were asked questions designed to enable them to use all the sub-dimensions of the mathematical language. However, participants tended to answer the questions using mainly the sub-dimensions of the verbal language. Although participants used visual and symbolic language as the weeks progressed, they indicated that they were most comfortable with verbal language during the first few weeks. In Akarsu's (2013) study, students transformed the dimensions of mathematical language when answering mathematical questions. They used both verbal and written language to explain the required expressions. However, he concluded that students generally used spoken language first. This could be due to the fact that students are used to responding with verbal language because of their previous experiences. The results of the study are completely consistent with this finding. When asked to explain a graphical or symbolic expression using verbal language, participants responded that they did not know the answer, that they could not find the result, rather than making comments and verbally expressing what they understood. When participants were reminded again what to do and the explanation that they did not have to reach a numerical value was repeated, they tried to answer in verbal form. This result is consistent with Yalvaç's (2019) finding that they were more likely to find a numerical value than to explain using mathematical language. In this case, it is assumed that participants focus on solving rather than expressing what they understood from the questions. It was found that the worksheets used during the study had positive effects on participants' verbal language use. This is because during the lessons, the rate of the participants to use the definitions and terms mathematically in their daily language use, to express the graphs correctly, and to explain the symbolic expressions verbally increased. It was observed that prior to the implementation of the action plan, participants used mathematical definitions and concepts inadequately. After the implementation of the action plan, it was found that the participants were able to achieve the results with the prepared worksheets, and the number and quality of mathematical definitions and concepts used increased. While the increase in the number of correct uses of definitions and concepts is lower for P1 and P11 participants with lower academic achievement, the rate of effective use of verbal language is higher for students with medium and high academic achievement. This result is consistent with the findings of Akarsu's (2019) study that there is a moderate, positive, and significant relationship between students' ability to understand and use mathematical language and their achievement in mathematics. Zengin (2017) addressed mathematical language as a whole in his study and defined mathematical language as the effective use of mathematical terminology and concluded that the use of GeoGebra has a positive effect on the use of mathematical language. This study also supports the result of the research. From the research conducted by Gökçe, Yenmez, and Özpınar (2016), in which they investigated mathematics teachers' opinions about the worksheets created with GeoGebra, it was found that before using the computer, the teachers only saw an advantage in speed and time. After use, they indicated that GeoGebra can be used to review concepts, and they agreed that the software can help students understand concepts that are difficult to convey verbally. Studies consistently show that numerous ideas can be explored using worksheets created with GeoGebra, that children can understand concepts that they have difficulty describing verbally and on the board, and that the software has a positive impact on verbal language use.

Symbolic language was the sub-dimension that participants had the most difficulty answering during the 6-week study. When asked to express a particular statement symbolically, participants were reluctant to respond. Even when they responded more in the following weeks, they initially tended to respond verbally. Argün (2016), in his study of prospective teachers' use of mathematical language, found that they tended to use verbal language rather than symbolic language when trying to understand a concept. As a result of the study, it was found that it would be beneficial for instructors and teachers to use not only symbolic language but also verbal language when trying to understand a concept while teaching the concept. This result is consistent with the finding that students in the study used verbal language instead of symbolic language. Altıner and Önal (2022), in their study in which they investigated the visual and non-visual representations used by students in solving verbal problems, concluded that although the success rate was higher for the answers in which they used visual structures, they used symbolic structures to a greater extent. The investigation with 10th grade students revealed that the participants avoided symbolic expressions most of all. The results of the study are not consistent in this regard. The reason for this is probably that the students participating in the study were not in situations where they would use symbolic language. Although the students intended to respond in symbolic language, examination of their responses revealed that they used meaningless symbols and that what they intended to say and what they rendered were not parallel. Capraro and Joffrion (2006) conducted a study on symbolic language and verbal language with seventh and eighth grade students. In the study, students were asked to write down mathematical expressions given verbally in algebraic form. It was found that few of the students gave correct answers, and it was concluded that the students were underusing symbolic language. The results of this study are consistent with the findings of Capraro and Joffrion's (2006) study. According to other research findings that support this result, the transitions between algebraic symbolization and verbal representation present many difficulties for students. Students with weak verbal language structures were also very unsuccessful in using symbolic language. Çakmak (2013) concluded in his research that these two languages were significantly and highly correlated in terms of the dimensions of verbal language and symbolic language, which are two important components of mathematical language. The conclusion that symbolic and verbal language are very important for the development of mathematical language and that they are interrelated is common to both studies.

Visual language structures were examined in the sub-dimensions of graphic design and graphic interpretation. Participants had difficulty interpreting the diagram. Instead of examining the relationship between the variables in the given diagram, they saw the diagram as a figure. Previous studies have noted that one of the difficulties encountered with graphs is the 'error of perceiving graphs as a picture' (Bell & Janvier, 1981). In this misconception, which is seen in students at different levels, the structure at hand is drawn as a picture on the plane or the given picture is simply transferred to the analytic plane (Slavit, 1994). Students with this misconception could not understand the relationship between variables (Bayazıt, 2011). The results of the study showed that one of the problems that students had in interpreting the graphs was a common misconception. When asked whether a particular graph belonged to a function, the participants indicated that when the function graph was mentioned, it should be a linear function graph. In the studies conducted at different times, it was concluded that the students' graph should be linear or increasing only. Another misconception is that students focus on linear graphs (Karataş & Güven, 2004). In their study, students put a certain shape as a graph without understanding the relationship between variables and concluded that they interpreted accordingly. The results of the study show that participants have an image of a graph of a function in their minds, and this image is usually a linear geometric shape.

In this study, the problems posed by students are generally those that do not have much to do with the daily life problems that participants have encountered before. The participants kept the problem posing as short as possible and did not tend to add any difficulty elements. The results of the research show different results on these questions. In this regard, the results of the study are contradictory. In general, the tasks given by the participants do not have an original structure, are not mathematically or linguistically complex, consist of simple sentences, and cannot always be related to situations from daily life. This is true even though the participants' performance in each of the three sections was different. In his study, Güç (2021) investigated teachers' performance in task setting related to correct use of mathematical language, appropriate task setting, solvable task setting, original task setting, and task setting in which GeoGebra can be functionally used to solve. As a result of the study, it was found that participants' performance in solving problems was generally low. Although it is still difficult for the participants to pose problems, it was found that progress was made over weeks in structured and semi-structured problem posing.

Activities related to problem-posing, symbolic language, visual language, and verbal language skills, which are the sub-dimensions of mathematical language, can be incorporated into mathematics instruction to strengthen students' mathematical language and sense of self-efficacy. Students' development in mathematical language can be studied longitudinally so that in-depth information about the durability of change in mathematical language structure can be obtained. In the GeoGebra classroom, the reasons why students who have not achieved positive change in their mathematical language structures have not been able to make changes can be explored in greater depth by adding factors such as attitude and readiness. Studies can be conducted to separately investigate the change in mathematical language structures of students with different achievement levels. The study was conducted with 10th grade students. Working with a different mathematics subject at different grade levels with appropriate data collection instruments can provide detailed information about how students' mathematical language structures change. The study was conducted with 20 students. Although the number of students is considered sufficient for action research, the results of the study with more students may provide different information. Teachers can be trained in this area in education departments to facilitate extensive communication in mathematics classrooms and to develop students who use mathematical language successfully.

GeoGebra software has been observed to facilitate students' conceptual understanding as it provides the opportunity to examine different representations of concepts (Zengin, 2017). Between representations transformation becomes easier with the use of GeoGebra (Zengin, 2017). It supports the framework in which conceptual understanding is associated with the transformation between representations. The participants' self-efficacy increased when they saw how the changes they made in the function equations changed the function graphs. GeoGebra allows students to see diagrams in two and three dimensions, helping users to understand mathematical relationships. GeoGebra allows students to examine the reflections of changes in equations on figures and graphs. Participants have the opportunity to control the changes they make (Gökçe & Güner, 2022). Via GeoGebra, students can actively participate in the lesson and develop a positive perspective on mathematics and a sense of self-efficacy by using different representation systems (Köysüren & Uzel, 2018). Similar to other studies, the features related to GeoGebra increased the participants' self-efficacy perceptions.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Niğde Ömer Halisdemir University with the decision numbered 69972237-302.08.01-E.52412.

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Author Contribution Statement

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Conceptualization, literature review, methodology, implementation, data analysis, translation, and writing.

Abstract

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Research Article

An Evaluation of Online Science Classes Based on Students' Science Learning Experiences *

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Abstract

Online science courses have become increasingly popular due to their accessibility and convenience. Consequently, evaluating their quality is essential for ensuring students receive a rigorous and valuable education. This study investigates the effectiveness of online science classes in terms of student- faculty interaction, time on task, active learning and cooperation among students by considering the participant students' experiences and their evaluations of online science courses. The participants were 2034 students from different middle (year 5 to 8) and high schools (year 9 to 12) during 2022-2023 academic year. All of the participants attended online science classes from 2nd half term of 2019-20 and whole school year of 2020-21. The data was collected by using the Student Evaluation of Online Teaching Effectiveness (SEOTE) scale, which was developed by Bangart (2005). The student responses were evaluated based on their school year, frequency of attendance, and means used to access online science classes. The findings of the study revealed that the participant students were not satisfied with online science learning experiences in terms of faculty-student interaction, time on task, cooperation among students and active learning practices. The study also found that faculty-student interaction, time on task, cooperation among students were important predictor of active learning for online science learning practices. Based on the findings the study suggests that when designing or implementing online science classes, students' engagement, teacher-faculty interaction, creating opportunities for students to cooperate and helping students to actively engage in the activities should be taken into consideration by teachers.

Keywords: Online science teaching, evaluation, active learning, students' experiences

1. INTRODUCTION

Online science learning has become increasingly prevalent in recent years, and several studies have explored students' experiences with this mode of instruction. Research has explored students' experiences of online science learning, highlighting both the benefits and challenges associated with this mode of learning. Students enjoy the flexibility and convenience of online science learning, as it allows them to study at their own pace and access course materials from anywhere with an internet connection (Al Rawashdeh, 2021; Yüksel, 2022). Studies have documented effective online science courses in promoting student learning outcomes, including knowledge acquisition, critical thinking skills, and problem-solving abilities (Cortázar et al., 2021) as well as providing an engaging and interactive learning experience, with multimedia-rich resources and simulations that enhance students' understanding of scientific concepts (Widiyatmoko, 2018). Online discussions and collaborations with peers and instructors can also contribute to a sense of community and promote active learning (Faja, 2013). Online science courses have also been found to increase student motivation and engagement in science learning, particularly for students who may not have had access to traditional science courses (Hsu, Rowland-Goldsmith, & Schwartz, 2022). Despite these documented benefits of online learning

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science learning different studies have identified challenges in students' experiences with online science learning, including a lack of social interaction and peer support, difficulties with time management, limited interaction with instructors, and a lack of motivation and technological issues, such as slow internet connection and software compatibility issues, which can hinder their learning experience (Barrot, Llenares, & Del Rosario, 2021). Studies, also, suggested that students may face challenges in staying motivated and engaged with the course material without the structure of traditional face-to-face instruction (Singh, Steele, &Singh, 2021). Additionally, online science courses require students to take greater responsibility for their learning, which can be challenging for some learners. Therefore, support from instructors and access to resources such as online tutorials and peer support groups are crucial for student success (Rotar, 2019).

1.1. Literature Review

The rapid integration of educational technologies, including computer simulations, games, and various software for learning and evaluation, has led to changes in instructional strategies at all levels of education (Brinkley- Etzkorn, 2018; Çoban, 2020). Online classroom activities such as Moodle, hybrid, and remote learning have become available tools for teachers to guide, facilitate, and support students in achieving learning outcomes (Singh & Arya, 2020). The demand for online courses is driven by factors such as flexibility, self-paced learning, enhanced computer and internet skills, richer content, and unlimited exercise opportunities at a lower cost than in-person classes (Kulal & Noyak, 2020). The blending of various online applications and processes can help instructors provide better learning environments for students (Lauran et al., 2014). The integration of online or remote learning technologies such as Moodle, computer simulations, games, and various software has facilitated a shift from a teacher-centered learning approach to a more student-centered one, as it allows for active engagement with the presented material (Kulal & Noyak, 2020). This shift has led to a focus on constructivist learning experiences, where learners actively construct meaning and knowledge during the learning process, as being crucial to the success of online learning (Bangert, 2005). As a result, teachers are adopting various student-centered teaching strategies and methods, such as inquiry-based and project-based learning activities, group work, higher-order thinking skills, interactivity, and learner choice (Bakioglu & Cevik, 2020).

The integration of educational technology has had a significant impact on educational institutions, students, and teachers, as previous knowledge and skills have become outdated and obsolete (Kulal & Nayak, 2020). In this new paradigm, it is crucial for teachers to guide, facilitate, and support students in reaching their learning goals during online learning experiences, as argued by Brinkley- Etzkorn (2018). As a result, teachers must now create learning environments that cater to students' personal learning styles, academic achievements, and interests, enabling them to perform better and gain a deeper understanding of the subject matter (Bangart, 2005). It is important to note that online teaching requires a different approach compared to traditional face-to-face instruction. Hence, the inclusion of e-pedagogy, which involves training instructors for effective online communication and course facilitation, is crucial for a successful online teaching experience (Kleinman, 2004). However, despite the shift from traditional in-person learning to online learning, the adaptation of online teaching can be time-consuming and presents various barriers, such as technical, pedagogical, and administrative issues. Moreover, there is an increasing requirement for appropriate science standards that include hands-on activities, such as inquiry-based learning, problem-solving, student investigation and discovery, and application of knowledge (Loucks-Horsley, Stiles, & Hewson, 1996). Hand-on activities in science classes offer students a valuable opportunity to actively engage in scientific experiments by observing and operating scientific processes, objects, and instruments (Hong, Liu, Liu, & Zhao, 2021). However, designing effective online science classes can be challenging for many science educators (Miller, 2008). Recent studies examining the effectiveness of online learning during the COVID-19 pandemic found that teachers faced difficulties in adapting to online instruction (Korkmaz & Toraman, 2020; Yao et al., 2020), which was compounded by technostress caused by the overload, complexity, insecurity, and uncertainty of using online technologies (Ozamiz-Etxebarria, Berasategi Santxo, Idoiaga Mondragon, & Dosil Santamaría, 2021). Furthermore, studies investigating teachers' perceptions of online learning during the COVID-19 pandemic have documented that teachers encountered problems such as poor internet connections, low student participation, and pressure from school administrators (Bakioglu & Cevik, 2020).

Online instruction has a significant impact on students as they are the key players in the learning process. According to Cheung and Kan (2002), high-achieving students in traditional classroom settings are most likely to experience a decline in academic performance in online courses compared to lower-performing students who tend to thrive in online environments. Noesgaard and Orngreen's (2015) review of 61 studies on e-learning effectiveness showed that 41 studies found it to be effective, six found it not effective, and 14 found it partly effective. The emergence of COVID-19 has presented a challenge for evaluating the effectiveness of online learning. UNESCO (2020) reported that more than 1.5 billion students in 194 countries were affected by the pandemic, leading to a switch from in-person to remote learning across all levels of education. While online learning was already gaining popularity in higher education, a survey of 6,000 educators in Georgia found that it was not effective for most students and led to increased depression, anxiety, and social isolation (Dalton, 2021). Technical knowledge, connectivity issues, and problems with communication between students and teachers are among the reasons for student reluctance towards online learning (Singh & Arya, 2020). Additionally, outdoor learning activities such as field instruction for environmental science topics pose a challenge during online instruction. Barton (2020) reported a substantial reduction in learning outcomes and less active and more instructional-centred remote learning activities for field activities based on instructors' views on field instruction and remote teaching alternatives. Humphrey and Wiles (2021) found that students perceived online science classes as less effective than face-to-face learning because it was difficult to stay engaged and learn the course material during online classes. The study also revealed that the course instructor did not adapt well to online teaching. Additionally, research suggests that students' motivation to learn is best fostered in face-to-face learning environments, where instructors can identify nonverbal cues and make necessary adjustments to content and instructional methods (Singh et al., 2021).

Humphrey and Wiles (2021) suggest several strategies to motivate students during online classes, including clearly expressing and maintaining expectations for achieving learning outcomes, involving students in decision-making about topics, assigning challenging tasks, and providing opportunities for evaluation through writing and online discussions. The popularity of online learning is expected to continue to rise, both as a means of enhancing the learning process and as a substitute for in-person classes during the COVID-19 pandemic. Agustina and Cahyono (2017) assert that online instruction is seen as a modern tool for enhancing learning rather than a replacement for in-person instruction. As such, hybrid and blended learning are recommended as they allow instructors to combine the best elements of online and in-person instruction (Singh et al., 2021).

1.2. Context for the study

The resent devastating earthquake in south east of Turkey that affected 11 cities and claimed more than 50.000 lives has turned the attention to online learning again after one a half year of experience during Covid 19 pandemic. The decision to switch to online learning by the board of higher education institution was heavily criticized by a large section of the nation since online learning was not seen as effective taking the previous experience imposed by the conditions of Covid-19 era into account. In order to alleviate the criticism, the board has taken another decision to ask universities to use hybrid learning after two months of online learning only. The previous experiences of online learning have led to a general view that online learning is not as effective as face to face learning and that it does not provide equal opportunities for students particularly from low soci-economic background as there are problems related to the availability of instruments such as computers since there are usually more than a student in a family and opportunities to access internet as well as lack of social interaction that affects students' personal as well as academic development.

Online science courses have become increasingly popular due to their accessibility and convenience, but evaluating their quality is essential for ensuring students receive a rigorous and valuable education (Dziuban, Picciano, Graham, & Moskal, 2016). Evaluating online science courses includes assessing the course content and curriculum to ensure that they are comprehensive, accurate, and up-to-date. The quality of instruction and teaching is another crucial factor, with experienced and knowledgeable instructors who can communicate material effectively and engage students in active learning (Graham, & Woodfield, & Harrison, 2013). Assessing online education is a crucial process that helps to draw valid conclusions about teaching effectiveness. Engaging in scholarly inquiry that evaluates the effectiveness of instruction on student learning can inform teaching practices (Rapanta, Botturi, Goodyear, Guàrdia, & Koole, 2020). This study investigates the effectiveness online science classes in terms of student- faculty interaction, time on task, active learn and cooperation among students by considering the participant students' experiences and evaluations of online science courses. The research questions that guide this study are as follows:

1. How do participating students evaluate online science courses using the SEOTE scale?
2. Are there any differences in students' evaluations of online science courses based on their year of study?
3. Do students' evaluations of online science courses differ based on the medium they use to participate?
4. Are there any differences in students' evaluations of online science courses based on the frequency of attendance?
5. How does student-faculty interaction, time on task, and cooperation among students affect active learning in online science courses?

2. METHOD

The study employs a quantitative approach using the student evaluation of online teaching effectiveness (SEOTE) scale as the data collection tool and analysing the data through descriptive and inferential statistics.

2.1. Participants

Students willing to take part in the study to evaluate online science classes were 2034 individuals from different grades and gender (Table 1). A half of the participant students (n: 1015) were taking classes for middle school (year 5 to year 8) and the rest were students studying at high school (year 9 to 12) during 2022-2023 academic year.

Table 1. Number of the participant students based on their school year, means for access to online courses and gender

Grade	N	%	Access	N	%	Gender	N	%
Year 6	175	8.6	Computer	256	12.6	Female	1143	56,2
Year 7	504	24.8	Tablet	393	19.3	Male	891	43,8
Year 8	355	17.5	Phone	1302	64	Total	2034	100
Year 9	174	8.6	Smart TV	53	2.6			
Year 10	487	23.9	More than one	30	1.5			
Year 11	250	12.3	Total	2034	100			
Year 12	89	4.4						
Total	2034	100						

The table above demonstrates that the participant students mainly used phones as means to access online classes science classes (64%). This was followed by tablets (19.3%) and computers (12.6%).

2.2. Data Collection Instrument

The study collected data using the Student Evaluation of Online Teaching Effectiveness (SEOTE) scale, which was developed by Bangart (2005) based on the seven principles of effective teaching outlined by Chickering and Gamson (1987). The SEOTE scale consists of 25 items that measure four dimensions: student-faculty interaction (SFI-12 items), active learning (AC- 6 items), time on task (TOT- 4 items), and cooperation among students (CAS- 3 items). Students responded to each item using a six-point Likert scale ranging from strongly agree to strongly disagree. The stratified alpha value for the whole scale was .951 for this study, indicating high internal consistency. Additionally, the Cronbach alpha values for each dimension were as follows: .894 for student-faculty interaction, .851 for active learning, .809 for time on task, and .700 for cooperation among students. The mean values for the instrument items were categorized as strongly disagree, disagree, mildly disagree, mildly agree, agree, and strongly agree based on the following ranges:
1.00-1.82: Strongly disagree; 1.83-2.65: Disagree; 2.66-3.48: Mildly disagree; 3.49-4.32: Mildly agree 4.33-5.16: Agree; 5.17-6.00: Strongly agree.

2.3. Data Analysis

The responses from the participating students to the items on the SEOTE were analyzed in line with the research questions using SPSS 28. The student responses were evaluated based on their school year, frequency of attendance, and means used to access online science classes. Descriptive statistics, one-way ANOVA, and MANOVA were used for data analysis. When statistically significant differences emerged, multiple comparisons were conducted using either Tukey HSD or Games-Howell tests. As the sample sizes were often unequal across the participant groups, a test for homogeneity of variances was run to determine whether the assumption was met. If the Levene test result for homogeneity of variances was significant, the Welch test was preferred, and Games-Howell was used for multiple comparisons. If Box's test of equality of covariance matrices and Levene's test of equality of error variances were not significant ($p>.05$), a MANOVA test was employed to determine the significance of differences in the participant students' scores for the evaluation of online science courses scale. Moreover, multiple regression was used to analyse the effects of student-faculty interaction, time on task, and cooperation among students on active learning for online science courses.

3. FINDINGS

The findings were presented by considering the research questions.

3.1. RQ1 Students' Evaluation of Online Science Courses based on Descriptive Analysis

3.1.1. Students- faculty interaction

Table 2 presents descriptive statistics on the participant students' responses to items for student and faculty interaction. The table reveals that the items "The instructor was respectful of students' ideas and views" (mean: 3.67), "The instructor was enthusiastic about online teaching" (mean: 3.28), and "Flexibility was permitted when completing course assignments" (mean: 3.21) received the highest mean scores from the participant student responses. Conversely, the items "The course was designed so that technology would minimally interfere with learning" (mean: 2.77), "The amount of contact with the instructor was satisfactory" (mean: 2.83), and "I was provided with supportive feedback related to course assignments" (mean: 2.97) had the lowest mean scores for the sub-dimension of student and faculty interaction in online instruction.

Table 2. Students responses to items related to student and faculty interaction for online instruction

Items	N	Mean	SD
The instructor communicated effectively.	2034	3.18	1.717
The instructor was enthusiastic about online teaching.	2034	3.28	1.681
The instructor was accessible to me outside of the course.	2034	3.09	1.737
The amount of contact with the instructor was satisfactory. (e.g., email, discussions, face-to-face meeting, etc.)	2034	2.83	1.681
I felt comfortable interacting with the instructor and other students.	2034	3.09	1.734
My questions about WebCT were responded to promptly.	2034	3.13	1.693
My questions about course assignments were responded to promptly.	2034	3.11	1.663
I was provided with supportive feedback related to course assignments.	2034	2.97	1.631
This course used examples that clearly communicated expectations for completing course assignments.	2034	3.17	1.683
The instructor was respectful of students' ideas and views	2034	3.67	1.884
The course was designed so that technology would minimally interfere with learning.	2034	2.77	1.754
Flexibility was permitted when completing course assignments.	2034	3.21	1.683

The participant students' disagreement with the items in the subscale can be inferred from the mean average of 3.48 and below, except for one item. This indicates that they did not find the interaction between students and faculty during online classes effective or satisfactory.

3.1.2. Time on task

The evaluation of time on task was carried out using four items on the scale (as shown in Table 3). The item that received the highest mean score was "the course allowed me to take responsibility for my own learning" ($\bar{x}$= 3.28), followed by "The course was designed to provide an efficient learning environment" ($\bar{x}$= 3.08) and "The course allowed me to complete assignments across a variety of learning environments" ($\bar{x}$= 3.02). On the other hand, the item "The course was structured to be user friendly" received the lowest mean score ($\bar{x}$= 2.99) from the participant students. It is noteworthy that all mean scores for the items related to time on task were below the 3.48 threshold, indicating that the participant students disagreed with the items from a statistical standpoint.

Table 3. Students responses to items related to student and time on task for online instruction

Item	N	Mean	SD
The course allowed me to take responsibility for my own learning.	2034	3.28	1.803
The course was structured to be user friendly.	2034	2.99	1.603
The course was designed to provide an efficient learning environment.	2034	3.08	1.711
The course allowed me to complete assignments across a variety of learning environments.	2034	3.02	1.727

According to the results presented in Table 3, the participant students did not perceive the course structure as being designed to be user-friendly, offering diverse and effective learning environments, and encouraging them to take ownership of their learning.

3.1.3. Cooperation among students

There are three items for cooperation among students in the SEOTE scale (Table 4.). The data analysed revealed that the cooperation among students during online science classes were generally low.

Table 4. Students' responses to items related to cooperation among students for online instruction

Item	N	Mean	SD
The course was structured so that I could discuss assignments with other students.	2034	2.72	1.641
This course included activities and assignments that provided students with opportunities to interact with one another.	2034	3.01	1.704
The course was used to stimulate thoughtful discussions.	2034	2.99	1.654

Among these items, the one that received the highest mean score was "This course included activities and assignments that provided students with opportunities to interact with one another" ($\bar{x}$=3.01). This was followed by "The course was used to stimulate thoughtful discussions" ($\bar{x}$=2.99). On the other hand, the item with the lowest mean score in this subsection was "The course was structured so that I could discuss assignments with other students" ($\bar{x}$=2.72). These findings suggest that students felt that online classes did not offer enough opportunities for cooperation during their science learning experiences.

3.1.4. Active learning

The mean values for students' responses to active learning items ranged from 3.29 to 3.03, as shown in Table 5. Among these items, "The assignments for this course were of appropriate difficulty level" and "This course used a variety of assignments and activities that allowed students to demonstrate understanding of critical course concepts" received the highest mean score of 3.29. On the other hand, the item with the lowest mean score was "This course used realistic assignments and problem-solving activities that were interesting and motivated me to do my best work" with a mean score of 3.03. Similarly, the item "The course used realistic assignments and problem-solving activities related to situations that I am likely to encounter outside of this course or in a future job situation" also had a mean score of 3.05. These results suggest that students were not fully motivated or interested in the realistic assignments and problem-solving activities used in the online science course.

Table 5. Students responses to items related to active learning for online instruction

Item	N	Mean	SD
This course included interactive assignments and links to examples from the Web that directly involved me in the learning process.	2034	3.07	1.696
This course used realistic assignments and problem-solving activities that were interesting and motivated me to do my best work.	2034	3.03	1.752
This course provided good examples and links to other examples published on the Web that helped to explain concepts and skills.	2034	3.17	1.680
The assignments for this course were of appropriate difficulty level.	2034	3.29	1.736
The course used realistic assignments and problem-solving activities related to situations that I am likely to encounter outside of this course or in a future job situation.	2034	3.05	1.717
This course used a variety of assignments and activities that allowed students to demonstrate understanding of critical course concepts.	2034	3.29	1.788

These findings indicate that students did not perceive their online science experiences to offer suitable prospects for active learning.

3.2. RQ2 differences in the Participant Students' Evaluations of Online Science Courses based on the Participants' Year of Study

Table 6 provides descriptive statistics, indicating that students in lower grades (6^{th}, 7^{th}, 8^{th}, and 9^{th}) scored higher than those in higher grades (10^{th}, 11^{th}, and 12^{th}) in all four subsections of the online science scale, including student-faculty interaction, time on task, cooperation among students, and active learning. The results suggest that students in lower grades had better interactions with their teachers, spent more time on task, engaged in better cooperation with peers, and experienced more active learning opportunities compared to their counterparts in higher grades.

Table 6. The participant students' evaluation of online science courses based on grade

Variable	Grade	N	Mean	SD	Variable	Grade	N	Mean	SD
SFI	6	175	3.36	1.084	**CAS**	6	175	3.23	1.27
	7	504	3.40	1.09		7	504	3.28	1.27
	8	355	3.22	1.18		8	355	2.90	1.29
	9	174	3.20	1.13		9	174	2.96	1.33
	10	487	2.90	1.06		10	487	2.60	1.21
	11	250	2.76	1.18		11	250	2.64	1.36
	12	89	2.81	1.50		12	89	2.53	1.48
	Total	2034	3.12	1.16		Total	2034	2.91	1.31
TOT	6	175	3.34	1.31	**AL**	6	175	3.42	1.25
	7	504	3.49	1.27		7	504	3.52	1.23
	8	355	3.25	1.38		8	355	3.27	1.33
	9	174	3.13	1.35		9	174	3.20	1.36
	10	487	2.76	1.29		10	487	2.85	1.17
	11	250	2.64	1.33		11	250	2.72	1.29
	12	89	2.73	1.54		12	89	2.78	1.55
	Total	2034	3.09	1.37		Total	2034	3.15	1.30

The Welch test was employed to determine the statistical significance of the differences, as shown in Table 7.

Table 7. The Welch test results for student and faculty interaction based on year of study

Variable	Robust Tests of Equality of Means				Eta-squared
		df1	df2	Sig.	
Student Faculty Interaction	15.077	6	576.540	<.001	.043
Time on Task	21.030	6	579.212	<.001	.057
Cooperation among students	16.840	6	578.332	<.001	.047
Active learning	20.042	6	575.995	<.001	.054

The Welch test result shows that the participant students' evaluation of online science classes in terms of student and faculty interaction based on the participants year of study differed significantly, F_{Welch} (6, 576,54):15.077, p<.001 (Table 8). Similarly, the participant students' responses to the items related to time on task differ significantly across years of study, F_{Welch} (6, 579.212) =21.020, P<.001. In the same vain, the participant students' mean scores for "cooperation among students" subsection items were statistically significant based on students' year of study, F_{Welch} (6,578.332) =16.840, p<.001. The similar results are also evident for the active learning subsection as the mean differences for the participant students' responses to active learning items were statistically significant, F_{Welch} (6,575.995) =20.042, p<.001 (Table 7). But the same results also show that the effect of the participant students grade on the results of students' evaluation of online science courses are small, $\eta^2_{\text{student-faculty interaction}}$=.043; $\eta^2_{\text{time on task}}$=.057; $\eta^2_{\text{cooperation among students}}$=.047; $\eta^2_{\text{active learning}}$=.054. A η^2 value that is below .059 is considered as a small effect size (Cohen, 1988).

In order to determine the source of this significant difference among the participant students' mean score, Games- Howell multiple comparison test was used (Table 8).

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Table 8. Games- Howell multiple comparison test for time on task based on year of study

Dependent Variable	(I) Grade	(J) Grade	Mean Difference (I-J)	SE	Sig.	Dependent Variable	(I) Grade	(J) Grade	Mean Difference (I-J)	SE	Sig.
SFI	6	10	.45*	.095	<.001	**CAS**	6	10	.63*	.111	<.001
		11	.60*	.111	<.001			11	.59*	.129	<.001
		12	.54*	.179	.046			12	.70*	.184	.004
	7	10	.49*	.068	<.001		7	8	.37*	.088	<.001
		11	.64*	.089	<.001			10	.68*	.078	<.001
		12	.58*	.166	.012			11	.64*	.103	<.001
	8	10	.31*	.079	.002			12	.75*	.166	<.001
		11	.46*	.097	<.001		8	10	.30*	.087	.010
TOT	6	10	.58*	.115	<.001	**AL**	6	10	.57*	.108	<.001
		11	.70*	.129	<.001			11	.71*	.125	<.001
		12	.61*	.190	.028			12	.64*	.190	.017
	7	9	.37*	.117	.032		7	10	.67*	.076	<.001
		10	.73*	.081	.000			11	.80*	.098	<.001
		11	.85*	.101	<.001			12	.74*	.173	<.001
		12	.76*	.172	<.001		8	10	.42*	.088	<.001
	8	10	.49*	.094	<.001			11	.55*	.108	<.001
		11	.61*	.111	<.001						

The table presented above indicates that the statistically significant differences in all subsections are observed between lower grade and upper grade students, where the former have higher mean scores. Further analysis using Games-Howell multiple comparison test revealed that the significant differences obtained from the Welch test were due to the mean differences between the mean scores of 6th-grade students and those of 10th, 11th, and 12th-grade students. A similar pattern was observed between the mean scores of 7th and 8th-grade students and those of 10th, 11th, and 12th-grade students (Table 8).

3.3. RQ3 Differences in the Participant Students' Evaluations of Online Science Courses based on the Medium for Participating Online Science Courses

A MANOVA test was used to analyse students' evaluation of online science courses based on their means for participating in on line science courses. This was carried to find out if the medium for participating in online science classes had any effect on the participant students' evaluation of online science classes (Table 9).

Table 9. MANOVA results for the evaluation of online science classes based on the medium for participating

Multivariate Tests[a]							
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.601	762.544[b]	4.000	2026.000	.000	.601
	Wilks' Lambda	.399	762.544[b]	4.000	2026.000	.000	.601
	Hotelling's Trace	1.506	762.544[b]	4.000	2026.000	.000	.601
	Roy's Largest Root	1.506	762.544[b]	4.000	2026.000	.000	.601
Access	Pillai's Trace	.015	1.946	16.000	8116.000	.013	.004
	Wilks' Lambda	.985	1.948	16.000	6190.170	.013	.004
	Hotelling's Trace	.015	1.948	16.000	8098.000	.013	.004
	Roy's Largest Root	.009	4.645[c]	4.000	2029.000	<.001	.009

a. Design: Intercept + Access
b. Exact statistic
c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Multivariate tests show (Table 9) that there was statistically significant difference in the students' evaluation of online science courses based on a student's means to access to online course, F (16,6190.17) =1.948, p<.05; Wilk's Λ=0.985, partial η^2 =.004. Despite the significance in p value, the effect size is very small, which means the medium of participating in online science classes had very small effect on the participant students' evaluation of online science classes.

Table 10. Tests of between-subjects effects

Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	SFI	20.189[a]	4	5.047	3.743	.005	.007
	TOT	19.345[b]	4	4.836	2.603	.034	.005
	CAS	10.081[c]	4	2.520	1.453	.214	.003
	AL	12.062[d]	4	3.015	1.762	.134	.003
Intercept	SFI	4075.593	1	4075.593	3022.625	.000	.598
	TOT	3983.490	1	3983.490	2143.760	.000	.514
	CAS	3460.674	1	3460.674	1995.015	<.001	.496
	AL	4175.705	1	4175.705	2439.940	.000	.546
Access	SFI	20.189	4	5.047	3.743	.005	.007
	TOT	19.345	4	4.836	2.603	.034	.005
	CAS	10.081	4	2.520	1.453	.214	.003
	AL	12.062	4	3.015	1.762	.134	.003
Error	SFI	2735.826	2029	1.348			
	TOT	3770.246	2029	1.858			
	CAS	3519.627	2029	1.735			
	AL	3472.424	2029	1.711			
Total	SFI	22607.319	2034				
	TOT	23237.875	2034				
	CAS	20734.778	2034				
	AL	23676.722	2034				

a. R Squared = .007 (Adjusted R Squared = .005)
b. R Squared = .005 (Adjusted R Squared = .003)
c. R Squared = .003 (Adjusted R Squared = .001)
d. R Squared = .003 (Adjusted R Squared = .001)

The table 10 displays that the mean for access to online courses had a significant effect both on students and faculty interaction (F (4,2029) =3.743; p<.05; partial η^2 =.007) and time on task (F (4,2029) =2.603; p<.05; partial η^2 =.007). But this relation was insignificant for both cooperation among students and active learning subsections of online science evaluation (p>.05).

Multiple comparisons show that statistical significances stem the differences between the use of tablet and phone and tablet and smart Tv for student faculty interaction (Table 11). Similarly, between tablet and phone for time on task. Students using tablets to participate in online classes had higher mean scores the items related to student and faculty interaction and time on task in comparison to students using phone or smart Tv.

Table 11. Multiple comparisons

Multiple Comparisons
Tukey HSD

Dependent Variable	(I) means for access to online courses	(J) means for access to online courses	Mean Difference (I-J)	Std. Error	Sig.
Student Faculty İnteraction	Tablet	Phone	.1954*	.06683	.029
		Smart Tv	.5250*	.16992	.017
Time on Task	Tablet	Phone	.2422*	.07846	.017

3.4. RQ4 Differences in the Participant Students' Evaluations of Online Science Courses based on the Frequency of Attendance for Online Science Courses

One-way ANOVA was used to analyse whether there were statistically significant differences in students' evaluation of online science courses based on their frequency of attendance in online science courses (Table 12).

Table 12. ANOVA results for evaluation of online science courses based on the frequency participation in online courses

		N	Mean	SD	ANOVA	Eta-squared
Student Faculty Interaction	Attended in all online classes	190	3.74	1.27	F=69.45	.093
	Attended in most online classes	344	3.63	1.08		
	Attended in some of the online classes	474	3.18	1.05	Sig=<.001	
	Attended only in few online classes	1026	2.82	1.12		
	Total	2034	3.12	1.16		
Active Learning	Attended in all online classes	190	3.80	1.35	F=62.81	.085
	Attended in most online classes	344	3.70	1.25		
	Attended in some of the online classes	474	3.21	1.20	Sig:<.001	
	Attended only in few online classes	1026	2.82	1.26		
	Total	2034	3.15	1.31		
Time on Task	Attended in all online classes	190	3.72	1.43	F=53.65	.073
	Attended in most online classes	344	3.61	1.34		
	Attended in some of the online classes	474	3.16	1.26	Sig=<.001	
	Attended only in few online classes	1026	2.77	1.31		
	Total	2034	3.09	1.37		
Cooperation among Students	Attended in all online classes	190	3.54	1.44	F=39.47	.055
	Attended in most online classes	344	3.30	1.26		
	Attended in some of the online classes	474	2.92	1.25	Sig=<.001	
	Attended only in few online classes	1026	2.65	1.27		
	Total	2034	2.91	1.32		

The results reveal that the frequency of attendance in online science classes were a significant factor for all four subsection of the evaluation scale; $F(3,230)=69.45$, $p<.05$, $\eta^2=.093$ for student and faculty interaction, $F(3,230)=62.81$, $p<.05$, $\eta^2=.085$ for active learning, $F(3,230)=53.65$, $p<.05$, $\eta^2=.073$ for time on task and $F(3,230)=39.47$, $p<.05$, $\eta^2=.055$. Results from the table 12 shows that despite significant differences in students' evaluation of online science courses based on students' frequency of attendance, the size for all four subsections are small. Therefore, it can be concluded that attendance frequency in online science classes did not emerged as an important factor for the participant students' evaluation of online science classes. Multiple comparisons were calculated to find out the source of the differences emerged in the way-ANOVA test (Table 13).

Table 13. Multiple comparisons for students' evaluation of online science classes based on the attendance frequency

Tukey HSD Dependent Variable	(I) Attendance frequency	(J) Attendance frequency	Mean Difference (I-J)	SE	Sig.
Student Faculty Interaction	All	Some	.56244*	.09528	<.001
		Few	.92110*	.08764	<.001
	Most	Some	.45102*	.07859	<.001
		Few	.80969*	.06913	<.001
	Some	Few	.35867*	.06163	<.001
Active Learning	All	Some	.59641*	.10761	<.001
		Few	.98012*	.09898	<.001
	Most	Some	.49233*	.08877	<.001

		Few	.87604*	.07808	<.001
	Some	Few	.38371*	.06960	<.001
Time on Task	All	Some	.55861*	.11296	<.001
		Few	.94795*	.10391	<.001
	Most	Some	.45284*	.09318	<.001
		Few	.84218*	.08197	<.001
	Some	Few	.38934*	.07306	<.001
Cooperation among Students	All	Some	.61595*	.11006	<.001
		Few	.88460*	.10123	<.001
	Most	Some	.37677*	.09079	<.001
		Few	.64542*	.07986	<.001
	Some	Few	.26865*	.07119	<.001

The table for multiple comparisons reveals that in all subsection the statistically significant differences were between attending in all online science classes and attending in same and few online science classes, between attending in most online science classes and attending in some and few online science classes and between attending in some online science classes and attending in few online science classes (Table 13).

3.5. RQ5 the Effect of Student- Faculty Interaction, time On- Task and Cooperation among Students on Active Learning for Online Science Learning

Multiple regression analysis was used to test if student and faculty interaction, time on task and cooperation among students significantly predicted active learning for online science instruction.

Table 14. A model summary for multiple regression

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.884[a]	.782	.781	.61238	1.766

a. Predictors: (Constant), Student Faculty İnteraction, Cooperation among Students, Time on Task
b. Dependent Variable: Active Learning

The table above displays that the model explains 88.4% of the variation in the dependent variable.

Table 15. ANOVA results for the regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2723.209	3	907.736	2420.544	.000[b]
	Residual	761.277	2030	.375		
	Total	3484.486	2033			

a. Dependent Variable: Active Learning
b. Predictors: (Constant), Student Faculty Interaction, Cooperation among Students, Time on Task

The overall model is significantly useful in explaining active learning for online science courses (Table 15), F (3, 2030) = 2420.54, p < .05.

Table 16. Coefficients for the regression model

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	SE	Beta			Tolerance	VIF
1	(Constant)	.071	.039		1.813	.070		
	Time on Task	.256	.018	.267	14.256	<.001	.306	3.263
	Cooperation among Students	.161	.016	.162	9.907	<.001	.402	2.488
	Student Faculty Interaction	.582	.022	.518	25.899	<.001	.269	3.716

a. Dependent Variable: Active Learning

The results from table 16 show that with one-unit increase in student and faculty interaction, active learning increases .58 point during online science instruction, which was found to be a significant change, $t(2030)=25.90$, $p<.05$.Also, with one-unit increase in time on task, active learning increases .26 point during online science instruction, which was found to be a significant change, $t(2030)=14.26$, $p<.05$. Similarly, with one-unit increase in cooperation among students, active learning increases .16 point during online science instruction, which was found to be a significant change, $t(2030)=9.91$, $p<.05$. The equation to predict active learning from student and faculty interaction, cooperation among students and time on task for the evaluation of online science courses is:
Active learning=.071+(.058*SFI) +(.26*TOT) +(.16*CAS)

4. DISCUSSION and CONCLUSION

The current study investigated students' evaluation of online science experiences in terms of student- faculty interaction, time on task, cooperation among students and active learning. The overall findings showed that the participant students saw the online science classes less effective in comparison to face to face science learning in all four dimensions investigated. Also, in all four dimension of the online science learning evaluation that include student faculty interaction, time on task, cooperation among students and active learning, lower grade students responded more positively to the items related to online science classes compared to upper grade students. There are difference approaches to investigating the effectiveness of online or face to face learning in the literature. Some studies usually compare these two ways of learning by focusing on their benefits or disadvantages in areas such as flexibility, cost effectiveness, access, skills (Kulal & Nayak, 2020; Lauran et al., 2014). Learner preference, interactivity, workload, performance, and challenges (Mather & Sarkans, 2018) are also studied when comparing the two ways of learning. Previous studies comparing online learning to face to face learning reported that the main reasons students preferred face to face learning to online line learning was the opportunity to interact with peers and faculty as learning was enhanced through immediately available feedback, lack of motivation to attend online classes, and difficulties in time management for online classes (Mather & Sarkans, 2018). Selvaraj, Vishnub, Benson and Mathew (2021) studied students' and teachers' approach to online learning during the COVID 19. The study found that both students and teachers believed face to face learning are better in terms of knowledge transfer and learning efficacy and that student were more attentive in face to face learning. Comparing online learners' views to that of face to face learners, Mather and Sarkans (2018) found that online learners valued flexibility and convenience while face to face learners saw the importance of peer and faculty interaction as the main element of face to face learning. Bernard et al. (2009) found that online learning can be more effective than face-to-face learning when there is a high level of interaction between students and instructors. Similarly, Cook (2007) argues that online learning can be more effective than face-to-face learning in certain contexts, such as when students have access to multimedia resources and interactive simulations. A meta-analysis by Means, Toyama, Murphy, Bakia and Jones (2010) found that online learning was more effective compared to traditional face-to-face learning. Ganesh, Paswan, and Sun (2015) investigated four dimensions, overall evaluation, perceived competence, perceived communication, and perceived challenge, to find out how students rate online learning and face to face learning. The results of their study indicated that students rate traditional classes better on all four dimensions. The effectiveness of online learning is also well documented in the literature particularly when online science learning enriched with applications such as web 2.0 tools as students' motivation increases since learning activities resembles games and students compete with their peers (Hoic-Bozic, Holenko Dlab & Mornar, 2016). Lack of interaction with the instructors as seen a major factor that affect students' online learning experience (Hollister, Nair, Hill-Lindsay & Chukoskie, 2022). Student-student and student -faculty interactions are among the main benefits of the face to face learning that provide students to with opportunities to clarify and misunderstanding, misconception or response to questions during the learning process (Paul & Jefferson, 2019; Singh et al.,2021). Yao, Rao, Jiang, and Xiong (2020) found that teachers' involvement related to their teaching efficiency; their role as teacher and feedback provider was still critical to learning during online classes. In addition, more online communication between teachers and students positively affected student performance (Yao et al., 2020).

The majority (64%) of the participant of this study used mobile phone to attend online science courses. This is in line with the findings of previous studies that investigated online classes. Muthuprasad, Aiswarya, Aditya and Girish (2021) reported that students mostly used mobile phones for online class that was followed by laptops, tablets and only a few participant students used desktops to attend online classes Similarly, Gamage and Perera, (2021) found while students frequently used laptops and smartphones and they seldomly resorted to desktop computers. With rapid development of smart phone technologies, the mobile phones are seen as important instrument to support online science learning as it has potential to motivate students, help for inquiry-based learning, enhance learning through the applications for virtual learning and simulations, promote science process skills such as collaboration, critical thinking and decision making (Suarez et al., 2018). Previous studies reported that in lower- or middle-income groups, students faced problems of access to online courses (Barrot, et al., 2021). From the data collected from for the study, it was not clear whether the participant students preferred to use mobile phones or they did not have any other option as usually in a family of more than one student studying in different grades had to attended in online classes simultaneously during Covid 19 lockdown and that it was probably not possible for all students in a family to attend online classes through computers simply because families could not afford many computers.

The current study also investigated whether the medium used by students to attend online science classes had any effect in evaluating the effectiveness of online science classes. The findings of the study showed that students using tablets to attend on line classes had more positive views on the effectiveness of online science in terms of student- faculty interaction and time on task in comparison to students using phones or smart tv. Garcia-Mendoza (2014) compared the participation, interaction and collaboration between students using desktops and student using smartphones. The study found that mobile phones had a great potential for online learning in comparison to desktops in terms of student interaction, time on task and collaboration among students. In the same vein, Anshari, Almunawar, Shahrill, Wicaksono, and Huda (2022) found the use of smartphones in classes positively affected students' academic achievement. There are also studies that found challenges with the use of smartphones for online learning. Dolgunsoz and Yildirim (2021) found that students were mostly using smartphones for online classes but these devices were not effective as the participant students faced problems such as overheating of the phones, limited screen size for effective learning and problems of connectivity. The same study also found that tablets were not popular among students and the researcher recommended the use of notebooks for online learning. Similarly, Tal and Kurtz (2015) found that while using notebook or laptops is helpful for creating learning-supportive activities, smartphones can promote distractive activities in the learning environment. Kenar, Balci and Gokalp (2013) found that the use of tablet had positive impacts on students' attitudes toward technology and technology usage in the courses.

The study found that the frequency of attendance for online science classes was a major factor in students' evaluation of online science classes since students who attended in all or most of the online science classes had higher opinions for the effectiveness of online science classes in terms of student- faculty interaction, time on task, cooperation among students and active learning. Hollister, Nair, Hill-Lindsay and Chukoskie (2022) found that students' frequency for synchronous online learning was low and usually they preferred recorded classes rather than attending live online classes that negatively affects their learning experiences. Lu and Cutumisu (2022) did not find any relation between attendance and academic outcomes but, study suggested that, attendance enhances academic performance by utilizing active engagement in online learning and improved performance in formative assessments. The results of the study carried out by Hong et al. (2021) indicated that the level of online learning ineffectiveness among high school students had negative correlation between the quantity of online experimental courses and the duration of online hands-on learning.

One of the elements that often becomes a subject of discussion in online science learning is the fact that national curriculums persistently promotes student-centred learning that encompasses students' active engagements in the scientific processes that include hands on activities (Hong et al., 2021) during the knowledge building but online science learning can be challenging for active learning (Miller, 2008). In contrast, the increasing integration of available online tools such as games, simulations, virtual/ augmented realties etc. provides opportunities for students and teachers to increase student motivation, enhance science learning and make science learning fun (Lauran et al., 2014; Kulal & Nayak, 2020). Therefore, based on the participant students' views, the study was also interested in finding out whether in online science classes student-faculty interaction, time on task and cooperation among students were important in terms of active learning. The study revealed that these three factors were important elements of active learning in online science classes. The previous studies in the field found that engagement (Widiyatmoko, 2018) interaction between student- faculty and student- student (Faja, 2013), and working together for task (Bakioglu & Cevik, 2020; Kulal & Noyak, 2020) are important elements of active learning in online science teaching.

This study investigated the participant students' online science learning experiences to evaluate the effectiveness of online science courses by using the four subsections identified in the Student Evaluation of Online Teaching Effectiveness (SEOTE) scale developed by Bangart (2005). The participant students were not satisfied with online science learning experiences in terms of faculty-student interaction, time on task, cooperation among students and active learning practices. Although several factors such as participant students' motivation for online learning, availability of resources, teacher's expertise and connectivity problems can affect students' views for the evaluation of online science learning experiences, a relatively large group of participants' views from different grades and schools are important when considering online science learning activities. Therefore, assuring students engagement, teacher-faculty interaction, creating opportunities for students to cooperate and heling students to actively engage in the activities need consideration by teachers when designing or implementing online science classes. This consideration may well begin in preservice teacher education as the Covid-19 and the recent earthquake that effected a large part of Turkey have demonstrated, online teaching, in general and science in particular since the pace of educational technology that helps learning science is extremely high with new developments almost daily, has already become an important part of our instructional strategy. The study, also, confirmed that in online science learning interaction between student and faculty, time on task and cooperation among students are predictors of active learning. Therefore, when online science active learning activities for students are developed these three areas should be considered.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Dicle University with the decision dated 14/04/2021 and numbered 59225

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Abstract

The purpose of this research; The aim of this study is to examine whether the distance education competencies of physical education teachers working in Elazig differ in terms of different variables. The universe of the study consists of physical education teachers working in the province of Elazig in Turkey, while the sample consists of 155 physical education teachers selected by random method. In the research, which was prepared in a 5-point likert type consisting of a personal information form and 18 items, in order to collect data in the research; Physical Education Teachers' Distance Education Competencies Scale was used. According to the research findings, 69.7% of the participants are male, 52.9% are 36-45 years old, 78.1% are married, 54.8% are at school level, 31.0% are 16-20 years. seen as. When we look at the analysis of variance according to the age and seniority of the participants, it was seen that there was a significant difference between the groups. In conclusion; When the Distance Education Competencies of Physical Education Teachers were examined, it was seen that the distance education competencies of the teachers decreased as the age and professional seniority of the teachers increased.

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Research Article

Distance Education Competencies of Physical Education Teachers: Elazığ Province *

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Abstract

The purpose of this research; The aim of this study is to examine whether the distance education competencies of physical education teachers working in Elazig differ in terms of different variables. The universe of the study consists of physical education teachers working in the province of Elazig in Turkey, while the sample consists of 155 physical education teachers selected by random method. In the research, which was prepared in a 5-point likert type consisting of a personal information form and 18 items, in order to collect data in the research; Physical Education Teachers' Distance Education Competencies Scale was used. According to the research findings, 69.7% of the participants are male, 52.9% are 36-45 years old, 78.1% are married, 54.8% are at school level, 31.0% are 16-20 years. seen as. When we look at the analysis of variance according to the age and seniority of the participants, it was seen that there was a significant difference between the groups. In conclusion; When the Distance Education Competencies of Physical Education Teachers were examined, it was seen that the distance education competencies of the teachers decreased as the age and professional seniority of the teachers increased.

Keywords: Distance education, covid-19, physical education, teacher

1. INTRODUCTION

The Covid-19 outbreak emerged in Wuhan, China at the end of December 2019 and was officially confirmed on January 13, 2020. Over time, it spread to all provinces of the People's Republic of China and then to the world T.R. Ministry of Health (2020). Due to the destruction of the human body and the rapid spread of this epidemic all over the world, many activities have stopped Demir, Cicioğlu and İlhan (2020). One of the priorities of all pandemic countries is to ensure the continuation of uninterrupted education. In this context, almost every country has started to use distance education applications supported by technological infrastructure opportunities Can (2020). Due to the global crisis caused by the new covid-19 virus epidemic, it has been announced that schools will be closed as of March 16, 2020 to combat the epidemic and distance education activities will be started within the scope of educational measures accepted by the Ministry of National Education [MoNE] (2020). While distance education offers active communication opportunities to teachers and students living in different places, it provides an individual and collaborative working environment for teachers and students, independent of the influence of many variables Altıparmak, Kurt, and Kapıder

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(2011: 320). In addition, recorded lecture videos can be watched later and students can access various materials such as documents and videos individually whenever they want Solak, Ütebay, and Yalçın (2019: 42). Turkey; Although the entry to distance education is relatively late compared to developed countries, it has left many countries behind by strengthening the communication infrastructure and increasing technological investments.

Depending on this situation, the rapid development of technology and changes in social life have had an impact in the field of education and in many different fields (Özey & Demirci, 2010: 5). It is surprising that there are limited number of studies that reveal the situation of teachers in Turkey, especially in the field of physical education. Although Minister of National Education has created multi-faceted regulations covering all lessons and provided access to resources through EBA, it is necessary to understand the effect of these resources on learning and the ability of physical education teachers to acquire and use these resources effectively Aras and Işık (2020). Some comments indicate that applying for the EBA will not achieve the physical education goal.

In addition, in the studies on teachers' perceptions of competence, it was found that during the COVID-19 pandemic, 10 different courses were taught in primary and secondary schools with distance education and television support, and 22 separate courses in high school degrees, but within the scope of these courses, Physical Education course was taught in addition to Visual Arts, Music, Painting courses. On the other hand, it was seen that not all field teachers were included in this process Can (2020). Competent individuals decide how they think, how they feel, how they motivate themselves, and how they act. The cognitive process includes four main processes: the motivational process, the emotional process, and the choice process. These processes play a very important role in perception. It can prevent the expected behaviors from occurring, as well as encourage the expected behaviors to occur Bandura (1994). Competence, on the other hand, comes from four important sources. These; all life experiences such as success or failure; physical and emotional states such as fear and excitement; family, friends, colleagues, etc., provided by social models and to witness success or failure. They are indirect experiences such as given observations Bandura (1995). For teachers, the concept of competence is related to the amount and desire of students' success Goddard, Hoy, and Woolfolk Hoy (2000). Considering the teaching abilities of teachers, it is seen that students are more willing and their psychological development increases significantly when teachers show higher education ability Bandura (1994).

2.5. Questions of the Study or Hypotheses

• Is there a significant difference between the distance education qualifications of physical education teachers and their gender?

• Is there a significant difference between physical education teachers' distance education qualifications and marital status?

• Is there a significant difference between the distance education qualifications of physical education teachers and school levels?

• Is there a significant difference between the distance education qualifications of physical education teachers and their ages?

• Is there a significant difference between distance education qualifications and professional seniority of physical education teachers?

2. METHOD

2.1. Research Method

The aim of our study is to examine the distance education competencies of physical education teachers working in Elazığ through various variables. Descriptive scanning methods were used in our study.

2.2. Sample

The population of the study is the Elazığ province sample; It consisted of 155 physical education teachers working in Elazığ.

2.3. Data Collection Tools

In the research; Demographic information and the "Distance Education Competency Scale of Physical Education Teachers" developed by Sağın, Yücekaya and Güllü, (2021) were used. A five (5) point Likert type scale consisting of 18 items was used, each item is given a score between 1 and 5. It is a scale with a single factor structure (1 = never, 5 = always). The minimum score on the scale is 18, the maximum is 90 points, and higher scores indicate a positive increase in the evaluation.

2.4. Analysis of Data

SPSS package program was used to analyze the data. Percentage, frequency, standard deviation, mean value and normal distribution tests of the research findings were carried out and as a result of these checks, it was seen that the data were normally distributed and the study was concluded by converting the T test for double groups and the ANOVA analyzes for multiple groups into tables and turning them into suggestions within the framework of scientific generalizations.

3. FINDINGS

Table 1. Independent variables

	Variable	Number (N)	Percent (%)
Gender	Male	108	69.7
	Woman	47	30.3
Age	25-35 years	29	18.7
	36-45 years	82	52.9
	46 years and older	44	28.4
Marital status	Married	121	78.1
	Single	34	21.9
School grade	Middle school	70	45.2
	High school	85	54.8
Your year of employment	1-5 years	10	6,5
	6-10 years	24	15.5
	11-15 years	38	24.5
	16-20 years	48	31.0
	21 and over	24	22.6

69.7% of the participants' genders are male, 30.3% are female, 18.7% of their ages are 25-35, 52.9% are 36-45, 28.4% are 46 and over, their marital status is 78.1%. 100,000 are married, 21.9% are single, 54.8% are at school level, 45.2% are at secondary school level, 54.8% are at high school level, 6.5% of their working years are 1-5 years, 15.5% are 6-10 years. It was observed that 24.5% were 11-15 years old, 31.0% were 16-20 years old and 22.6% were 21 years and above.

Table 2. Average value

N	Min.	Max.	Skala değeri
155	33.00	86.00	67.00

Considering the average scores of the participants; It was observed that the minimum value was 33.00 points and the maximum value was 86.00 points. The scale value has an average of 67.00. Accordingly, the distance education qualifications of physical education teachers are above average.

Table 3. Mean and standard deviation of physical education teachers' scores from distance education competencies scale by gender

Gender	N	Mean Score	sd	t	df	p
Male	108	66.97	14.573	.036	154	.972
Woman	47	67.06				

When the mean and standard deviation of the scores received from the Physical Education Teachers' Distance Education Competencies scale according to the gender status of the participants were examined, no significant difference was seen between men and women (p>0.05). This shows that physical education teachers' distance education qualifications have no effect on their gender.

Table 4. Mean and standard deviation of physical education teachers' scores from distance education competencies scale by civilization

Marital Status	N	Mean Score	sd	t	df	p
Married	121	67.95	14.41	1.52	154	.129
Single	34	63.61				

When the mean and standard deviation of the scores received from the Physical Education Teachers' Distance Education Competencies scale according to the participants' civilization status were examined, no significant difference was seen between married and single individuals (p>0.05). This has shown that physical education teachers' distance education qualifications have no effect on their marital status. 726

Table 5. Mean and standard deviation of physical education teachers' scores from the distance education competencies scale by school level

School level	N	Mean Score	sd	t	df	p
Secondary School	70	67.68	14.16	.526	154	.599
High School	85	66.43				

When the mean and standard deviation of the scores received by the participants from the Physical Education Teachers' Distance Education Competencies scale according to school level were examined, no significant difference was seen between secondary school and high school (p>0.05). This shows that the distance education qualifications of physical education teachers do not have an effect on the school level.

Table 6. Analysis of variance by age

	Sum of squares	df	Mean of squares	f	p
Between groups	23868.508	1	1064.091	8.738	.000
Within groups	27060.780	154	121.778		

Tukey HSD			
		Average difference	Sig.
46 years and older	25-35 years *	-11.32421*	.000
	36-45 years*	-10.32387*	.000

When we look at the analysis of variance according to the age of the participants, there is a significant difference between the groups. The difference between the mean scores is significant (p<0.05). When we look at which groups the difference is, considering the results of the Tukey hsd test, it is seen that it is between the ages of 46 and over, 25-35 years * and 36-45 years*. This shows that physical education teachers' distance education qualifications have an impact on their age, and those who are older have lower distance education qualifications.

Table 7. Analysis of variance by year of employment

	Sum of squares	df	Mean of squares	f	p
Between groups	5197.171	1	1732.390	7.818	.000
Within groups	43434.184	154	221.603		

Tukey HSD			
		Average difference	Sig.
16-20 year	1-5 year *	-11.32421*	.000
	6-10 year*	10.32387*	.000

When we look at the analysis of variance according to the status of the participants, there is a significant difference between the groups. The difference between the mean scores is significant (p<0.05). When we look at which groups the difference is, considering the Tukey hsd test results, it is seen that it is between 16-20 years and 1-5 years* and 6-10 years*. This shows that physical education teachers' distance education qualifications have an impact on their years of service, and those with higher years of service have lower distance education qualifications.

4. DISCUSSION AND CONCLUSION

In the rapidly changing and developing world, it is a current situation that teachers meet with distance education. However, due to the outbreak of the covid 19 epidemic preventing the face-to-face education in schools, the process of meeting teachers with distance education has begun. This study aims to determine the distance education and competencies of physical education teachers. When the mean and standard deviation of the scores of physical education teachers from the distance education competency scale according to the gender of the participants were examined, there was no significant difference between women and men (p>0.05). This shows that physical education teachers' distance education qualifications have no effect on their gender. In the study conducted by Özcan and Saraç (2020) to examine the online distance education role and competence perceptions of physical education teachers (42.75% female, 57.25% male), it was seen that teachers did not differ in terms of gender. In another study, Kocasaraç (2003) found a difference in terms of gender, and it was seen that male teachers perceived themselves more competent than women. When the mean and standard deviation of the scores obtained from the Physical Education Teachers' Distance Education Competencies scale according to the marital status of the participants were examined, there was no significant relationship between married and single people (p>0.05). This has shown that physical education teachers' distance education qualifications have no effect on their marital status. When the mean and standard deviation of the scores obtained from the Physical Education Teachers' Distance Education Competencies scale according to the school level of the participants were examined, there was no significant difference between middle school and high school (p>0.05). This shows that the distance education qualifications of physical education teachers do not have an effect on the school level. The teachers in the research sample of Jannah, Prasojo, and Jerusalem (2020), who examined the digital technology perceptions of secondary school teachers in a qualitative way, emphasized that an effective digital-based teacher depends on teacher competence rather than the availability of digital opportunities (technological tools/equipment). When we look at the analysis of variance according to the age of the participants, there is a significant difference between the groups. The difference between the mean scores is significant ($p<0.05$). When we look at which groups the difference is, considering the results of the Tukey test, it is seen that it is between the ages of 46 and over, 25-35 years* and 36-45 years*. This shows that physical education teachers' distance education qualifications have an impact on their age, and those who are older have lower distance education qualifications. Özcan and Saraç revealed that there is a relationship between the ages of teachers and their perceptions of role and competence, and as the age of the teacher increases, the perception of role and competence towards online distance education decreases. When we examine the literature, we come across different results. In the study conducted by Kocasaraç (2003) it was revealed that the most self-sufficient group is the teachers in the 36-40 age range. When we look at the analysis of variance according to the status of the participants, there is a significant difference between the groups. The difference between the mean scores is significant ($p<0.05$). When we look at which groups the difference is, considering the Tukey hsd test results, it is seen that it is between 16-20 years and 1-5 years* and 6-10 years*. This shows that physical education teachers' distance education qualifications have an impact on their years of service, and those with higher years of service have lower distance education qualifications. We can say that as the number of years of service of the participants increases, their level of proficiency also decreases. We can say that this result progresses in parallel with age.

In conclusion; When the Distance Education Competencies of Physical Education Teachers are examined, it is seen that teachers' gender, marital status and school grades do not have an effect on their distance education qualifications, but they do affect their age and professional seniority. It is seen that distance education competencies decrease as teachers' age and professional seniority progress.

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Abstract

With the introduction of the mobile phone into our life, several social media and game applications were created, and individuals began to spend their time in the virtual world. The purpose of this study was to measure the loneliness levels of students at the Faculty of Sport Sciences using mobile phones. People have been more focused on their mobile phones as technology has advanced, and this has unavoidably led to a shift away from the environment and people. The research population consists of students from Fırat University's Faculty of Sports Sciences. The sample consists of 146 students enrolled in the faculty of sports sciences in the academic year 2022-2023. The "Problematic mobile phone use scale" established by Kutlu and Pamuk and the "UCLA loneliness scale" developed by Russell (1996) were utilized as data collection techniques in the study. The SPSS package program was used to analyze the data. Female students of the Faculty of Sports Sciences had higher mobile phone usage values than male students, and their loneliness levels were lower than male students, according to our study, and when the values of the students participating in the study were examined, they used mobile phones between 0-4 hours. As a result, in our study, it was shown that students generally spend the majority of their time alone on the phone and playing games, while female students' PCPU (Problematic Mobile Phone Use Scale) scores are higher than men's, and women's values on the UCLA loneliness scale are low.

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Research Article

Assessment of Mobile Phone Usage and Loneliness Levels of Faculty of Sports Sciences Students*

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Abstract

With the introduction of the mobile phone into our life, several social media and game applications were created, and individuals began to spend their time in the virtual world. The purpose of this study was to measure the loneliness levels of students at the Faculty of Sport Sciences using mobile phones. People have been more focused on their mobile phones as technology has advanced, and this has unavoidably led to a shift away from the environment and people. The research population consists of students from Fırat University's Faculty of Sports Sciences. The sample consists of 146 students enrolled in the faculty of sports sciences in the academic year 2022-2023. The "Problematic mobile phone use scale" established by Kutlu and Pamuk and the "UCLA loneliness scale" developed by Russell (1996) were utilized as data collection techniques in the study. The SPSS package program was used to analyze the data. Female students of the Faculty of Sports Sciences had higher mobile phone usage values than male students, and their loneliness levels were lower than male students, according to our study, and when the values of the students participating in the study were examined, they used mobile phones between 0-4 hours. As a result, in our study, it was shown that students generally spend the majority of their time alone on the phone and playing games, while female students' PCPU (Problematic Mobile Phone Use Scale) scores are higher than men's, and women's values on the UCLA loneliness scale are low.

Keywords: Sports, student, cell phone, loneliness

1. INTRODUCTION

It aims at people, plays an active role in reaching the results, and is time efficient. The effort to use it is called time management. With the development of technology, an even more important time management, which has become a situation, is a care that should be taken care of by people. Time while the importance of use does not only mean the time control, it does not affect the living conditions of the units of time control. It is one of the most important factors in promotion (Alay, 2000). People play games on their mobile phones in their free time and spend most of their time here. After the Covid 19 process, an increase in mobile gaming and internet addiction on mobile phones has been observed. In a study, they observed that the athletes made good use of their free time during the covid 19 process (Sezer & Çelikel, 2021). Technology is a notion that acts to improve human existence, acquires pace in response to demands and needs, and evolves. By providing a comfort zone, technology enables maximum efficiency with minimal effort. Smartphones have grown as indispensable devices, particularly with the increase in internet speed and mobile phone capability. your cell phones; It has been supplanted by computers and is widely used due to its compact size, easy portability, and nearly infinite network connectivity. The ability to use many functionalities

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simultaneously, such as video calling, messaging, and recording, has boosted the desirability and usage rates of smart phones. It makes human existence easier with these features. Smartphones' habits, communication methods, cultural attitudes, and family interactions continue to differ (Işık, 2015; Samaha & Hawi, 2016). However, while it eliminates hurdles and speeds up life, it also causes behaviors that cannot be avoided in another realm. In the world and in our country, the prevalence of smartphone addiction or problematic smartphone use has reached alarming levels (Poushter, 2016). According to Tanju 2022, 77% of the Turkish population owns a smartphone. According to the results of the "Mobile User Survey" in Turkey, it was determined that the use of smartphones, which was known to be 86% in 2015, increased to 92% in 2017 (Goodall et al, 2017). For the usage rates increasing exponentially day by day; According to the 2020 data of the research conducted by the Turkish Statistical Institute (TUIK), it was determined that the rate of smartphone usage in Turkey is 95.3% in the 16-74 age group, with the strongest usage rate being 98% in the 18-24 age group (Tanju, 2022). Cisco Connected World Technology Report (2012) shared a study conducted on 1800 people between the ages of 18-30. In the study, it was determined that phone control was the first among the morning tasks, 97% in Turkey and 90% in the whole world. 60% of the participants from all over the world and 93% of the participants from Turkey obsessively check social networks, message boxes and e-mails via their mobile phones (Tanju 2022). University students are among the first to experience the use of smartphones. According to the increase in the frequency of use, studies to increase the awareness level of university students have a serious importance. The fact that students spend long periods of time with their phones causes deterioration in their course performance in their school life (Alakurt, & Yılmaz, 2021). Smartphones have been shown to have a negative impact on students' academic progress by interfering with their learning process (Boumosleh & Jaalouk, 2018). According to one study, smartphone addiction among university students was not associated to enjoying life, but was negatively related to academic accomplishment (Samaha & Hawi, 2016). Another study conducted with university students found that 68% of them felt disconnected when they were without a phone, 63% thought their phone was ringing even though it was not, and 66% felt lonely when their phone was not with them (Emanuel et al., 2015).

2. METHOD

2.1. Research Method

In this research, source documents were examined, and comparison type relational survey model, one of the quantitative research methods, was used (Karasar, 2012). Research data was collected using a scale from students who voluntarily participated in the research in the fall semester of the 2022-2023 academic year.

2.2. Working group

The research population consists of students from Frat University's Faculty of Sports Sciences. The sample consists of 146 students enrolled in the faculty of sports sciences in the academic year 2022-2023. A total of 146 students, 80 male students and 66 female students, participated in the research.

2.3. Data collection tool

The "Problematic mobile phone use scale" established by Kutlu and Pamuk and the "UCLA loneliness scale" developed by Russell (1996) were utilized as data collection techniques in the study. In the first portion of our study, we asked about gender, sports year, social media use, and whether or not you play mobile phone games. How frequently do you play video games? Demographic data in the form of questions is included.

In the second part of our study, "The Problematic Cell Phone Usage Scale" consists of 27 questions and 4 sub-dimensions (Deprivation, Negative results, control problem, avoidance of interaction). The “UCLA Loneliness Scale” consists of 20 questions and consists of 2 sub-dimensions (Unity and Uniqueness).

2.4. Analysis of Data

It is analyzed by applying PCPU and UCLA loneliness scales to the Faculty of Sports Sciences. Data analysis was analyzed using SPSS 22.0 statistical package program. For the normality analysis of the data, skewness and kurtosis tests and Cronbach's alpha reliability analysis were performed and the frequency (f) and percentage (%) distributions have been checked. Parametric tests were applied to the data determined to be normally distributed. In examining the PCPU and UCLA loneliness scales of the Faculty of Sports Sciences according to their sub-dimensions, independent samples t-test, which is one of the parametric tests, and ANOVA test for differences between groups and multiple comparisons were determined and interpreted. Tukey and LSD Tests were applied to understand which groups were in favor of the significant difference revealed in the one-way analysis of variance. Comments are supported by tables. In the analyses, the significance level was accepted as $p<0.05$.

3. FINDINGS

Table 1. Demographic information of the students of the faculty of sports sciences

		f	%
Gender	Male	80	54,8
	Female	66	45,2
Sports Year	0-3 years	45	30,8
	4-7 years	32	21,9
	8-11 years	39	26,7
	12 years and over	30	20,5
Social Media Usage	Yes	126	86,3
	No	20	13,7
Do you play games on your Mobile?	Yes	76	52,1
	No	70	47,9
How often do you play game?	0-4 hours	90	61,6
	5-9 hours	32	21,9
	10 hours and over	20	16,4

When Table 1 is assassed, the gender, year of sports, use of social media, status of playing games on the mobile phone and how often you play games of the students in the research group, respectively, 146 people participated and 54.8% of the participants were male, 66 of them 45.2% were female, 0-3 years 45 people, 4-7 years 32 people, 8-11 years 39 people, the number of people with 12 or more years of sports is 30, in the case of using social media no, 86% of them use the mobile phone, 86% yes, 86% of them use the mobile phone, 86% 1 of them yes, 47.9% of them I don't play, they determined that 90 people play 0-4 hours, 32 people 5-9 hours, 20 people 10 or more hours.

Table 2. Analysis of the problematic cell phone use (PCPU) sub-dimensions of the faculty of sport sciences students and the sub-dimensions of the UCLA loneliness scale by gender variable

	Gender	N	Mean	sd	t	p
Deprivation	Male	80	3,01	,96	-1,988	0,079
	Female	66	3,35	1,11		
Negative Results	Male	80	2,20	1,00	1,876	0,198
	Female	66	1,88	1,00		
Control problem	Male	80	2,71	,89	-1,384	0,049*
	Female	66	2,95	1,27		
Avoid from Interaction	Male	80	1,64	,71	,265	0,063
	Female	66	1,61	,90		
UCLA sub dimension Unity	Male	80	3,09	,89	-1,772	0,944
	Female	66	3,36	,90		
UCLA sub dimension singularity	Male	80	2,21	,72	1,293	0,094
	Female	66	2,06	,62		

p<0,05

732

When Table 2 was monitored, it was specified that there was a statistically significant difference in the control problem sub-dimension of the problematic mobile phone use scale in the gender variable of the research group ($p<0.05$). It was determined that there was no statistically significant difference in the sub-dimensions of deprivation, negative results, and avoidance of interaction with PCPU. No statistical significance was found in the sub-dimensions of the UCLA loneliness scale ($p>0.05$). As a result of the analysis, it was determined that the values of women in the control problem sub-dimension were higher than that of men.

Table 3. Analysis of the PCPU sub-dimensions of the faculty of sport sciences students and the sub-dimensions of the UCLA loneliness scale according to the social media use variable

	Social Media Usage	N	Mean	Sd	t	p
Deprivation	Yes	126	3,25	1,00	2,484	0,014*
	No	20	2,63	1,14		
Negative Results	Yes	126	2,12	1,00	2,100	0,037*
	No	20	1,62	,97		
Control Problem	Yes	126	2,92	1,07	3,029	0,003*
	No	20	2,15	,92		
Avoidance of Interaction	Yes	126	1,66	,82	1,213	0,227
	No	20	1,43	,58		
UCLA sub dimension Unity	Yes	126	3,22	,85	,099	0,921
	No	20	3,20	1,20		
UCLA sub dimension Singularity	Yes	126	2,17	,66	1,169	0,244
	No	20	1,98	,77		

When Table 3 is reviewed, it is discovered that there is a statistically significant difference in the research group's social media usage variable in the sub-dimensions of PCPU deprivation, control problem, and bad results. There was shown to be no statistically significant difference in the sub-dimension of interaction avoidance in PCPU. There was no statistically significant difference in the UCLA loneliness scale's unity and uniqueness sub-dimensions ($p>0,05$). It was discovered that those who use social media have higher averages in the sub-dimensions of deprivation, control problem, and negative results of PCPU than those who do not use social media.

Table 4. Sub-dimensions of PCPU of faculty of sport sciences students and sub-dimensions of UCLA loneliness scale. Do you have a gaming on cell phone? analysis by variable

	Do you play game on the cell phone?	N	Mean	sd	t	p
Deprivation	Yes	76	3,03	,98	1,175	0,111
	No	70	3,31	1,08		
Negative Results	Yes	76	2,18	1,02	,355	0,135
	No	70	1,92	1,00		
Control Problem	Yes	76	2,63	1,00	-1,605	0,032
	No	70	3,02	1,14		
Avoidance of Interaction	Yes	76	1,53	,80	1,502	0,149
	No	70	1,73	,78		
UCLA sub dimension Unity	Yes	76	3,30	,84	0,526	1,175
	No	70	3,12	,96		
UCLA sub dimension Singularity	Yes	76	2,16	,69	0,908	0,355
	No	70	2,12	,67		

When Table 4 was assessed, it was determined that there was no statistical significance in the PCPU sub-dimensions of the research group ($p<0.05$). In the sub-dimensions of deprivation, control problem and avoidance of interaction, it was determined that the average of the students who do not play games on their mobile phones is higher than the students who play games on their mobile phones. It was determined that there was no statistical significance in the sub-dimensions of the UCLA loneliness scale ($p>0,05$).

Table 5. ANOVA analysis of the sub-dimensions of PCPU of faculty of sports sciences students and the sub-dimensions of the UCLA loneliness scale of the sport year variance

	Sports Year	N	Mean	Std. Deviation	f	p	Difference
Deprivation	0-3	45	3,59	,92	3,920	0,010*	A-B,D
	4-7	32	2,97	1,17			
	8-11	39	3,02	1,03			
	12+	30	2,91	,91			
	Total	146	3,16	1,04			
Negative Results	0-3	45	2,20	1,13	1,688	0,172	
	4-7	32	1,72	,93			
	8-11	39	2,17	,87			
	12+	30	2,04	1,03			
	Total	146	2,05	1,01			
Control Problem	0-3	45	3,21	1,10	4,819	0,003	A-B
	4-7	32	2,30	1,01			
	8-11	39	2,87	,99			
	12+	30	2,73	1,05			
	Total	146	2,82	1,08			
Avoidance of Interaction	0-3	45	1,57	,86	2,357	0,074	
	4-7	32	1,44	,75			
	8-11	39	1,90	,79			
	12+	30	1,55	,68			
	Total	146	1,63	,80			
Unity	0-3	45	3,38	,78	1,217	0,306	
	4-7	32	3,12	,99			
	8-11	39	3,03	,81			
	12+	30	3,29	1,05			
	Total	146	3,21	,90			
Singularity	0-3	45	1,98	,54	2,240	0,086	
	4-7	32	2,29	,81			
	8-11	39	2,28	,63			
	12+	30	2,04	,73			
	Total	146	2,14	,68			

A) 0-3 B) 4-7 C) 8-11 D) 12+

When Table 5 is examined, it has been determined that there is a statistically significant difference in the PCPU deprivation and control problem sub-dimensions of the research group ($p<0.05$). It was determined that there was a difference between the variables of 4-7 and 12 years and above in the deprivation sub-dimension and the variable of 0-3 years, and a difference between 0-3 years and 4-7 years in the control problem sub-dimension. It was determined that there was no statistically significant difference in the sub-dimensions of negative results and avoidance of interaction with PCPU. It was determined that there was no statistically significant difference in the unity and uniqueness sub-dimensions of the UCLA loneliness scale. In the deprivation sub-dimension, a significant difference was observed between the students who did sports for 0-3 years and the students who did sports for 8-11 years and 12 or more years. It was determined that there was a difference between the students who had been doing sports for 0-3 years and the students who had been doing sports for 4-7 years in the control problem sub-dimension.

Table 6. ANOVA analysis of the variable of "How often do you play games" sub-dimensions of PCPU of faculty of sport sciences students and sub-dimensions of UCLA loneliness scale

How often Do You play Games		N	Mean	Std. Deviation	f	p
Deprivation	0-4	90	3,13	,99	,749	0,475
	5-9	32	3,35	1,10		
	10+	24	3,03	1,14		
	Total	146	3,16	1,04		
Negative Results	0-4	90	2,05	1,01	1,919	0,151
	5-9	32	2,29	1,10		
	10+	24	1,75	,81		
	Total	146	2,05	1,01		
Control Problem	0-4	90	2,71	1,01	2,156	0,119
	5-9	32	3,17	1,14		
	10+	24	2,75	1,19		
	Total	146	2,82	1,08		
Avoidance of Interaction	0-4	90	1,59	,77	,795	0,454
	5-9	32	1,78	,90		
	10+	24	1,55	,76		
	Total	146	1,63	,80		
Unity	0-4	90	3,30	,90	1,160	0,316
	5-9	32	3,04	,89		
	10+	24	3,11	,92		
	Total	146	3,21	,90		
Singularity	0-4	90	2,17	,70	0,425	0,654
	5-9	32	2,13	,59		
	10+	24	2,03	,69		
	Total	146	2,14	,68		

When the sub-dimensions of PCPU Deprivation, negative results, control problem, and interaction avoidance are analyzed in Table 6, there is no statistically significant difference. It was discovered that students who played games for 5-9 hours in the PCPU sub-dimensions had a higher average than students who played games for 0-4 and 10 hours or more. The UCLA loneliness scale was shown to be statistically insignificant in the unity and uniqueness sub-dimensions. In the sub-dimensions of unity and unity, students who played games for 0-4 hours performed better than students who played games for 5-9 and 1 hour or more ($p>0,05$).

4. DISCUSSION and CONCLUSION

The purpose of this study was to look at the mobile phone attachment and loneliness levels of students at the faculty of sports sciences. The study included 146 students, 80 of whom were male and 66 of whom were female. In our study, there was no statistically significant difference in the sub-dimensions of the cell phone use and loneliness scale when gender was considered. Izgar (2009) discovered no statistically significant difference in loneliness and gender characteristics among school principals in his study. Bozgeyik's (2019) study titled "Examination of the relationships between teachers' early maladaptive schemas, interpersonal relationship styles, and loneliness" found no significant relationship between the gender variable and the level of loneliness. Deursen et al. (2015) examined the relationship between smartphone addiction and many variables in their study and concluded that female adolescents have a higher probability of showing negative symptoms of smartphone addiction. Turhan and Canpolat (2023) in their study found that men's social media addiction was higher compared to women. There was found to be a substantial difference in terms of The UCLA loneliness scale sub-dimensions were found to have no statistically significant difference. In individuals who use social media, most of the smart phone users in their spare time look at their smart phones when they wake up in the morning and before going to sleep at night (Lee et al., 2014). It has been observed that being constantly connected to the internet and following the developments in social media platforms, the environment or the world reduces the feeling of emptiness and loneliness in individuals (Townsend, 2000). It has been determined that the values of people who use social media are higher. When we evaluated the variable do you play games on your mobile phone, we found that there was no statistically significant difference in the sub-dimensions of the PCPU and UCLA loneliness scales, and students who played games on their mobile phone had high values. According to Erboy's (2010) study on his pupils, computer game addiction is higher in students who do not have a personal computer. Tel (2021), in his study, determined that the playing time of the research group was high. In the study conducted by Horzum (2011) on primary school students, it was concluded that there was no statistically significant difference between having a personal computer and game addiction. It was determined that the research group had a statistically significant difference in the PCPU deprivation and control problem sub-dimensions ($p<0.05$). There was a difference in the deprivation sub-dimension between the variables 4-7 and 12 years and above, and a difference in the control problem sub-dimension between the variables 0-3 years and 4-7 years. There was no statistically significant difference in the sub-dimensions of unfavorable outcomes and avoidance of PCPU engagement. There was no statistically significant difference in the UCLA loneliness scale's unity and uniqueness sub-dimensions. In their study, Hazar et al. (2017) concluded that the digital gaming addiction of secondary school pupils who do not frequently participate in sports is much higher than that of those who do. They stated that the increase in the tendency to use technological game tools and therefore the avoidance of games that require physical activity may be the reason for this result. Tel and Erdoğan (2015) determined in their study that the participants use the internet and developing technology at a high rate. It was determined that there was no statistically significant difference in the sub-dimensions of PCPU Deprivation, negative results, control problem and interaction avoidance of the research group. It was discovered that students who played games for 5-9 hours in the PCPU sub-dimensions had a higher average than students who played games for 0-4 and 10 hours or more. The UCLA loneliness scale was shown to be statistically insignificant in the unity and uniqueness sub-dimensions. In the sub-dimensions of unity and unity, students who played games for 0-4 hours performed better than students who played games for 5-9 and 1 hour or more. According to the "WeAreSocial and Hootsuite 2020 Report", 92% of our country's population (77 million) is a smartphone user. Tanju (2022) estimates that smartphone usage time is approximately 4 hours.

As a result, in our study, it was determined that students generally spend most of the day on the phone and play games when they are alone, while the PCPU scores of female students are higher than that of men, and women's values are low in the UCLA loneliness scale.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Fırat University with the decision dated 10/08/2023 and numbered 358565.

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Conceptualization, literature review, methodology, implementation, data analysis, translation, and writing.

Abstract

This study aims to examine the effects of activities prepared using the Actionbound application on students' academic achievement and mathematical attitude in the field measurement subject in the 6th-grade mathematics course. The study was designed using a quasi-experimental design with a control group from quantitative research methods. The study group of research consists of students studying in two different 6th grades of a secondary school in the central district of Elazığ province in the school year 2022-2023. The achievement averages of the branches in the previous semester were used in forming the experimental and control groups and in ensuring the equivalence of the branches. The research, which was conducted in parallel with the MoNE curriculum, was applied simultaneously to the experimental and control groups. The research, which used parametric testing procedures due to the normal distribution of the data, was analyzed using the SPSS package program. The results show that the digital learning game developed using Actionbound improves performance and attitude, but does not cause a significant difference between the groups. It is recommended to extend the application period of the study and continue the study for one semester.

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Research Article

The Effect of Actionbound Application on Academic Success and Attitude on 6th Grade Field Measurement *

Ebru KORKMAZ [1]

Abstract

This study aims to examine the effects of activities prepared using the Actionbound application on students' academic achievement and mathematical attitude in the field measurement subject in the 6th-grade mathematics course. The study was designed using a quasi-experimental design with a control group from quantitative research methods. The study group of research consists of students studying in two different 6th grades of a secondary school in the central district of Elazığ province in the school year 2022-2023. The achievement averages of the branches in the previous semester were used in forming the experimental and control groups and in ensuring the equivalence of the branches. The research, which was conducted in parallel with the MoNE curriculum, was applied simultaneously to the experimental and control groups. The research, which used parametric testing procedures due to the normal distribution of the data, was analyzed using the SPSS package program. The results show that the digital learning game developed using Actionbound improves performance and attitude, but does not cause a significant difference between the groups. It is recommended to extend the application period of the study and continue the study for one semester.

Keywords: Actionbound, educational digital game, attitude, academic achievement, field measurement

1. INTRODUCTION

Games, which have entered our lives since childhood, are expressed as an act of creativity that enables to achieve a solution within some unique and certain rules (Aytaş & Uysal, 2017). Thanks to games, which are among the most important tools that enable people to communicate with their environment, they can reflect their inner world to the outside world (Aldemir-Engin, 2023). Many emotionally experienced emotions are revealed with the help of games. It can be said that they also allow drawing conclusions about people's priorities or how to get rid of the difficulties they face in real situations.

With rapidly developing and advancing technology, digitalization has become a necessity in all fields. Education, which has a dynamic structure and an interdisciplinary character, has been and continues to be significantly affected by current developments. However, the trend of digitalization in education is increasing day by day, and there are many changes and developments in this direction. To keep up with the digitization initiative in education, students and parents are forced to turn to digital tools to continue their education (Livari, Sharma & Ventä-Olkkonen, 2020).

Digital games are games that can be played by one or more players in digital environments using various technical devices (Aslan, Turgut, & Karakuş-Yılmaz, 2019; Özer, 2020). Digital games are divided into PC games, console games, massive online games, mobile games, and social games. Mobile games in this class include games designed for portable mobile devices such as tablets or phones (Ilgaz-Büyükbaykal & Abay-Cansabuncu, 2020). Educational games, on the other hand, are

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games that aim to educate while providing fun for the person and offering fun and seriousness together (Anastasiadis, Lampropoulos & Siakas, 2018; Aslan et al., 2019). In this direction, we can say that digital learning games are games developed with the help of technology and based on both education and entertainment. Conventional resources, especially textbooks, used in education and training are not sufficient for teaching (Prensky, 2008). Thanks to the constantly evolving technological innovations, educational and training processes are also affected. It is well known that digital games have great importance in the development of mathematics education (Giannakos, 2013). Digital educational games represent an important part of the educational process. Educational computer games, which reflect the entertaining and motivational nature of computer games, are among the teaching materials used for educational purposes (Çankaya & Karamete, 2008). Moreover Fadda, Pellegrini, Vivanet and Zandonella-Callegher, (2022) stated that digital games are more effective tools compared to traditional teaching methods. Thanks to teaching tools called digital learning games, individual learning processes are facilitated, motivation (Aşıksoy, 2018), critical thinking (Hwang & Chen, 2017), and cognitive development (Issa, 2007) are positively influenced. Therefore, it can be said that it is effective in developing a positive attitude towards mathematics (Divjak & Tomić, 2011), gaining self-confidence in mathematics, increasing motivation to learn mathematics (Divjak & Tomić, 2011), promote the enjoyment of mathematics (Uğurel, 2003), and increase interest in the lessons (Tsai, Yu & Hsiao, 2012). Digital educational games, which can be designed differently for almost any level of learning, can be designed according to the purpose and duration of the topic to be taught or played individually or in groups. Digital games designed for educational purposes can be used to create opportunities to interact with individuals with different learning styles and behaviors. In addition, both individual and group instruction can be provided in all formal and informal learning environments (Turner, Johnston, Kebritchi, Evans & Heflich, 2018).

There are many educational digital games used today. One of them is Actionbound. Actionbound is an educational tool that can provide feedback based on digital multimedia content (images, audio, video, etc.) and it can be used to create instant exams. Developed in 2012 in Berlin for educational purposes, this educational tool offers possibilities such as designing tools and providing interactive educational programmes. It can also be used without an internet connection in external or internal areas. Students can become independent while playing the game. Students and teachers participating in this application, which requires simple technical skills to use, can access the game results at any time (Rosdiana, Busono & Yosita, 2020). Actionbound, which has several games, creates a digital space that can be played both individually and as a team with GPS locations, directions, maps, compass, pictures, tasks, videos, and multiple choice or true-false options (Kissi & Dreesmann, 2017). It is similar to a digital orientation application. With Actionbound, it is also possible to organize educational competitions at historical and archeological sites, large cities, and schools. The main achievements of this program, which has been implemented in a limited number in Turkey, include creating group awareness, contributing to teamwork, learning together, discovering together, and competing in cooperation toward the same goal.

Actionbound takes students into an exploration adventure. The tasks assigned by the teacher in an interactive manner are designed to be performed individually or as a group and are very entertaining and play-based educational practices. The logic of the practice is based on the correct and timely completion by the students of the tasks given by the teacher.

1.1. Aim of Study

The aim of this study is to examine the effect of the area measurement subject taught with the effects of educational digital games on academic achievement and attitudes towards the mathematics of 6th-grade students in a mathematics course. The research aims to associate the subject of area measurement with daily life and to make the lesson enjoyable for students.

The problem statement of the study was determined as "Does teaching with the help of educational digital games affect academic achievement and attitude in 6th-grade students?". In line with this main purpose, answers to the following questions were sought:

1. Is there a statistically significant difference between the pretest achievement scores of the experimental and control group students?
2. Is there a statistically significant difference between the pre-test and post-test achievement scores of the experimental group students?
3. Is there a statistically significant difference between the pre-test and post-test achievement scores of the control group?
4. Is there a significant difference between the post-test achievement scores of the experimental and control group students?
5. Is there a statistically significant difference between the pre-attitude scores of the experimental and control group students?
6. Is there a statistically significant difference between the pre-and post-attitudes of the experimental group?
7. Is there a statistically significant difference between the pre-and post-attitudes of the control group?
8. Is there a statistically significant difference between the final attitude scores of the experimental and control group students?

1.2. Importance of Research

With the development of technology, the education and training process has been affected by different fields and the use of technology has become widespread in this process. There are different approaches and ideas about the integration of technology into educational environments. Considering the research, the digital game sector, which is growing day by day, draws attention. In this direction, it can be said that the idea of using digital games for educational purposes is important as a result of the decrease in the age of playing digital games, the time allocated to digital games, and the player audience.

Existing studies in the literature that educational games increase mathematics achievement have led to the curiosity of examining their effects on achievement in mathematics teaching. Considering the benefits of educational digital games, it is thought that the studies to be conducted in this field can be guiding for those working in the field of mathematics, teachers, and students in terms of taking measures to increase achievement and providing the opportunity to try new approaches in educational environments. In addition, it is seen that there are few studies on educational digital games and mathematics teaching at the 6th-grade level in the literature. In this direction, it is thought that the study will contribute to the field

2. METHOD

In this study, in which the effect of the course supported by the educational digital game prepared with the help of Actionbound on academic achievement and attitude was examined, and a quasi-experimental design with a control group, one of the quantitative research methods, was used. In the quasi-experimental design, which is used in cases where real experimental models cannot be realized, the amount of change and difference between two different groups can be measured with this method (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2013).

2.1. Working Group

The research was conducted at Mezre Secondary School in the center of Elazığ province after obtaining the necessary permissions. A total of 46 students from two different 6th-grade classes studying in the spring term of the 2022-2023 academic year were included in the study group. The school where the study will be implemented and the students selected as the sample were determined by convenience sampling method in terms of the accessibility of the sample and the ease of implementation. Convenient sampling is the method of selecting the sample from accessible, easily applicable units due to the limitations in terms of time, money, and labor force (Büyüköztürk et al., 2013). The equivalence of the groups in this study, in which the quasi-experimental design with an experimental control group was used, was determined by taking into account the students' grade point averages in the previous semester (Experimental Group=74.1; Control Group=73.8). In addition, the equivalence of the groups was also confirmed by the field measurement achievement test (pre-test). There were 25 students in the experimental group and 21 students in the control group.

2.2. Data Collection Tool

The data collection tools of the study are the “Area Measurement Achievement Test” prepared by the researcher and the “Mathematics Attitude Scale” developed by Gülburnu and Yıldırım (2015) for primary and secondary school students. The “Field Measurement Achievement Test” was prepared by the researcher by taking the test questions of the “Field Measurement” subject in the MoNE book. In order to ensure the content validity of the achievement test questions, the validity and reliability of which were carried out by the Ministry of National Education, the opinions of 3 expert mathematics teachers were consulted. The Field Measurement Achievement Test consisting of a total of 30 questions was applied to the classes as a pre-test and post-test before and after the application during 1 lesson hour. Grade 6 “Area Measurement” sub-learning area (after repeating the units, terms, and concepts of area and length measurement) has a total of 5 learning outcomes. These are;

1. Forms the area relation of the triangle, and solves related problems.
2. Forms the area relation of the parallelogram, and solves related problems.
3. Recognises the units of area measurement, and converts m^2-km^2, m^2-cm^2-mm^2 units to each other.
4. Recognises land surveying units and associates them with standard land surveying units.
5. Solves problems related to the field (MoNE, 2018).

In addition, in order to measure the students' attitudes towards the course, the Mathematics Attitude Scale was applied to the classes as pre-attitude and post-attitude for 1 class hour before and after the application. The Matehematics attitude scale consists of 27 items. It has a five-point Likert type. The item factor loadings of this scale are between 0.44-0.75. The Kaiser-Meyer Olkin (KMO) value was .89, and the internal consistency coefficient (Cronbach alpha) value calculated for the reliability study was found to be α=.88. Findings regarding validity and reliability studies show that the scale has a valid and reliable structure.

2.3. Implementation Process

In this study, an educational digital game was developed by the researcher with the help of Actionbound software in order to enrich the content of the mathematics course and to positively affect students’ interest in mathematics. This game includes objectives such as connecting with what is already known, drawing conclusions, self-evaluation, data collection, and connecting with real life. In addition, information was obtained from the secondary school mathematics teacher about the student's prior knowledge and readiness levels. In this direction, an educational digital game activity was prepared by adhering to the achievements of the field measurement. Finally, the learning environment for the experimental group students was determined according to the activity to be implemented.

Before the research, a pre-achievement test and a pre-attitude test were applied to the groups in order to determine whether there was a statistically significant difference between the groups in terms of academic achievement and attitudes towards mathematics courses. The experimental group students were told that the lesson would be taught in the garden. The 25 students in the experimental group were divided into groups of 5. Each group was provided with a smartphone. The actionbound application was installed on these phones and information about the application was given. It was explained that the students needed to find the correct answer in order to complete the tasks. The digital educational game activity named "Treasure Hunt" was started by reading the QR code of the bond prepared by the researcher. The students tried to reach the treasure by fulfilling the tasks given to them in order.

The steps of the “Treasure Hunt” activity prepared with the help of Actionbound are given below.

1. Find the area of the handrails on the sides of the school staircase in the form of parallel sides.
2. Write lyrics about the field.
3. Sing the lyrics you wrote under the video recording.
4. Go to the flagpole in the garden.
5. Imagine that you cut the square plate under the flagpole in half diagonally.
6. Calculate the area of one of the triangles.
7. Find and read the QR code hidden in the school garden.
8. Determine the furthest distance jumped after a jumping tournament.
9. Convert this distance to decimetres.
10. Finally, find the treasure.

A race against time was organized between previously formed student groups in the school building and garden. Students were encouraged to use basic measuring instruments in order to realize the conceptual learning of the acquisitions related to area measurement. It was aimed for students to learn actively by doing-living, game-based active learning.

The implementation phase of the research took place in two lesson hours in both groups. In the first lesson, the subject of measurement was explained to the experimental group by showing it through concrete materials. In the second lesson hour, the students were taken to the school garden to experience what they had learned. The control group students were taught the subject theoretically in their own classrooms, as they always did, with a smart board, slides, and some examples. In addition, it was noted that there was no variable that would affect the measured features positively or negatively. After the application, the effect of the independent variable (teaching method) on the dependent variable (academic achievement and attitude) was measured.

The presence of the researcher during the research process or the thought that the individual is being observed causes some changes in their behavior. The situation that affects the results of the study and creates expectations at the end of the study is called the Hawthorne effect. In addition, the application of experimental and control groups by different practitioners creates the John Henry effect. This effect is the subconscious feeling of competition of the classroom teacher who carries out the practices in the Control group (CG) against the experiment group (EG), and this situation manifests itself as an increase in performance (Kocakaya, 2012). In order to prevent all these effects, EG and CG's lessons were taught by their current teachers. Additionally, students in the CG were not informed that they would be involved in an experimental study and would be compared with a EG. Thus, precautions were taken against the John Henry effect that may occur on CG students.

2.4. Data Analyses

The data collected with the "Attitude Scale" and "Field Measurement Achievement Test" were analyzed with the SPSS package program. Skewness and Kurtosis values of the data obtained in the study were analyzed. In this direction, test techniques were determined. When Kurtosis and Skewness values are between -1.5 and +1.5, the normal distribution is accepted (Tabachnick & Fidell, 2013)

Table 1. Normality analysis of the data of the experimental group

Experiment Group	Pre-Test Success	Post-Test Success	Pre-Attitude	Post-Attitude
Skewness	.549	-.529	-.248	.254
Kurtosis	-.242	-.193	1.089	-.285

Table 2. Normality analysis of the data of the control group

Control Group	Pre-Test Success	Post-Test Success	Pre-Attitude	Post-Attitude
Skewness	-.112	-.053	-.255	-.152
Kurtosis	-.883	-.419	-.233	-.650

When Table 1 and Table 2 are examined, it can be said that the analyses to be made for the experimental and control groups should be selected from parametric test techniques.

3. FINDINGS

In this study, a statistically significant difference between the academic achievement and attitude towards mathematics levels between the groups before and after the application was investigated. The findings obtained from the data analyses are given below.

3.1. Findings Related to Field Measurement Achievement Test

Independent groups t-test was applied to determine whether there was a statistically significant difference between the test scores of the groups (EG - experiment group and CG – control group) before and after the application.

Table 3. Independent groups t-test of experimental and control groups (pre-test)

Groups	N	$\overline{X}$	S	sd	t	p
EG	25	6.88	2.65	44	-.608	.546
CG	21	7.33	2.35			

$p > .05$

In the independent groups t-test analysis, no statistically significant difference was found between the mathematics achievement of the two groups ($p = .546 > 0.05$). According to this analysis result, it is possible to say that the groups were equal to each other before the application. At the end of the application, the Independent Groups t-test was applied to determine whether there was a statistically significant difference between the post-test scores of the groups. The results obtained are given in Table 4.

Table 4. Post-test Independent groups t-test of experimental and control groups

Groups	N	$\overline{X}$	S	sd	t	p
EG	25	10.04	3.39	44	1.150	.256
CG	21	8.85	3.56			

$p > .05$

As a result of the independent groups t test analysis, $p = .256 > 0.05$ was found. Therefore, it is possible to say that there was no statistically significant difference between the groups in terms of academic achievement after the research. As seen in Table 4, academic achievement is in favour of the experimental group (X=10.04). Although the academic achievement of the experimental group was higher than that of the control group, there was no statistically significant difference between the post-test scores of the groups.

Dependent groups t test was performed to see whether the change in the pretest and posttest scores of EG and CG created a statistically significant difference. The results obtained are given in Table 5.

Table 5. Dependent groups t test results for the pretest-posttest achievement scores of the groups

Groups	Measurement	N	$\bar{X}$	S	sd	t	p
EG	Pre-test	25	6.88	2.65	24	12.97	.000
	Post-test	25	10.04	3.39			
CG	Pre-test	21	7.33	2.35	20	14.286	.000
	Post-test	21	8.85	3.56			

$p < .05$

According to the results of the dependent groups t-test analysis, there was a statistically significant difference between the pre-test and post-test achievement scores of the experimental group students whose pre-test mean score was ($X = 6.88$) and the post-test mean score was ($X = 10.04$) ($p = 0.000 < 0.01$).

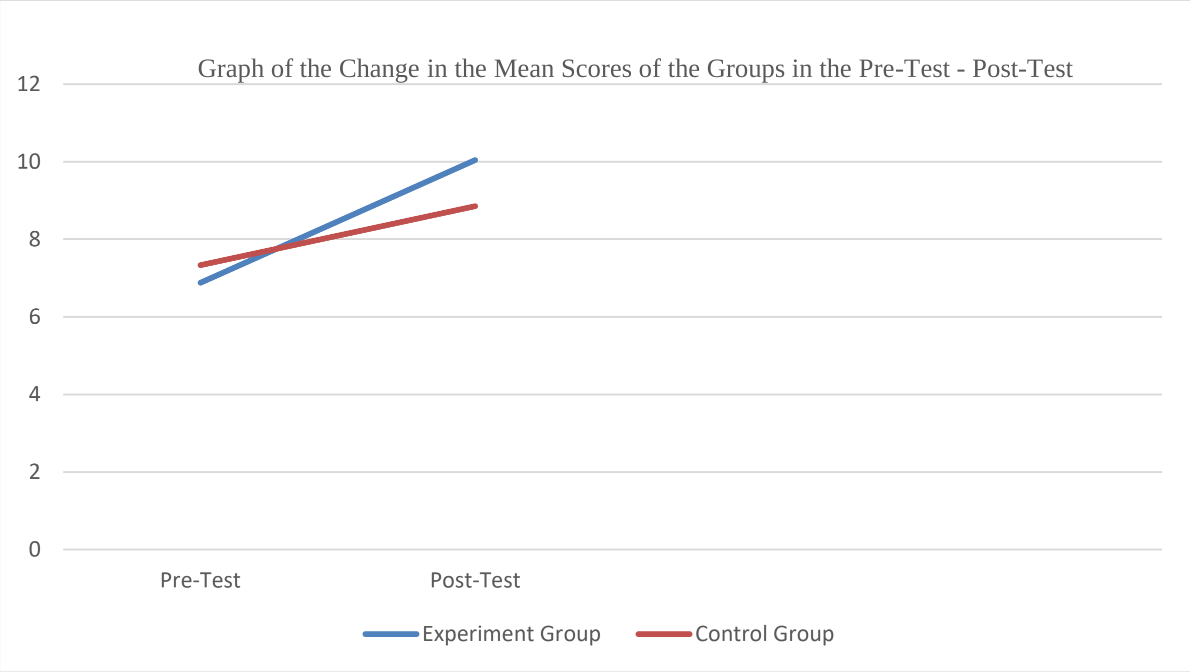

Figure 1. Graph of the change in the mean scores of the groups in the pre-test – post-test

This shows that the educational digital game used had a statistically significant effect on student achievement in favour of the post-test. In addition, the achievement test was applied to the control group, in which the lessons were taught with the traditional teaching method, before and after the research. the average score on the exam before the application was ($X = 7.33$); the average score on the exam after the application was ($X = 8.85$). When Table 5 was examined, a statistically significant difference was found in favour of the post-test in the control group ($p = 0.00 < 0.01$).

3.2. Findings on Attitudes towards Mathematics

Independent Groups t-test was applied to determine whether there was a statistically significant difference between the test scores of the groups before and after the application.

Table 6. Pre-attitude Independent groups t-test of experimental and control groups

Groups	N	X̄	S	sd	t	p
EG	25	77.24	11.05	44	.015	.988
CG	21	77.19	11.90			

p > .05

In the independent groups t-test, p = .988 > 0.05 was found. This shows that there was no statistically significant difference between the experimental and control groups before the application. Therefore, it is possible to say that the attitude levels of the experimental and control groups in the mathematics course before the research were equal.

Table 7. Post-attitude Independent groups t-test of experimental and control groups

Groups	N	X̄	S	sd	t	p
EG	25	77.64	8.64	44	-.008	.993
CG	21	77.66	13			

p > .05

In the independent groups t-test, p = .993 > 0.05 was found. This shows that there is no statistically significant difference between the attitude scores of the experimental and control groups after the application. Therefore, it is possible to say that the attitude levels of the groups were the same after the application. Dependent groups t-test was performed to see whether the change in the pre-attitude and post-attitude scores of EG and CG created a statistically significant difference. The results obtained are given in Table 8.

Table 8. Dependent groups t-test results for the pre-attitude-post-attitude achievement scores of the groups

Groups	Measurement	N	X̄	S	sd	t	p
EG	Pre-test	25	77.24	11.05	24	34.92	.000
	Post-test	25	77.64	8.64			
CG	Pre-test	21	77.19	11.90	20	29.72	.000
	Post-test	21	77.66	13			

p < .05 745

In the dependent groups t test analysis, the mean attitude score before the application was (X=77.24) and the mean attitude score after the application was (X=77.64). It is also seen that p = .000 < 0.01.

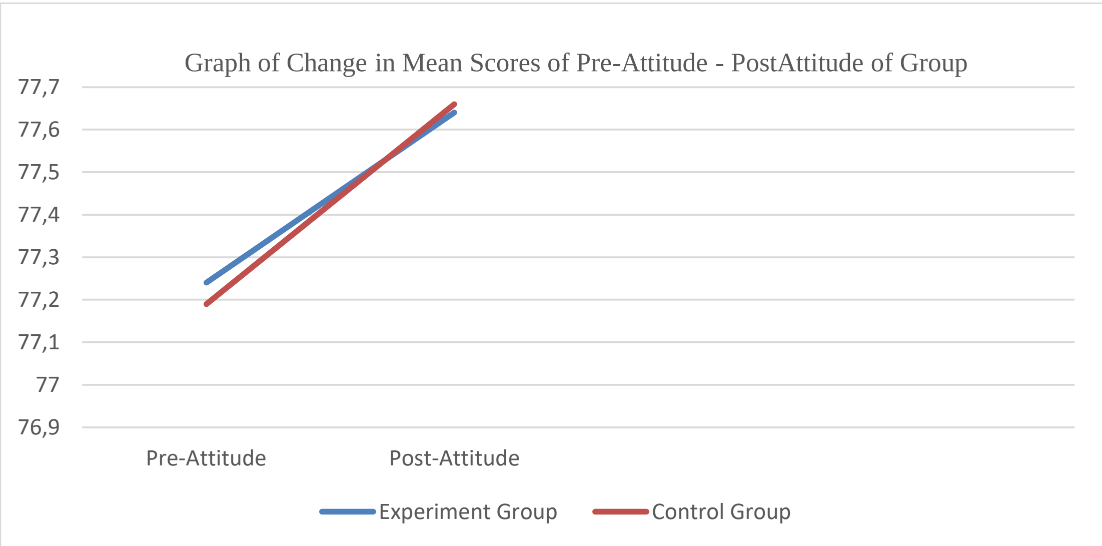

Figure 2. Graph of change in mean scores of pre-attitude - post-attitude of groups

In this case, it is possible to say that a statistically significant difference occurred in the attitude level in the experimental group after the application. In addition, an attitude test was applied to the control group, in which the lessons were taught with the traditional teaching method, before and after the research. In the dependent groups t-test analysis, there is a statistically significant difference between the mean attitude score (X=77.19) before the application and the mean attitude score (X=77.66) after the application ($p = .000 < 0.01$). The results of this analysis show that the subject covered was liked by the students and improved their attitudes towards the course.

4. DISCUSSION and CONCLUSION

Considering the results obtained, it was found that the experimental and control groups were equivalent in terms of performance. Statistically significant differences were found between the pretest-posttest results of the experimental group and the pretest-posttest results of the control group in terms of academic performance. In this case, it can be said that the instruction in the experimental and control groups significantly increased academic achievement. In other words, both the course supported by digital learning games and the course taught with traditional teaching methods were effective for students. However, it can be seen that there is no statistically significant difference between the performance levels of the experimental and control groups after the test. This means that the performance level of the students is the same again after teaching in both branches. Therefore, it can be said that there is no superiority between different teaching methods applied in different branches. The statistically significant difference between the pre-test and post-test in the experimental group in favor of the post-test supports that educational digital games increase achievement. However, the non-significant difference between the post-test achievement scores between the branches shows that the teaching method actually applied is equivalent to the traditional teaching method. In parallel with this result, Aslan Akın and Atıcı (2015); Şahin (2016) did not find a statistical difference between the groups in terms of academic achievement. In addition, Yıldız-Durak (2019) found in his study that educational digital games are not suitable for the exam system, not every subject can be taught with this method, the preparation process is long, and technical support needs, technological literacy competence (Kara, 2021), workload increase, problems that may be experienced in practice, and the perspective of the school administration. In addition, Avcu (2023) mentioned the contributions of educational digital games to the student and the teaching process, the limitations of digital games, and some issues that need to be considered. The limitations include classroom dominance, lack of technological knowledge, and access impossibilities. Jensen and Skott (2022), on the other hand, mentioned that digital games are not suitable for the course content and that a meaningful relationship cannot be established between all subjects. Similarly, Joung and Byun (2021) pointed out that digital games cannot be useful for the mathematics performance of all students at kindergarten, primary, middle, and high school levels, and that for a game to be effective, its content should be created by the course teacher and should be parallel to the course outcomes.

On the other hand, we can say that educational digital games are effective in increasing student achievement (Aksoy, 2014; Şahin, 2016; Yavuzkan, 2019) or a useful method in developing positive emotions (Aslan-Akın & Atıcı, 2015; Avcu, 2023; Kara, 2021; Meşe & Meşe, 2022; Yıldız-Durak, 2019). Similarly, the studies of Ağırgöl, Kara & Dönel-Akgül, (2022) with Yıldız and Zengin (2021) were encountered. In the study conducted for science courses, it was determined that educational digital games increased success. In addition, Günbaş and Öztürk (2022) examined the digital mathematics games in EBA content according to Bloom's taxonomy and mentioned that students can gain positive emotions such as group learning, struggle, and solving real-life problems from game mechanics. In studying the mathematical setting in accordance with the results, the analyses show that the experimental and control groups were equal to each other before the application. We can conclude that the groups are also equal after the application. This fact shows that the different teaching methods did not cause any change in the students. Parallel to the literature review, it is found that digital learning games cannot change the attitude (Ağırgöl et al., 2022; Çankaya & Karamete, 2008; Şahin, 2016; Yavuzkan, 2019). The inability of digital learning games to change student attitudes may be based on short-term research. Changing a person's attitude is a phenomenon that can change over a very long process. Therefore, it is unlikely that a few hours of application can change people's attitudes (Yavuzkan, 2019). On the other hand, Aksoy (2014) found that digital educational games caused a statistically significant difference in favor of the experimental group in terms of attitude.

This study includes teaching the 6th-grade field measurement subject with an educational digital game prepared with the help of the Actionbound application. It is thought that the fact that the study was limited to only one subject and the application process was limited to only 2 lesson hours prevented the increase in attitude and achievement levels. In this direction, it is recommended to use educational digital games in different subjects and class levels. In addition, it is also recommended that the teaching method applied should be spread over a longer period of time.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Research Ethics Committee of Fırat University with the decision dated 14/06/2023 and numbered 2023/12.

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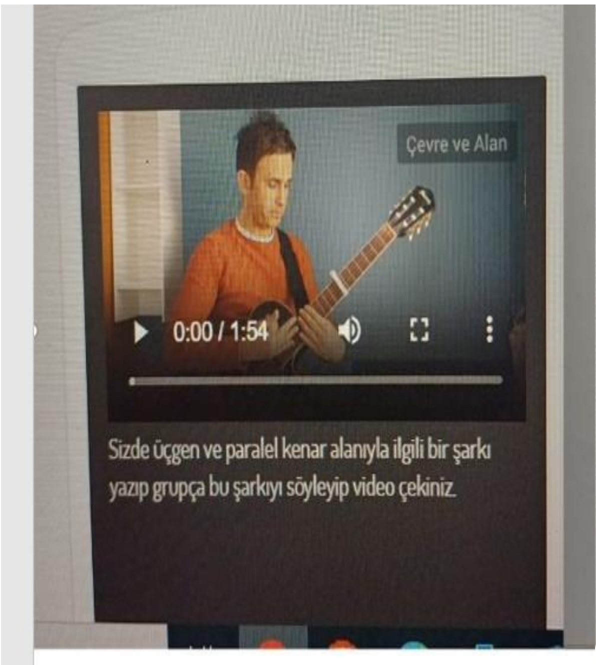
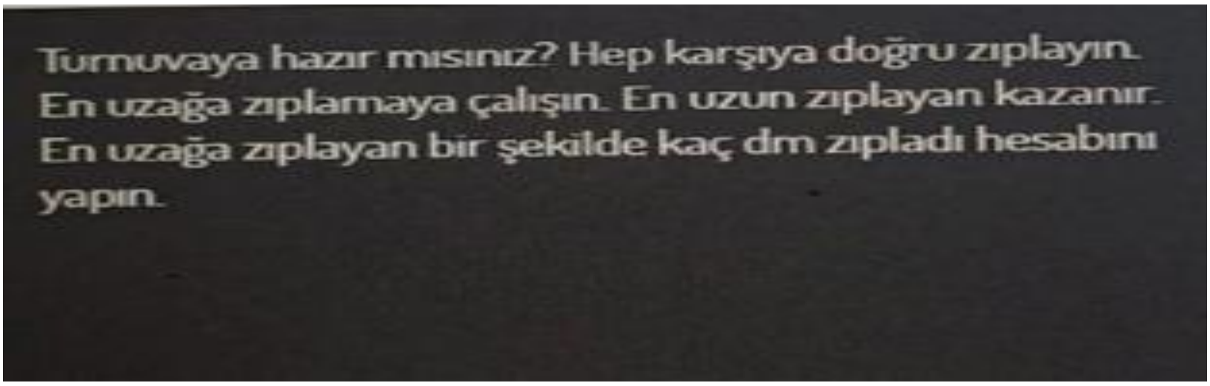
Appendix
Pictures from the Implementation Process





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Abstract

In this study, it was aimed to present the pre-service elementary mathematics teachers' (PEMT) evaluations of meetings with expert and peer participation based on van Hiele geometric thinking levels (vHGTL). The case study method was used and the study group of the research consists of three PEMT who are studying in the third year of a state university. Data were collected with meeting records, reflection reports of the PEMTs, researcher's field notes and interviews and were analyzed simultaneously by two researchers to ensure coding reliability with content analysis method. As a result of the research, it was seen that there was a positive change in PEMTs' criteria for determining vHGTL. It was determined that they had difficulties in clearly distinguishing the differences between the levels at the beginning, and that in the last meetings, they insisted on the criteria related to the levels they determined and made more accurate determinations about the levels. As a matter of fact, the teacher candidates also stated that meetings enabled them to determine the achievements', solved and unsolved problems' vHGTL better. In addition, they stated that allowing them to freely express their ideas in meetings contributed to their professional development in geometry teaching knowledge. Suggestions regarding experts and peers participatory meetings were presented.

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Research Article

Pre-Service Elementary Mathematics Teachers' Evaluations of Meetings with Expert and Peer Participation Based on van Hiele Geometric Thinking Levels*

Duygu ARABACI [1] **Oben KANBOLAT** [2]

Abstract

In this study, it was aimed to present the pre-service elementary mathematics teachers' (PEMT) evaluations of meetings with expert and peer participation based on van Hiele geometric thinking levels (vHGTL). The case study method was used and the study group of the research consists of three PEMT who are studying in the third year of a state university. Data were collected with meeting records, reflection reports of the PEMTs, researcher's field notes and interviews and were analyzed simultaneously by two researchers to ensure coding reliability with content analysis method. As a result of the research, it was seen that there was a positive change in PEMTs' criteria for determining vHGTL. It was determined that they had difficulties in clearly distinguishing the differences between the levels at the beginning, and that in the last meetings, they insisted on the criteria related to the levels they determined and made more accurate determinations about the levels. As a matter of fact, the teacher candidates also stated that meetings enabled them to determine the achievements', solved and unsolved problems' vHGTL better. In addition, they stated that allowing them to freely express their ideas in meetings contributed to their professional development in geometry teaching knowledge. Suggestions regarding experts and peers participatory meetings were presented.

Keywords: : Preservice elementary mathematics teachers, van Hiele theory, meetings, expert, peer

1. INTRODUCTION

The rapid and versatile development of society, science and technology has led to the changes in the individual's needs, interests, sources of motivation, values and characteristics. In this regard, it is crucial for teachers, who are responsible for raising individuals, to keep up with this rapid change and to design and implement learning environments. Indeed, this is inherent in the teaching profession, which is dynamic and open to life-long change and development. Taking the first step into the profession with undergraduate education, teachers have been in an attempt to maintain their professional development through activities such as in-service seminars, courses, projects or collaborative professional practices they have attended since they started to work (Özgenel, 2019). Researchers pointed out that promoting the collaborative work of the pre-service teachers/teachers is regarded as a significant component for professional development practices (Guskey, 2007). The primary objective of these practices is to ensure and durability between pre-service teachers/teachers. Working in cooperative groups has become a tradition of the teaching profession in some countries

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(e.g. Japan) (Lewis, 2002). In our country, pre-service teachers or teachers are involved in collaborative work either through undergraduate courses or projects with the participation of peers or colleagues along with experts such as administrators, families or academicians (Kanbolat, 2015; Watanable, 2005). It is most probable to provide pre-service teachers/teachers with their professional knowledge, skills, attitudes and values thanks to the groups created for professional development in which different knowledge and experiences related to learning and teaching are shared. Because participants and experts have the opportunity to examine and discuss the subject they are working on and teaching of the subject in such environments (Kanbolat, 2015; Kriewaldt, 2012). Cooperation with experts, peers or colleagues is also paramount in these environments (Kanbolat, 2015). The reason for engaging experts in collaborative working teacher groups may be due to either benefiting from in-depth theoretical knowledge, resources or materials related to the subject or providing collaborative work between group members (Kanbolat & Arslan, 2022).

Collaborative teacher practices focused on learning and teaching mathematics in particular maintain the exchange and development of pre-service teachers'/teachers' knowledge of mathematics instruction (Kanbolat, 2015). Teachers are considered as the designers and implementers of mathematics learning environments; moreover, their knowledge of teaching mathematics and how effectively and competently they use this knowledge are fundamental in the teaching and learning process of mathematics (Baki, 2012). Because the knowledge and learning experiences of the teachers, who are one of the most significant components of the learning environment, are reflected in the classroom environments. The components of mathematics instruction knowledge were defined in different ways by various researchers (Ball et al., 2008; Shulman, 1986). Knowledge of teaching mathematics was firstly explained by Shulman (1986) with the components of subject matter content knowledge, pedagogical content knowledge and curriculum knowledge. Afterwards, the researchers added many variables related to the learning process such as knowledge of student recognition, knowledge of teaching methods and strategies, context knowledge, measurement and evaluation knowledge (Baki, 2012). As regards the teacher competencies published by the General Directorate of Teacher Training and Development (GDTTD) under the Ministry of National Education (MoNE) in Turkey, a mathematics teacher's knowledge of teaching mathematics can be classified as mathematics content knowledge, skills, attitudes and values (GDTTD, 2017). Knowledge of mathematics teaching may refer to information about learning and teaching, or it can be classified under categories such as Number Teaching Knowledge, Geometry Teaching Knowledge, and Data Teaching Knowledge according to learning domains (Aydın, 2018). Especially since the beginning of the 20th century, many studies have been conducted to enrich the learning and teaching processes of geometry (Atasoy, 2019). Therefore, teachers equipped with the knowledge of teaching geometry need to possess a comprehensive and deep knowledge of geometry and be receptive about the relationship between geometry subjects and concepts (Altaylı et al., 2014). Teachers' mastery about the conceptual knowledge on geometry is vital for overcoming the problems faced by the students in the classroom (Gürbüz & Durmuş, 2009). Mathematics teachers' ability to design and implement ideal geometry learning environments in which they reflect their current knowledge is as significant as their content knowledge about geometry (Toluk et al., 2002). Hence, a course called teaching geometry and measurement was incorporated in the primary school mathematics teaching undergraduate curriculum, which was implemented in Turkey as of the 2018-2019 academic year. Pre-service teachers are familiar with the concepts and theories that are important in teaching geometry within the scope of this course, and that they are expected to perform tasks by considering these concepts and theories. The van Hiele Theory is considered as one of the most significant theories available in this course.

The van Hiele theory was developed in 1957 by two mathematics educators, Pier M. van Hiele and his wife Dina Van Hiele-Gelfod during their Ph.D. studies in Ultrehct University (Crowley, 1987; Güven, 2006), to explain why some students have difficulties with higher-order cognitive processes, especially in proof, required for success in geometry (Usiskin, 1982). This theory involves five geometric thinking levels, which indicates that geometric thinking goes through certain stages in a hierarchical manner. In that theory, each level indicates how individuals think about these geometric concepts and these different types of thought processes (Atasoy, 2019, p. 162). Table 1 depicts the names and descriptions of these levels.

Table 1. Names and descriptions of van Hiele geometric thinking levels

Levels	Characteristics	Example
Level 1 (Visualisation)	The student is interested only in the image of the given figure so s/he can learn the names of figures and recognizes the shape as a whole, but cannot recognize the geometric features of the shape. The students can also identify, name and compare the figures only in terms of their appearance.	Squares and rectangles seem different.
Level 2 (Analysis)	The student can identify the features of geometric figures. However, the student cannot associate its features with each other since s/he perceives the features of a geometric shape independently of each other. On the other hand, students can discover the features and rules of a figure by making use of activities such as folding and measuring, and can prove these via experimental methods.	Rectangles have four right angles. The student can list the properties of square and rectangle separately. But (s)he cannot say that every square is also a rectangle.
Level 3 (Informal deduction)	Students at this level can enumerate geometric figures and see the relationships between features of these, but use informal reasoning to establish these relationships. Namely, they can follow a proof, but cannot make their own proofs.	Every square is also a rectangle.
Level 4 (Deduction)	The student understands the importance of definitions, inferences, postulates and theorems in proof and can use them in geometric proofs and determines the necessary and sufficient conditions for a class of shapes. The student can prove other theorems deductively by making use of the already proven theorems and axioms.	The student can prove that the sum of the measures of the interior angles of a triangle is 180^0 through using the postulate of parallelism.
Level 5 (Rigor)	The student at this level can use the axioms, theorems, definitions of Euclidean geometry in non-Euclidean geometries and comprehend the relationships and differences between different axiomatic systems.	The student can work on non-Euclidean geometries.

**Table 1 was developed under favor of Atasoy (2019), Güven (2008) and Usiskin (1982).*

The van Hiele theory offers that students who have trouble are being taught at a higher van Hiele level than they are at or ready for (Usiskin, 1982). The theory offers a remedy for identifying the geometry thinking levels of the students in terms of planning the teaching and helping the students to reach a higher level. Baki (2008) noted that the van Hiele theory holds two different proposals: determining the students' geometric thinking levels, planning the lessons according to the students' levels, and developing geometric thinking through concrete objects. Pre-service teachers need a strong understanding of content knowledge in geometry, awareness of students' misconceptions, learning theories that explain the source of these misconceptions, and teaching strategies to address these misconceptions (Pusey, 2003). This will be possible if teacher education programs enable pre-service teachers to engage in self-reflection and provide plenty of guidance and input for teacher educators to help trainees develop their reflection (Bischoff, Hatch, & Watford, 1999). In fact, studies reported that learning opportunities are effective on students' success, teacher training outcomes and learning (Çelik et al., 2020).

On analyzing the relevant literature, the studies were mostly grounded on determining the pre-service teachers' van Hiele geometric thinking levels (Armah et al., 2017; Atasoy, 2019; Salifu et al., 2018), the effect of dynamic geometry software and/or physical manipulatives on the pre-service teachers' van Hiele geometric thinking levels (Karakuş & Peker, 2015) and the impact of van Hiele theory-based learning environments on pre-service teachers' knowledge of geometry or geometric thinking (Alex & Mammen, 2016; Armah et al., 2018; Erdoğan & Durmuş, 2009; Kaleli-Yılmaz & Koparan, 2016; Yi et al., 2020). These studies analyzed the development of students' existing van

Hiele geometric thinking levels and counted in activities that would improve their geometry thinking. However, there is no such a study specifically published on depicting the reflections from implementation-containing and expert-aided meetings that would help pre-service teachers understand van Hiele Geometric Thinking Levels (vHGTL). Only Yi et al. (2020) conducted a study to examine the impact of van Hiele theory-based instructional activities on pre-service elementary school teachers' knowledge of geometry content, students' geometric thinking levels and geometry activities as well as their relationships. The present study differs from the related study and others in the literature in various ways. This study was conducted with pre-service Elementary Mathematics Teachers (PEMTs); moreover, the study also provides them the opportunity to share and discuss the results of these examinations in expert-aided environments through examining the learning objectives, activities and problems in the textbooks in terms of vHGTL. Some studies suggested that pre-service teachers had low vHGTL (Erdoğan & Durmuş, 2009; Kaleli-Yılmaz & Koparan, 2016), van Hiele theory-based instruction was identified to have a positive effect on high school students' vHGTL (Alex & Mammen, 2016; Kutluca & Gömlekçi, 2022) and undergraduate students' vHGTL (Armah et al., 2018; Erdoğan & Durmuş, 2009; Yi et al., 2020). Moreover, the pre-service teachers were determined to have insufficient geometry content understanding based on van Hiele levels, and pedagogical content knowledge, including students' understanding of geometric thinking levels or geometry instructional activities, may be improved through participation in well-designed instruction tasks (Yi et al., 2020). For this reason, it is critical for pre-service teachers, who are the teachers of the future, to have knowledge and experience about these levels, to be able to determine the levels of students, and to design learning environments in accordance with the levels of students. It is also of great importance to provide guidance and opportunities for teacher educators to help their students in the transitions between these levels and to have first-hand experience about van Hiele levels during their undergraduate education through active participation in subjects such as presenting appropriate activities/problems. It is a matter of curiosity what kind of results will be generated by the meetings created with the participation of expert academicians through concrete examples. In the literature, it is stated that collaborative sharing environments formed by bringing together experts and pre-service teachers positively affect the professional development of pre-service teachers (Ruohotie-Lyhty & Moate, 2016). In sharing environments with the participation of pre-service teachers and experts, experts support pre-service teachers to access theoretical knowledge (Kanbolat, 2015); make self-evaluation (Suh & Parker, 2010); deepen their mathematical knowledge (Bieda et al., 2013); focus on students'mathematical thinking (Bieda et al., 2013; Potari, 2011); and develop their understanding of teaching and learning mathematics (Potari, 2011). Inspired by this fact, the study focused on the creation of sharing environments where pre-service teachers and experts take place together and the interaction experiences of pre-service teachers with their peers and experts with vHGTL content. Thus, it is believed that the sharing environments will contribute to pre-service teachers' professional development as well as their content knowledge about vHGTL. In this regard, this study sought for an answer to the problem "How do the Pre-Service Elementary Mathematics Teachers evaluate the meetings with expert and peers participation based on vHGTL?". In service of this research problem, answers to the following sub-problems were sought:

1. What are the gains of PEMTs about vHGTL through meetings with experts and peers based on vHGTL?
2. How do PEMTs evaluate the presence of experts in the meetings with expert and peers participatory based on vHGTL?
3. How do PEMTs evaluate the presence of their peers in meetings with expert and peers participatory based on vHGTL?
4. How do PEMTs evaluate their professional development through meetings with expert and peers participatory based on vHGTL?

2. METHOD

This section covers information regarding the research design, participants, data collection tools and process, data analysis and ethical statement.

2.1. Research Design

Having a qualitative research method, this study employed the case study design. Creswell (2007) defines the case research as a qualitative research approach in which the researcher explores one bounded case or more bounded cases over time through multiple sources of information (observations, interviews, documents, reports, etc.), and reports a case description and case-based themes. This study is a sample of a case study since it presents PEMTs evaluations of meetings with expert and peer participation, and describes the process with a variety of data collection tools such as meeting records, reflection reports of the PEMTs, researcher field notes and interviews.

2.2. Participants

This study was conducted with three 3rd grade pre-service teachers who study at the department of the elementary mathematics teaching in a state university and two academicians who are experts in the field of mathematics education.The study used convenience sampling method, which is one of the purposive sampling methods. This method refers to the collection of data from a sample that the researcher can easily reach (Büyüköztürk et al., 2015).

The pre-service teachers, who voluntarily participated in the study, have successfully received Teaching Geometry and Measurement course, in which one of the experts was an educator in the previous term, and they have prior knowledge regarding the van Hiele theory. Experts in sharing environments have doctoral degrees in mathematics education and conducting courses related to mathematics teaching at undergraduate and graduate levels. Due to the confidentiality of the participants, the real names of the pre-service teachers were not used; instead, they were represented by the code names as Damla, Ecmel and Zümra.

2.3. Data Collection Tools and Data Collection Process

This study deployed meeting logs, reflection reports of the pre-service teachers, researcher field notes and interviews. Figure 1 summarizes the data collection process.

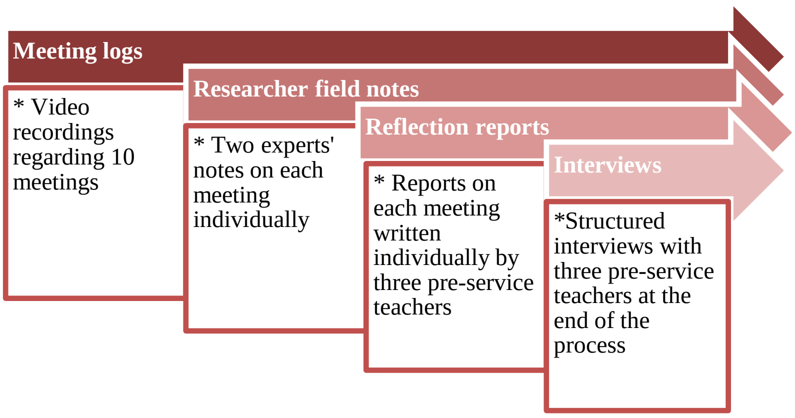

Figure 1. Data collection process

Meeting logs: A total of 7 interviews were conducted with the PEMTs to determine vHGTL. The interviews were conducted online and lasted approximately 45-90 minutes. The interviews were conducted and recorded via the Zoom application. All learning outcomes, solved and unsolved problems in the "Lines and Angles" sub-learning area within the "Geometry and Measurement" learning area of the 5th, 6th and 7th grade mathematics textbooks were examined according to vHGTL in the video-recorded meetings. The textbooks examined during the research process are 5th, 6th and 7th grade secondary school mathematics textbooks belonging to MoNE publications. The reason for the choice of textbooks from this publishing house is that MoNE is the ministry responsible for national education services in Turkey. The reason why textbooks from this publisher are preferred is that MoNE publishing belongs to the ministry responsible for carrying out national education services in Turkey.

The pre-service teachers identified the relevant parts at each grade level according to the vHGTL through discussion before the meetings. Discussions were carried out on the levels determined by the PEMTs in the meetings with the participation of expert academicians. The discussions were carried out on topics such as how solved/unsolved problems were classified according to vHGTL, why they thought it was at the relevant level, and what distinguished the problem from other levels. In this regard, PEMTs' views were taken into account, and then necessary explanations were made by expert researchers on the accuracy/incorrectness of the levels. The data on the meeting records were used to support the findings.

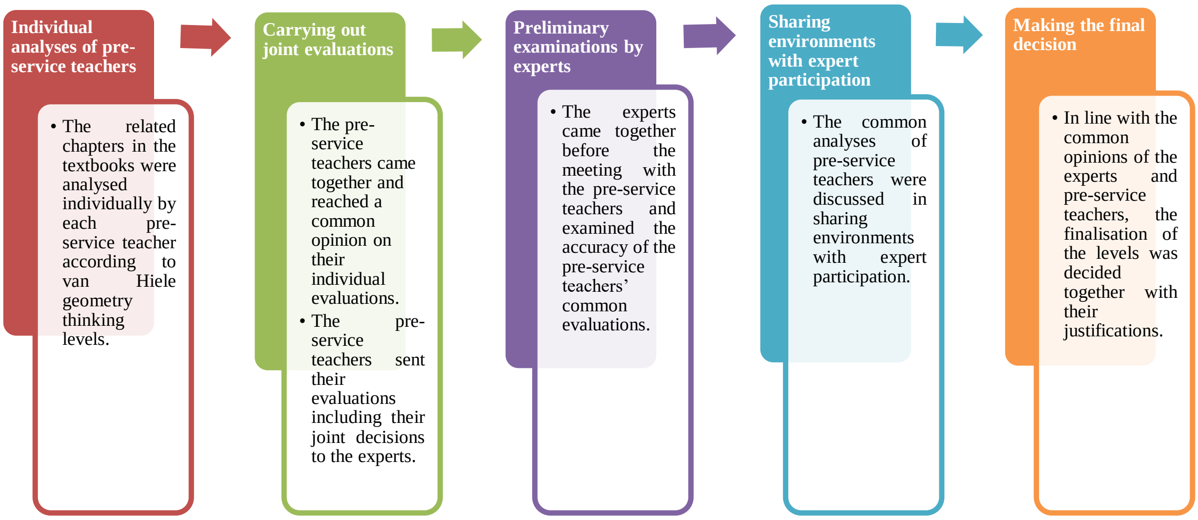

Figure 2. Process of meeting logs

Reflection reports: Unstructured reflection reports, in which pre-service teachers individually reflected on their experiences and professional development after each meeting, were used to support the research data.

Researcher field notes: The unstructured field notes of the experts on meetings and the development of pre-service teachers after each meeting were used to support the findings.

Interviews: Semi-structured interviews were held with PEMTs to evaluate the whole process. The interviews were conducted individually with the PEMTs, they were audio-recorded and lasted an average of 5-15 minutes. The following problems were posed to the PEMTs during the semi-structured interviews:

1. How did this whole process contribute to you? What aspect (variable) of the environment contributed to you? (previous meetings with experts and peers, etc.)
2. What are your views on the presence of experts in the meetings?
3. What are your views on the presence of peers in the meetings?

2.4. Data Analysis

The interview data were primarily analyzed in parallel to the sub-problems. Content analysis was used during data analysis (Patton, 2002). In inductive content analysis, codes emerge from the participants' expressions and form meaning clusters. Similar data are brought together and handled, and documents related to the data are systematically examined and analyzed (Yıldırım & Şimşek, 2013). For this purpose, firstly, the audio recordings of the interviews were transcribed. Then, each participant's transcript was coded and themes were generated by bringing together similar codes. A similar process was carried out for reflection reports. Related codes and themes were presented in tables and direct quotations of the codes are presented. As stated above, the main data source of the research is interviews. The findings were supported with excerpts from meeting logs, reflection reports and researchers field notes. While the findings of the study are presented, the categories emerging are described with the relevant data in detail (Patton, 2002).

2.5. Validity and Reliability of the Research

Validity in qualitative research includes the strategies researchers use to ensure the reliability of their studies (Creswell & Miller, 2000). Reliability in qualitative research is ensured by consistency, which means that another researcher can reach similar results; and confirmability, which means taking into account the entire process, from the applied method to long-term interaction with the participants, from the researcher's position to the researcher's experience and perspective (Noble & Smith, 2015). In this context, for ensuring a long-term interaction 7 meetings lasting between 45-90 minutes were held with the participants of the research; in addition, the first researcher conducted different courses of the participants for 7 semesters. Researchers attended meetings with participants in the role of experts. All meetings and interviews with participants were recorded to prevent data loss. Both of the researchers are experts in the field of mathematics education and have experience in qualitative studies. One of the researchers teaches "Qualitative Research with NVIVO" as a post graduate course. Hence, the researchers have experience in qualitative research. On the other hand, one of the researchers instructed the "Geometry and Measurement" course for two semesters. Therefore, it can be stated that the researcher has knowledge and experience about van Hiele geometric thinking levels. For ensuring coding reliability the data were analyzed simultaneously by two researchers. Hence, audio recordings of the interviews with PEMTs were transcribed and coded simultaneously. Similar coding processes were also carried out for the pre-service teachers' reflection reports. Afterwards, the researchers came together and analyzed each code and the codes got their final version. Therefore, reliability was ensured by the expert review method suggested by Yıldırım and Şimşek (2013) to provide credibility in qualitative research.

3. FINDINGS

This section presents findings under four main headings in line with the sub-problems of the study.

3.1. Findings Regarding the Pre-service Teachers' Gains about vHGTL through Meetings

Table 2 depicts the pre-service teachers' evaluations on their gains about vHGTL through the meetings.

Table 2. The pre-service teachers' evaluations on their gains about vHGTL through the meetings

Views	f
Recognize their misinformation about vHGTL	D, E, Z
Enhance their knowledge of vHGTL	E, Z
Distinguish vHGTL more clearly	D, E
Opportunity to study more deeply about vHGTL	D

As in Table 2, the pre-service teachers noted that meetings based on vHGTL helped them realize the wrong information they had about vHGTL, contributed to their knowledge about vHGTL, allowed them to distinguish vHGTL more clearly and had the opportunity to study vHGTL in more detail.

All of the pre-service teachers underlined that meetings made them realize the wrong information they had about vHGTL. These statements were frequently encountered especially in the pre-service teachers' reflection reports.

To exemplify, the reflection report that Zümra wrote after the 2nd meeting indicates a change in her knowledge about vHGTL "I missed the detail that these problems could be solved as an activity in the classroom under the heading “Let's do it together”. I evaluated the problems only with student thinking, not with their solution.”.

Similarly, Zümra’s views changed after the speeches in another meeting related to the problem “Are we ready?” in Figure 2 in the 5th grade mathematics textbook. Zümra's expressions referring that there has been a change in the knowledge regarding this problem are displayed as follows.

Figure 3. The problem “Are we ready?” in the 5th grade secondary school mathematics textbook (MoNE, 2019)

English version of the problem presented in Figure 3.

1) Match the following statements with the appropriate models.

a) Line b) Line segment c) Closed half-line

“This is a problem that we thought as a Level I but agreed that it was Level 2 during the meeting. The problem involved matching the shapes of lines, line segments and rays with daily life contexts such as the light coming out of the lantern and the violin. We believed that this problem was at Level 1 by analyzing the images, yet we decided that the images could not be understood clearly and exceeded the visual level along with the evaluations of our teachers. My perspective towards Level 1 has changed with this problem.”

[Excerpt from Zümra's 3rd meeting reflection report.]

Here are the statements of Zümra, who expressed that meetings contributed to PEMTs’ knowledge about vHGTL.

“My knowledge of levels was insufficient before I started working. So yes, we learned it in the lesson, you also taught it, but that's it. When I saw the problems, I did not have enough knowledge to categorize them. First of all, I had to do some research on the levels before I started working. I searched on studies first, so I did it myself. Then, I got information about the levels and made a note for myself, I made a note on which level we call this level, whatever, second level, whatever, third level, and I used that note. We also examined the textbooks ourselves, it was very useful for them to examine the books related to our field, to deal with the problems there and to put them into certain categories.” [Excerpt from Zümra's interview statements.]

Considering the PEMTs’ reflection reports after the interviews, they were identified to take notes on distinguishing across the levels more clearly. For instance, the following statements in the reflection report of the 7th meeting show that Ecmel can distinguish more clearly between the 2nd and 3rd levels.

“[...] we have reached another conclusion that we can set a roadmap for ourselves. This was the 2nd level if there was a direct use of information, and the 3rd level if the student was expected to make inferences.”

Besides, Ecmel commented on distinguishing across the levels better in the interview with the following statements.

“I think we had a lesson for levels in the second grade. We learned the van Hiele levels. [...] But it wasn't like that, of course, as we studied it in class, I began to understand more. I started to be able to distinguish more and more which problem belongs to which level. In that sense, the lesson contributed a lot.”

One of the PEMTs, Damla evaluated the ability to distinguish the levels more clearly by having the opportunity to study in more detail about vHGTL during the process. Some views of the participant are as follows.

“For instance, we learned the van Hiele Levels in the lesson, teacher, we learned them last year, but we have studied them in more detail. We've learned it in more detail this year. [...] Now, when I analyze a problem, I can understand more clearly what level it is.” [Excerpt from Damla's interview statements]

3.2. Findings Regarding the Pre-service Teachers' Evaluations on the Presence of Experts in the Meetings Based on vHGTL

Table 3 displays the pre-service teachers' evaluations regarding the presence of experts in the meetings.

Table 3. The pre-service teachers' views on the presence of experts in the environment

Views	**P.T.***
Helping to find the accurate information	D, E, Z
Gaining different perspectives	E, Z
Eliminating ambiguity	Z
Instant feedback	D
Ensuring permanent learning	D
Encouraging systematic work	E
Boosting the use of academic language	E

**P.T.: Pre-service Teacher*

As is seen in Table 3, the pre-service teachers' views on the presence of experts in the meetings were categorized as helping to reach the accurate information; gaining different perspectives; eliminating ambiguity; instant feedback; ensuring permanent learning; encouraging systematic work and boosting the use of academic language.

All the pre-service teachers stated that the experts helped them to have the right information. Damla's statement is depicted as an example.

"[…] (experts) *directed us to find the truth instead of telling directly. The presence of experts in the environment allowed me to learn more permanently and contributed to me academically."* [Excerpt from Damla's interview statements]

The field note of the researcher 2 regarding the following dialogue between PEMTs and experts related to the vHGTL activity at the 5th grade level in the 6th meeting supports the view that the experts encouraged the pre-service teachers to reach the correct answer. 760

"The pre-service teachers stated that the activity is the third level. Some reasons were presented and the pre-service teachers were requested to discuss the possibility of being considered as a 2nd level to encourage them to think and discuss. While Damla and Zümra argued that their views were correct, Ecmel stated that our problems and the examples we gave confused them. Ecmel was also unsure of their previous decision. Researcher 1 opened an activity that they previously considered as level 3 and asked them to compare the two activities. Zümra shared her opinion with her justifications and stated that she evaluated it as 3 levels. Researcher 2 drew attention to the explanation related to the solution of the activity and asked them to think about it. All the pre-service teachers stated that they were sure of their decisions after reading the explanation." [Excerpt from the field note of the 6th meeting.]

Ecmel and Zümra reported that experts helped them gain different perspectives. Zümra's statements in the reflection report after the first meeting are presented as follows.

"I had a hard time evaluating the learning outcomes before the first meeting. There were points where I hesitated and made me think. I did not think that we would evaluate the level determinations we made during the meeting in this way. Although I determined reasons for each of them, it was very useful to talk to my teachers and evaluate them. I was able to evaluate it from different perspectives."

Zümra concluded that they were hesitant to determine the levels of some problems before the meeting and that they got rid of these uncertainties with the comments of the experts in the reflection report written after the 5th meeting.

"The meeting we held today was mostly grounded on the problems that we talked about with my friends and were undecided about. Frankly, I'm happy about this because we are on the right track in the evaluations we made before the meeting. Discussing and clarifying the problems that we have hesitated during the meeting, clears the problem marks in my mind."

Damla mentioned that they can receive immediate feedback from the experts when they need it, and that the experts contribute to the permanent learning.

"The presence of experts in the environment allowed me to get immediate feedback on the problems I asked. When I did not understand, I was able to consult immediately, I could contact quickly. Besides, they provided us with an environment for discussion. They guided us to find the truth instead of telling directly in this discussion environment. [...]"

Unlike other pre-service teachers, Ecmel pinpointed that experts encouraged PEMTs to work systematically and to use academic language. Ecmel's statements related to the experts' encouragement to work systematically are as follows.

"Not doing the review randomly may be the biggest contribution in the academic sense. In other words, we normally examine the textbook with the assignments in our lessons, but there is a general randomness in accordance with the homework instructions, but in a certain order. Because we have progressed under your [...] management, we have progressed in a certain order. We consciously researched the things we needed to examine, not randomly like this. So this has been very useful for me."

Ecmel's statements regarding the experts' encouragement of the PEMTs to use academic language are summarized as such.

"[...] we tried to use more academic language, which was significant to me. Namely, we tried to talk in a more descriptive way, not in a more friendly environment. [...] Of course, we also need to pay attention to the work we do since you are experts. How can I say, since you can be aware of an information we say without really researching, we have to talk about such things that we need to pay extra attention to, any explanation we would say, either by paying extra attention to a speech or a sentence, and really filling it up."

3.3. Findings Regarding the Pre-service Teachers' Evaluations on the Presence of Peers in the Meetings

Table 4 depicts the pre-service teachers' evaluations on the presence of their peers in the meetings.

Table 4. The pre-service teachers' evaluations regarding the presence of peers in the meetings

Views	P.T.
Gaining different perspectives	D, E, Z
Ensuring they are confident in their decisions	D, Z
Increasing communication skills	E, D
Complementing each other's drawbacks	Z
Feeling comfortable	E

**P.T.: Pre-service Teacher*

Table 4 suggests the PEMTs' views on the presence of their peers in the meetings as gaining different perspectives; being sure of their decisions; increasing communication skills; completing each other's drawbacks and feeling comfortable.

All pre-service teachers confirmed that the presence of their peers in the meetings had them gain different perspectives. In this regard, some views of Ecmel during the interview are suggested as follows.

"My thoughts changed in some problems. Let me give an example. If I believe that a problem is at the second level, but you doubt it, we definitely discuss this problem together. When we discussed, sometimes we left it on the same level, sometimes we took it to a different level as we had different opinions. I gained a different perspective. Before we had a discussion with you, I got some information from my friends. Therefore, we all have different ideas because we think differently. This has also provided benefit for our home meetings."

Damla indicated that she was more confident about the decisions she made thanks to her peers during the interviews, and that her communication skills also improved thanks to her peers.

"They supported me when I was unsure. They helped me have an idea about which direction I should go. In other words, my communication skills developed in this way."

Zümra mentioned in the interviews that working with her peers provided different perspectives and that they complemented each other's shortcomings.

"Since they are my friends, we proceeded comfortably through the process. So everyone knew their own responsibility and what to do. We have a feeling for this. That's why, I think it's a process by which we contribute

to each other. We had an effective process with our friends, we gained different perspectives and made up for each other's deficiencies."

Ecmel also stated that she felt more comfortable in the environment thanks to her peers during the interview.

"My teacher assured me, actually. I think having a friend or a peer reassures you. So I'm not alone. Even if I had an extra task to do, I felt more comfortable and better because we did it together."

3.4. Findings on the Pre-service Teachers' Evaluations Regarding Their Professional Development through Meetings

Table 5 presents the findings on the PEMTs' evaluations regarding their professional development through meetings.

Table 5. The pre-service teachers' evaluations regarding their professional development through meetings

Views	*PT
Reviewing the mathematics curriculum and textbook	D, E
Examine and relate concepts related to geometry	D, E
Update knowledge of geometry related terms	D, E
Solving problems about geometry	D, E
Ability to self-assess	D, E
Gaining different perspectives	E, Z
Ability to work systematically	E
Ability to express oneself	E
Ability to use academic language	E

**P.T.: Pre-service Teacher*

As observed in Table 5, the pre-service teachers' views are categorized as reviewing the mathematics curriculum and textbook, examining and associating concepts related to geometry, updating knowledge of geometry-related terms, solving problems about geometry, ability to self-assess, gaining different perspectives, ability to work systematically and expressing oneself and using academic language.

The statements of Damla and Ecmel regarding that they had the opportunity to examine secondary school mathematics books and curriculum are displayed as follows.

"We had the opportunity to review the textbooks. We revised the variety of problems. We examined the levels of those problems. In addition, we examined the curriculum, the secondary education curriculum." [Excerpt from Damla's interview statements]

"I have examined the curriculum related to my field and the problems in the textbook in more detail. Namely, I have gained experience in my field. This is how I examined the syllabus in detail as a pre-service teacher. I have examined more consciously what kind of problems are included at which grade level."

[Excerpt from Ecmel's interview statements.]

Damla and Ecmel pointed out that they had the opportunity to examine and associate concepts related to geometry from time to time in their meeting. In this regard, it is noteworthy to take the expressions by Ecmel during the interview into consideration.

"I have some drawbacks like this. For instance, sometimes I cannot remember very simple things in geometry and other mathematical sense, but I forget. As we examine everything in detail, whether it is very simple or not, and to what level it belongs, I also learned them in terms of geometry. For example, what exactly a ray is or what kind of examples we can give. Or there were different solutions in the solutions of the problems about angles, I did not know all the solutions, but when we talked about those solutions in detail, I learned more than one way, which contributed a lot."

Similarly, it is remarkable what Damla wrote in the reflection report after the 2nd meeting on examining and associating the concepts related to geometry.

"*One of the problems that we focused on the most at this meeting was the explanation of the parallelism by associating it with the triangle. We did not see the association part in this problem while we were discussing the problems, but I observed that it was obvious to associate with a triangle there, and I began to examine more carefully whether any association is available in such direction and unit problems during the meeting."*

In addition, Damla emphasized that she sometimes had the opportunity to solve problems about geometry and work on mathematical terms during the process.

"You know, I had to do the solutions in order to understand the problems, the level of geometric concepts, etc.. Of course, it contributed in this sense. So, teacher, I forgot some terms. I had the opportunity to remember. I had the opportunity to understand their differences on terms."

The field note received by Researcher 2 for the 3rd meeting may be an example of the work process on the geometry problems as Damla expressed *"We talked to the pre-service teachers about this problem (the one presented in Figure 3) for about 10 minutes. We discussed at length each item of the problem and how the students would solve these items and which skills they would solve. In the meantime, we almost solved the problem together. In particular, we discussed the item 'ç' in detail. We have discussed in detail the cases where two lines are parallel to each other, intersect and even intersect perpendicularly."*

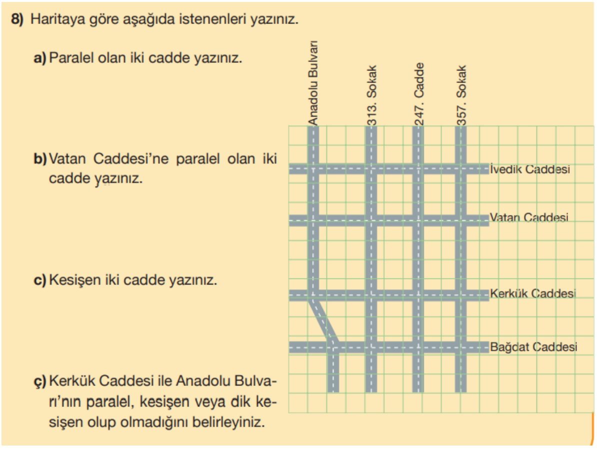

Figure 4. The problem "Your turn" in the 5th grade secondary school mathematics textbook (MoNE, 2019)

English version of the problem presented in Figure 2.

8) Write the following asked according to the map.

a) Write two parallel streets.

b) Write two streets parallel to Vatan street.

c) Write two intersecting streets.

ç) Determine whether Kerkuk Street and Anadolu Boulevard are parallel, intersecting or perpendicular.

Ecmel and Zümra reported that their self-evaluation skills improved in the process with the examples related to the meetings. Ecmel's statements regarding this code are as follows.

"Because, teacher, I have some drawbacks, I am aware of this and I have not fully developed it yet. I have shortcomings like this. For instance, sometimes I cannot remember very simple things in geometry and other mathematical sense, but I forget. As we examine everything in detail, whether it is very simple or not, and to what level it belongs, I also learned them in terms of geometry. For example, what exactly a ray is or what kind of examples we can give. Or there were different solutions in the solutions of the problems about angles, I did not know all the solutions, but when we talked about those solutions in detail, I learned more than one way, which contributed a lot."

Elif and Zümra affirmed that they made progress towards gaining different perspectives. In this sense, the statements of Zümra written in the diary after the 2nd meeting are noteworthy.

"I had the opportunity to examine and query the problems from different perspectives with the explanations of both my friends and instructors during the meeting."

Ecmel evaluated the process as a good experience in terms of systematic working culture.

"We consciously investigated the things we needed to study, not randomly like this. Therefore, this has been very useful for me. In other words, it was good for me to analyze in detail about these van Hiele levels rather than open the textbook and categorize it as an unsolved problem."

Ecmel's statements written in her diary after the 1st meeting was related to finding the opportunity to express herself in a discussion-based environment.

"I would like to state that I like the environment for discussion and that we are defending our ideas, namely, the creation of such an environment. :)"

Moreover, another issue that Ecmel expressed within the context of professional development was about using academic language.

"We tried to use more academic language, which was significant to me. In other words, we tried to speak more descriptively by trying to use more words rather than in a more friendly environment. It has had such an effect."

4. DISCUSSION and CONCLUSION

It is concluded that pre-service teachers had wrong information about vHGTL thanks to the process they experienced on van Hiele geometric thinking levels with the participation of experts; the process contributed to their knowledge about VHGTL; it offered the opportunity to study more about vHGTL, and that they were able to distinguish vHGTL more clearly. On analyzing the relevant literature, the van Hiele theory-based instructional practices (Alex & Mammen, 2016; Armah et al., 2018; Erdoğan & Durmuş, 2009; Kaleli-Yılmaz & Koparan, 2015; Yi et al., 2020), well-structured geometry lessons (Guven, 2006; Toluk et al., 2002; Tutak & Birgin, 2008), dynamic geometry software (DGY), concrete materials and drawing activities (Karakuş & Peker, 2015) were determined to be effective on the pre-service teachers' van Hiele geometric thinking levels. It is recommended to design appropriate experiences so that pre-service teachers are familiar with the van Hiele theory (Alex & Mammen, 2016). Therefore, it is most likely that the meetings on van Hiele geometric thinking levels with expert participation designed for pre-service teachers helped them to better understand their van Hiele geometric thinking levels and to distinguish the levels more clearly. When the pre-service teachers talked about the learning outcomes or activity during the interviews, the experts frequently asked why the objectives did not belong to a lower level or to a higher level. Such inquiries and explanations are thought to raise the pre-service teachers' awareness towards van Hiele geometric thinking levels.

Besides, the pre-service teachers indicated that they had knowledge about vHGTL, and that they had the opportunity to deepen their knowledge and distinguish the differences across levels more clearly through examining many samples of learning outcomes and activities during the process. Thus, it may be wise to mention that the pre-service teachers' knowledge of vHGTL and the classification practices as well as the examinations related to these levels are significant in terms of their knowledge of van Hiele geometric thinking levels. In this regard, it is recommended to provide environments in which they examine resources such as learning outcomes, activities, examples, and problems related to geometry, rather than sharing theoretical content knowledge in the relevant courses to support the knowledge of pre-service teachers regarding van Hiele geometric thinking levels.

Pre-service teachers also suggested that the presence of experts in the environment helped to reach accurate information, gained different perspectives, helped remove uncertainty, had the opportunity to receive instant feedback, provided permanent learning, encouraged systematic study and academic language use. The pre-service teachers examined the learning outcomes and the solved/unsolved problems according to the vHGTL before the meetings. The experts organized the process by means of a calendar to inform the pre-service teachers at the first meeting about which date, which grade level and which section would be discussed. The pre-service teachers stated that this provided them with systematic work. They were also found to have the opportunity to discuss the learning outcomes they examined, solved/unsolved problems with experts and defend their ideas in expert participatory meetings designed on vHGTL. Thus, many ideas were put forward when analyzing a problem, different ideas were discussed and the most appropriate level was determined through justifications. This may be effective in gaining different perspectives, reaching correct information and eliminating ambiguity. Likewise, Baş and Işık (2014) concluded that face-to-face communication environments were created with the participation of teachers and academicians. It is vital that the category of gaining different perspectives is jointly expressed for both profiles (expert and pre-service teacher) in the meetings. In fact, individuals have the opportunity to gain different perspectives thanks to the sharing of different information, opinions or experiences in various applications within this social environment, which consists of the participants from different profiles (Baki, 2012; Baş & Işık, 2014; Kanbolat, 2015). Watanable (2005) pinpointed that experts may contribute to meetings with their domain knowledge. The pre-service teachers had the opportunity to work one-on-one with the experts in the meetings, to pose problems to the experts whenever they wanted, and to get instant feedback. Besides, the pre-service teachers discussed their ideas with experts, leading them to use academic language during discussions. Kanbolat (2015) confirmed that the presence of experts in meetings to ensure the pre-service teachers' professional development contributes to their knowledge in teaching mathematics. Since the presence of experts in vHGTL content meetings is considered to be more effective and efficient, it is recommended to engage experts in such environments.

The pre-service teachers' views on the presence of their peers in the process were categorized as gaining different perspectives; ensuring assuredness in their decisions; increasing communication skills; complementing each other's drawbacks and feeling comfortable. Some studies demonstrated that the professional development practices that pre-service teachers carried out together by focusing on a certain common purpose contributed to their professional and personal development (Baki, 2012; Lewis, 2000). Hence, the competency of working collaboratively with colleagues is included in the general competencies of the teaching profession (ÖYGM, 2017). It is suggested to create meetings that enable pre-service teachers to interact with their peers and to urge them to work collaboratively.

Given that the pre-service teachers evaluated the process they experienced in terms of their professional development; their views were categorized as examining the mathematics curriculum and the book, examining and associating concepts related to geometry, updating knowledge of geometry-related terms, solving problems about geometry, ability to self-assess, gaining different perspectives, able to work systematically, ability to express themselves and using academic language. In this vein, the environment created in the study may feed the pre-service teachers' knowledge of the curriculum materials defined by Shulman (1986). Furthermore, teachers' sharing on the concepts related to geometry and the associations between these concepts while examining geometry problems may support their knowledge of geometry since they updated their knowledge of geometry-related terms. Likewise, the related literature affirmed that van Hiele-phased education improves the pre-service teachers' knowledge of geometry content (Armah et al., 2018; Yi et al., 2020). The study conducted by Yi et al. (2020) with the pre-service classroom teachers showed that van Hiele theory-based instructional activities were effective on pre-service teachers' understanding of geometry content knowledge, students' knowledge of van Hiele levels, and their geometry teaching activities. Thus, it is vital that the pre-service teachers be provided with opportunities to work actively with their peers through primary sources before starting the profession as well as expert support for their professional development. The relevant literature uncovers that the pre-service teachers should be provided guidance on geometry-related experiences and improving their geometric thinking levels (Erdoğan & Durmuş, 2009), and that higher levels of geometric thinking can be achieved with the implementation of a student-centered and educator-guided applied curriculum (Alex & Mammen, 2016). It is of great significance to design the geometry teaching courses in the undergraduate program by taking this result into account.

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Abstract

This study aims to determine the cognitive and metacognitive strategies used by pre-service mathematics teachers for activating mental processes in a semi-structured problem-posing task. A holistic multiple-case design was used to in this study. For the case study, five voluntary pre-service mathematics teachers participated in this study. This task involves problem-posing in the context of science appropriate for different mathematical expressions. A think-aloud protocol, a semi-structured interview, observation and the pieces of papers for each question were used in this study. Open coding was performed using the continuous comparative analysis technique. The main results are that (a) they used various cognitive and metacognitive strategies to activate mental processes in problem-posing, (b) these strategies differed both in diversity and the usage of frequency of them and some strategies are either domain-specific or general-specific and (c) the use of metacognitive strategies is more common than cognitive strategies.

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Research Article

Cognitive and Metacognitive Strategies in Problem-Posing Tasks in the Context of Science*

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Abstract

This study aims to determine the cognitive and metacognitive strategies used by pre-service mathematics teachers for activating mental processes in a semi-structured problem-posing task. A holistic multiple-case design was used to in this study. For the case study, five voluntary pre-service mathematics teachers participated in this study. This task involves problem-posing in the context of science appropriate for different mathematical expressions. A think-aloud protocol, a semi-structured interview, observation and the pieces of papers for each question were used in this study. Open coding was performed using the continuous comparative analysis technique. The main results are that (a) they used various cognitive and metacognitive strategies to activate mental processes in problem-posing, (b) these strategies differed both in diversity and the usage of frequency of them and some strategies are either domain-specific or general-specific and (c) the use of metacognitive strategies is more common than cognitive strategies.

Keywords: Cognitive strategies, mathematical expressions, metacognitive strategies, semi-structured problem-posing, the context of science

1. INTRODUCTION

Studies on science and mathematics education have focused on the need to integrate the disciplines of science and mathematics since the beginning of the 20th century (McBride & Silverman, 1991). This is because while science uses mathematics to calculate and explain relationships between concepts (McBride & Silverman, 1991), science is used as a context to pose mathematical problems (Davison, Miller & Metheny, 1995). In the 21st century, the importance of interdisciplinary education started to increase (Kim & Cho, 2015) with the prevalence of the idea that using concepts from different disciplines can help learners solve real-world problems (Burrows & Slater, 2015). The integration of science and mathematics education has paved the way for STEM education. STEM education emerged with the combination of science, technology, engineering and mathematics disciplines (Dugger, 2010). It is aimed to develop 21st century skills in students through the integration of science and mathematics, as well as technology and engineering (Blackley & Howell, 2019). STEM education is an approach that enhancing critical thinking, problem solving and high-level thinking skills (Gül, 2019). The importance of research on STEM education is increasing internationally (Li, Wang, Xiao & Froyd, 2020; Öztürk & Özdemir, 2020). This study focused on the integration of the disciplines of science and mathematics within the scope of problem-posing tasks.

1.1. Problem-Posing in the Context of Science in Mathematics Education

This study focused on "problem-posing" as a step of problem-solving. Problem-posing was added to Polya's problem-solving methodology as the fifth step by Gonzales (1994). Silver (1994) defined problem-posing as either creating new problems or questions or reforming a given problem to

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investigate a given situation. Stoyanova and Ellerton (1996) classified problem-posing situations according to their structures: (a) problem-posing tasks based on a specific problem as a structured form, (b) problem-posing tasks by giving the student an open-ended situation, by using the individual's own knowledge, skills, and experience as a semi-structured form, and (c) problem-posing tasks by giving a situation related to daily life as free problem-posing.

In problem-posing, informal contexts such as personal experiences, visual expressions such as pictures, graphs, or tables, and symbolic expressions such as equations are used. Additionally, mathematical expressions can be classified as internal and external expressions. Internal expressions address to abstractions of mathematical ideas or cognitive schemata developed through personal experiences, whereas external expressions address the physical depictions of a concept using elements such as numerals, algebraic equations, graphs, and tables (Pape & Tchoshanov, 2001). These expressions are used to improve the conceptual understanding and mathematics achievement of students (Kopparla et al., 2019). The semi-structured problem-posing context was used in this study, as it focused on the task of posing a problem in the context of science appropriate for three different mathematical expressions, which are tabular, graphical, and algebraic expression. Tabular, graphical and algebraic expressions are common expressions in both science and mathematics contexts. These expressions are more suitable for the nature of the semi-structured problem-posing context. Additionally, it was thought that it would be better to use more general expressions to reveal the metacognitive activities of the participants during the implementation.

1.2. Strategies Used in the Problem-Posing Process

In order to be successful in problem-posing, students always ask themselves questions like "What… changed?", "What if…?" and "What if ... not?" when they face a math problem, problem situation, or the answer to a problem (Ghasempour, Bakar & Jahanshahloo, 2013). They also resort to a number of strategies (Ghasempour et al., 2013) such as the "What if" or "What if not" strategy (Brown & Walter, 2005), the imitation strategy (Kojima, Miwa & Matsui, 2009), and the effective questioning strategy (English, 1997). Considering that problem-solving involves the usage of cognitive and metacognitive strategies (Schoenfeld, 1992), it is necessary to use both cognitive and metacognitive strategies in the process of problem-posing.

Performing a task is related to the formation of various mental processes. These processes include cognitive and metacognitive activities (Hıdıroğlu, 2018). For instance, learning is a cognitive process that requires the use of cognitive strategies (Yerdelen-Damar & Eryılmaz, 2021). Cognitive strategies are used to perform a task, while metacognitive strategies are used to understand how the task is performed (Garner, 1987). Cognitive strategies are needed to activate mental processes such as a better understanding of basic concepts and learning and remembering concepts (Leutwyler, 2009). Metacognitive strategies are needed to activate mental process such as becoming aware of one's mental activities, monitoring and evaluating them (Gunstone & Mitchell, 1998), and ensuring one's pre-regulation, directing one's attention, and selective attention and self-management while performing a task (O'Malley & Chamot, 1990). Questions such as "Why do I do something?" or "How is it done?" often trigger metacognition (Larkin, 2009). Cognitive and metacognitive processes can set the stage for each other. For example, cognitive processes can help students become aware of what they do and do not know, which can trigger monitoring and regulation processes. Monitoring and regulation can also improve the quality of the following cognitive processes (Roelle, Nowitzki & Berthold, 2017).

Students actively plan and monitor problem posing process and carry out self-evaluations. While the students use metacognitive strategies in this process, they are constantly engaged in how to understand information, improve a problem posing plan, formulate problems, solve problems and examine solutions (Taufik, Pagiling, Mayasari, Munfarikhatin, Natsir & Dadi, 2019). Although metacognitive strategies play an important role in problem-posing (Ghasempour et al., 2013), the literature on metacognition and problem-posing is very limited (Karnain, Bakar, Siamakani, Mohammadikia & Candra, 2014). Aydoğdu and Türnüklü (2023), examined the problem posing strategies of secondary school students on geometry learning. The study was carried out with 160 middle school students. In line with the findings obtained in the study, it was determined that students used thirteen different problem posing strategies while posing problems. The most frequently used problem posing strategies by the students were the Strategy of Adapting to Daily Life and the Strategy of Drawing a Figure and Posing the Problem According to this Figure Strategy. The problem posing strategies that the students used the least were the Backward Checkout Strategy and the Emotional Approach Strategy. Altun and Yeşilpınar-Uyar (2023) investigated the predictive relations between reading strategies metacognitive awareness and problem posing skills of seventh grade students. 373 seventh grade students participated in the research. As a result of the research, it was determined that reading strategies metacognitive awareness levels of seventh grade students significantly predicted problem posing skills and explained 42% of the change in problem posing skills. The authors recommend that teachers plan and implement interdisciplinary problem posing activities that include the use of different reading and problem posing strategies for the development of reading comprehension and cognitive awareness. It is also unclear which strategies are most effective for teaching problem-posing. In addition, general information about learners' problem posing processes is limited (Cai & Leikin, 2020). There is also limited information about both what these strategies are and the effectiveness of including these strategies in different problem-posing processes of students (Cai, Hwang, Jiang & Silber, 2015).

1.3. Objective and Significance

Problem-posing is an important part of research and practice in school mathematics, and it has been regarded as a critical intellectual activity in scientific research for a long time (Cai et al., 2015). The usage of various strategies in the development of this skill in teacher education is an important goal (Osana & Pelczer, 2015). Considering that metacognition has a critical role in the development of problem-posing skills (Osana & Pelczer, 2015), it is important for future teachers to be aware of the usage of metacognitive strategies in problem-posing. The aim of this study was to determine the cognitive and metacognitive strategies used by pre-service mathematics teachers for activating mental processes in a semi-structured problem-posing task in detail. For this purpose, answers were sought to the following questions in the context of science appropriate for different mathematical expressions: (a) What are cognitive strategies? (b) What are the metacognitive strategies used by pre-service mathematics teachers?

Much more research is needed to develop a widely applicable understanding of basic processes and strategies for problem-posing (Cai et al., 2015). It is thought that this study can contribute in terms of presenting recommendations for (a) developing a taxonomy of cognitive and metacognitive activities in problem-posing and (b) developing a scale for strategies used in problem-posing in the context of science.

2. METHOD

2.1. Research Design

A holistic multiple-case design was used to determine the strategies used by pre-service mathematics teachers to pose problems in the context of science appropriate for different mathematical expressions. In this design, there are multiple situations, and each situation is examined in a holistic way and compared to each other (Yin, 2018). In this study, three different cases -tabular, graphical and algebraic expressions- were investigated. Each case was studied and compared in terms of strategies used in problem-posing.

2.2. Participants

A semi-structured problem-posing test was implemented with 17 pre-service mathematics teachers who were studying at the education faculty of a university in a small city in the northern region of Turkey. For the case study, the criterion sampling method was used because the participants were selected based on the inclusion criterion requiring them to solve at least four items in the problem-posing test. Then, convenience sampling was used, and five voluntary pre-service mathematics teachers, one who had a low score, two who had medium scores, and two who had high scores in the test, were selected. The rate of the participants completing the problem-posing test varied between 40% and 90%. The rate of completion was 90% for tabular expressions, 65% for graphical expressions, and 65% for algebraic expressions. In line with this information, the sample was selected by maximum diversity sampling.

2.3. Data Collection Tools

A problem-posing test consisting of 10 questions and different mathematical expressions - tables, graphs, and algebraic expressions- was prepared by the researchers. In the preparation of the test, the questions including tabular, graphical and algebraic expressions in the science sections of national examinations such as the Examination for Transition from Elementary Education to Secondary Education (ETEESE), the Undergraduate Placement Examination (UPE), and the Field Proficiency Test (FPT) and international examinations such as PISA and TIMMS were examined. Attention was paid to the variety of data in the questions (one-digit positive numbers, two-digit positive numbers, decimal number) and the selection of the questions from basic science subjects on the secondary school level. The participants were asked to pose problems in the context of science related to daily life in accordance with the data in the given expression. Examples of questions in the problem-posing test are given in Figures 1, 7, and 9.

The problem-posing task rubric developed by Rosli, Capraro, Goldsby, y Gonzalez, Onwuegbuzie and Capraro (2015) was used to examine the participants' problem-posing cases. While deciding on the use of this rubric for this study, it was considered that this rubric had the criteria for problem-posing, it was current and comprehensive, and it was developed for pre-service secondary school teachers. This rubric is based on a 4-point scale ranging from 1 to 4 (1: Unsatisfactory and 4: Extended) in ascending order of proficiency. The problems posed by the participants were examined and scored in terms of appropriateness based on their structure/context, scientific concepts, mathematical expressions, and problem-posing design.

In this study, a think-aloud protocol and a semi-structured interview form consisting of eight main questions and some side questions developed by the researchers were used. A think-aloud protocol is when individuals perform a task and verbally express everything that crosses their minds during task performance (Jääskeläinen, 2010). It is used to assess metacognitive activities in educational research (e.g., Bannert & Mengelkamp, 2008). Therefore, in this study, the participants were asked to think aloud while posing problems to define the strategies they used cognitively or metacognitively and determine their purposes for using strategies. While preparing the semi-structured interview form, which was used to determine the cognitive and metacognitive strategies used in the problem-posing process and the purposes of the participants for using them, studies examining strategies used in problem-solving, problem-posing, and reading processes were investigated (e.g., Karnain et al., 2014; Kumlu, 2012; Mishra & Iyer, 2015). This form consisted of fifteen main items and some sub-items. Two of these items related to the planning phase of problem-posing, such as “What did you think when you encountered the tabular/graphical/algebraic expression?”, were asked in the form. Six items were related to the stage of organizing the problem. For instance, questions such as “How did you go about posing the problem? Why?”, “Did you have any difficulties while posing the problem? In which parts?”, “When you became aware of that you were having difficulties, how did you go about solving this problem?” were asked in the form. Two of these items were related to the stage of solving the problem. To exemplify, there were questions such as “Can your problem be solved? Why?”, “Can you solve the problem?” Five of these items were related to the phase of correcting the error and completing the problem. For instance, questions such as “Is there something missing or an error in the problem sentence or the solution of the problem you have posed? Why?” were asked in the form. This interview form was administered after the participants had written down and solved each problem-posing question to not affect their problem-posing process.

The problem-posing test and problem-posing process semi-structured interview form were submitted to two experts for their assessments. The domain of one of these experts is problem-solving in mathematics education, and the domain of the other is scientific reasoning skills in science education. After the feedback from the experts, these data collection tools were finalized.

This study used by the participants in posing problems were analyzed as data collection documents.

2.4. Data Collection Process

An interview calendar was created by determining the appropriate day and time for the participants and researchers. Before the interview, information was given about the purpose of the study and the process of thinking aloud. The interviews were recorded after the participants had been informed about recording. The questions in the problem-posing test were given to the participants. Participants were asked to think aloud while posing and solving problems. A piece of paper for each question was given to the participants to write down the problems they planned. These pieces of paper were analyzed as documents. One of the researchers also took notes on the ways the participants used in the problem-posing process and their thoughts that were expressed aloud, and the researcher took the role of an “external observer” by not interfering with the problem-posing process. After the completion of the problem-posing process for each question, the researcher interviewed the participants. The observations and interviews lasted about two hours. These observations and interviews were transcribed.

2.5. Data Analysis

To determine the problem-posing levels of the participants, the problem-posing task rubric developed by Rosli et al. (2015) was used, and a descriptive analysis was performed. Inductive content analysis, which is used to create concepts, categories, and themes from data (Kyngäs, 2020), was utilized to determine in detail the strategies used by the participants in the problem-posing process and their purposes for using these strategies. In the data analysis part of this study, the transcripts of the interviews with the participants, the observation notes of the researcher, and the pieces of paper used by the participants to pose problems were examined.

In this study, open coding was performed using the continuous comparative analysis technique (Straus & Corbin, 1998). In other words, the researchers read the transcript of the participants' problem-posing process line by line, took notes and defined the strategies they used and their purposes for using these strategies. These strategies were coded. In this study, the concept of strategy was discussed as a “general way to fulfill the problem-posing task” (Pelczer, Voica & Gamboa, 2008, p. 98). While naming the strategies, information in the literature on problem-posing, problem-solving, and reading strategies (e.g., Brown & Walter, 2005; Ekici, 2016; Gonzales, 1998; Silver, Mamona-Downs, Leung & Ann-Kenney, 1996) was used. A similar coding process was carried out for the strategy usage purposes of the participants. In the process of coding the purposes of the participants for using the strategies, tasks in the problem-posing steps (Polya, 1957), sub-dimensions of the Problem-Posing Skills Scale proposed by Pilten, Isik and Serin (2017), planning, monitoring, and evaluation processes of metacognitive regulation (Karnain et al., 2014), metacognitive awareness elements (Schraw & Dennison, 1994), cognitive prompts such as organization and elaboration, and metacognitive prompts such as monitoring, self-diagnosis, and planning remedial processes that encourage the use of cognitive and metacognitive strategies (Roelle et al., 2017) were used. Attention was paid to the conceptual nature of the names of the strategies and their intended use. Additionally, the coding of whether the strategies were cognitive or metacognitive was carried out according to the purposes of strategies. If an individual used a strategy to understand, learn, and remember a task, it was cognitive (Leutwyler, 2009), and if they used a strategy for being aware of, monitoring, and evaluating mental activities (Gunstone & Mitchell, 1998), it was metacognitive. For example, if the strategy of questioning was used to make sense of the components of the problem, this strategy was coded as a cognitive strategy. If this strategy was used to decide on the components of the problem or overcome difficulties in deciding on the components of the problem, this strategy was coded as a metacognitive strategy. It was determined that 34 different cognitive strategies were used to perform five different cognitive activities, and 53 different metacognitive strategies were used to perform ten different metacognitive activities.

Performing a task is related to the formation of various mental processes. These processes include cognitive and metacognitive activities (Hıdıroğlu, 2018). In fact, the purpose of using a strategy can be defined operationally as using it to perform a cognitive activity or a metacognitive activity. In this study, the usage purposes of the strategies were addressed based on mental activities that were activated in problem-posing in the results section. Based on this information, the strategies used to perform cognitive activities such as understanding the information that is given, activating prior knowledge about the given information, making sense of the components of the problem, organizing the problem, and realizing the problem's solution from the tasks to be completed regarding the problem-posing steps were coded as cognitive strategies. Deciding on the components of the problem, being aware of the difficulties encountered in deciding the components of the problem and overcoming this difficulty, paying attention to the important elements while organizing the problem, being aware of the difficulty encountered while organizing the problem and overcoming this difficulty, evaluating the correctness/plausibility of the problem's solution, being aware of the errors in the organized problem and monitoring errors (debugging), and evaluating the correctness/plausibility of the organized problem were coded as metacognitive activities The coding sets consisting of sample data segments for each mental activity and each strategy were coded by one of the researchers and an expert of metacognitive strategy in science education. The coders discussed until they reached a satisfactory agreement on the inconsistent coding sets, and the final taxonomy was reached by reviewing the literature. The problem-posing question regarding the context of graphical expression in the problem-posing test is given in Figure 1.

3. Using the data in the graphic on the side, pose a verbal problem about science subjects.

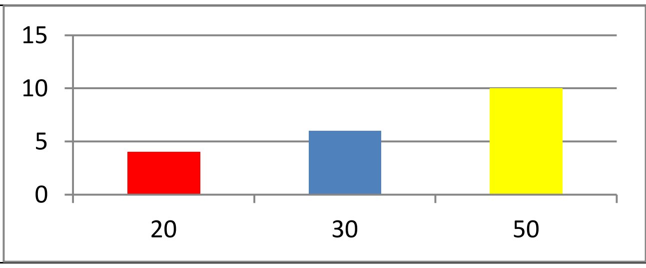
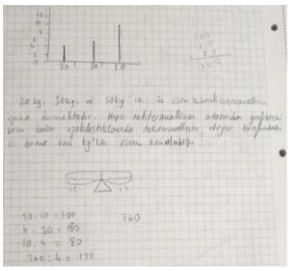


Figure 1. Graphical expression example

The paper of the problem posed by P1 was shown in Figure 2.



(Three objects of 20kg, 30kg, and 50kg put on a 24-unit wooden board. How much do objects put at a 4-unit on the other side of the seesaw must weigh when all present objects are moved away from the center of the seesaw by the unit on the graph?)

Figure 2. An example of p5's paper about the problem-posing in the context of graphical expression given

The sample coding section regarding the various strategies used to perform different activities by P1 who had a medium score from this test and their usage purposes in this process are given below:

P1: The column chart has 20, 30, and 50 at the bottom. 20 intersects with 4 on the y-axis, 30 intersects with 6 on the y-axis, and 50 intersects with 10 on the y-axis. There are 3 columns [Understanding the information given-Cognitive Activity (CA) /Examining the information given-Cognitive Strategy (CS)]. I can also consider the balance board. 20, 30, and 50 can be placed on a balance board. The numbers on the y-axis can also be the units where they stand [Making sense of the components of the problem-Cognitive Activity (CA) / Associating with prior knowledge and experiences-Cognitive Strategy (CS)].

Researcher's observation: The participant writes the problem [Organizing the problem-Cognitive Activity (CA) / Writing the problem designed in one's mind-Cognitive Strategy (CS)]

Researcher: How did you associate the problem with the graph?

P1: I did it by multiplying the intersections of the x-axis and the y-axis, which are marked directly. So, I came up with such a question from there [Making sense of the components of the problem -Cognitive Activity (CA) / Finding correlation -Cognitive Strategy (CS)].

Researcher: So, what did you think while writing? How did you decide on the balance problem?

P1: If there are small numbers and large numbers, my mind will go to balance questions, if there are numbers close to each other, I guess I will think of speed questions. Here, I thought of posing a balance problem since the y-axis consists of small numbers and the x-axis consists of large numbers [Deciding on the components of the problem-Metacognitive Activity (MCA) / Choosing the concepts according to the mathematical characteristics of the information given-Metacognitive Strategy (MCS)].

The cognitive and metacognitive activities of the participants and the strategies they used to perform these mental activities that were identified as a result of the analysis of the data are presented in the results section as a figure. Moreover, the frequencies of using cognitive and metacognitive strategies are presented as a word cloud. In the word cloud, the higher the frequency of using the strategy, the larger the font. While calculating these frequencies, the numbers of strategies used by five participants in the problem-posing test that included ten questions were added.

2.6. Validity and Reliability of the Study and Ethics

Triangulation, maximum variation, adequate engagement in data collection, rich and thick descriptions, and audit trail, which are strategies for promoting validity and reliability (Merriam & Tisdell, 2016), were used in this study. The triangulation method was employed by using multiple data collection tools which were semi-structured interviews, observations, and problem-posing sheets, and the think-aloud protocol was used to verify obtaining findings. Through data triangulation, the cognitive/metacognitive strategies and mental activities that become activated were coded, and reliable and common evidence was achieved.

The maximum variation strategy was used in sample selection. In this study, the participants had different problem-posing levels and their rates of completing the problem-posing test varied. One of the researchers spent two hours for each participant while interviewing them in line with the adequate engagement in data collection strategy. An 85-page observation and interview transcript were obtained in the study, indicating highly rich and dense descriptive data. The information about the usage of the audit trail strategy is available in the data collection process and data analysis section.

With regard to ethics, first of all, the necessary permissions were obtained from the Human Research Ethics Committee (letter dated 18.12.2020 and numbered 2020-135). Moreover, pre-service teachers who voluntarily agreed to participate in the study were included, and the identifying information of the participants was kept confidential by assigning them codes from P1 to P5.

3. FINDINGS

The mental processes that became activated and strategies that the participants used in problem-posing in the context of science appropriate for different mathematical expressions were examined within the scope of this study. The mental processes that were examined included cognitive activities and metacognitive activities. Information about the cognitive activities and the frequency of using of the cognitive strategies while posing problems in the context of different mathematical expressions are given in Table 1.

Table 1. The cognitive activities and the frequency of using of the cognitive strategies in problem posing

Cognitive activities	Cognitive strategies	Table		Graphic		Algebraic expression		Total	
		f	%	f	%	f	%	f	%
Understanding the information given	Estimating	1	0.90	0	0.00	0	0.00	6	1.47
	Examining the information given	8	7.21*	19	11.59*	19	14.96*	46	11.30*
	Finding correlations	8	7.21*	14	8.54*	15	11.81*	37	9.09
	Total	17	15.32	33	20.12	34	26.77	89	21.87
Activating his/her prior knowledge about the information given	Associating with previous problems	2	1.80*	3	1.83*	0	0.00	5	1.23*
	Associating with prior knowledge and experience	2	1.80*	4	2.44*	1	0.79*	7	1.72*
	Relating with formulas	1	0.90	1	0.61	1	0.79*	3	0.74
	Questioning	0	0.00	1	0.61	0	0.00	1	0.25
	Total	5	4.50	9	5.49	2	1.57	16	3.93
Making sense of the components of the problem	Associating with daily life	0	0.00	4	2.44	0	0.00	4	0.98
	Associating with previous problems	1	0.90	1	0.61	1	0.79	3	0.74
	Associating with prior knowledge and experience	6	5.41*	9	5.49*	4	3.15	19	4.67
	Envisioning the problem	7	6.31*	9	5.49*	6	4.72	22	5.41
	Estimating appropriate concepts to the given information	8	7.21*	13	7.93*	14	11.02*	35	8.60
	Finding correlations	2	1.80	5	3.05	3	2.36	10	2.46
	Making sense of the information given	10	9.01*	21	12.80*	8	6.30*	39	9.58
	Relating with different discipline issues	3	2.70	2	1.22	0	0.00	5	1.23
	Relating with formulas	4	3.60	3	1.83	3	2.36	10	2.46
	Questioning	1	0.90	5	3.05	0	0.00	6	1.47
	Total	42	37.84	72	43.90	39	30.71	153	37.59
Organizing the problem	Assigning symbolic representations to concepts in the problem	1	0.90	2	1.22	0	0.00	3	0.74
	Associating with daily life	1	0.90	1	0.61	1	0.79	3	0.74
	Finding correlations	1	0.90	0	0.00	1	0.79	2	0.49
	Making sense of the components of the problem	7	6.31*	4	2.44	6	4.72*	17	4.18
	Making sense of the information given	4	3.60*	5	3.05*	5	3.94*	14	3.44
	Making the operation easier	2	1.80	1	0.61	1	0.79	4	0.98
	Relating information given with the other components of the problem	0	0.00	3	1.83	5	3.94*	8	1.97
	Relating with different discipline issues	0	0.00	1	0.61	2	1.57	3	0.74
	Relating with formulas	1	0.90	0	0.00	1	0.79	2	0.49
	Sampling	0	0.00	1	0.61	0	0.00	1	0.25
	Sampling the information given	1	0.90	1	0.61	0	0.00	2	0.49
	Using mathematical structure in the solution	1	0.90	2	1.22	0	0.00	3	0.74
	Using scientific expressions	2	1.80	0	0.00	0	0.00	2	0.49
	Using scientific notation	0	0.00	0	0.00	2	1.57	2	0.49

Table 1. (Continued)

Cognitive activities	Cognitive strategies	Table		Graphic		Algebraic expression		Total	
		f	%	f	%	f	%	f	%
Organizing the problem	Using symbols	1	0.90	0	0.00	2	1.57	3	0.74
	Using the mathematical structure of the information given	0	0.00	0	0.00	1	0.79	1	0.25
	Using unit	0	0.00	1	0.61	1	0.79	2	0.49
	Writing the problem conceived in the mind	6	5.41*	11	6.71*	4	3.15	21	5.16
	Writing without thinking	2	1.80	3	1.83	7	5.51*	12	2.95
	Total	30	27.03	36	21,95	39	30.71	105	25.80
Realizing the problem solution	Associating with prior knowledge and experience	2	1.80	1	0.61	0	0.00	3	0.74
	Converting the unit	1	0.90	0	0.00	0	0.00	1	0.25
	Establishing equality	1	0.90	0	0.00	0	0.00	1	0.25
	Expressing the steps of the process in one's own sentences	1	0.90	1	0.61	0	0.00	2	0.49
	Finding correlations	3	2.70*	2	1.22*	0	0.00	5	1.23
	Interpreting the information given with concepts	1	0.90	1	0.61	0	0.00	2	0.49
	Percentage calculation	1	0.90	0	0.00	0	0.00	1	0.25
	Proportioning	1	0.90	3	1.83*	4	3.15*	8	1.97
	Using formulas	4	3.60*	6	3.66*	9	7.09*	19	4.67
	Using four operations	2	1.80	0	0.00	0	0.00	2	0.49
	Total	17	15.32	14	8.54	13	10.24	44	10.81
	General Total	111	100	164	100	127	100	407	100

** It shows that the cognitive strategies frequently used in each cognitive activity category for each representation.*

As seen Table 1, the participants used various cognitive strategies to perform cognitive activities which included understanding the information that is given, activating one's prior knowledge about the information given, making sense of the components of the problem, organizing the problem, and realizing the problem's solution in the problem-posing process. The number of cognitive strategies used to perform each cognitive activity varied. For example, three different strategies for understanding the information given and nineteen different strategies for organizing the problem were defined. It was found that some of the cognitive strategies were used to activate only one cognitive activity, and some were used to activate multiple cognitive activities. For example, the strategy of examining the information that is given was used only to understand the information given, and the strategy of relating with the formulae was used to activate one's prior knowledge about the information given, make sense of the components of the problem, and organize the problem. Furthermore, it was determined that the frequency of using of some strategies such as making sense of the information given and estimating the appropriate concepts to the information given in order to make sense of the components of the problem was high in performing some activities in all three mathematical representations. The finding correlations strategy was the most frequently used strategy. This was followed by making sense of the information that is given, examining the information given, estimating the appropriate concepts, associating with prior knowledge and experience, visual imagery of the problem, writing the problem conceived in the mind, using formulae, and making sense of the components of the problem. The frequencies of using these strategies while posing problems were higher than those of other cognitive strategies.

The number of different cognitive strategies used in problem posing in the context of table representation given was the highest in terms of diversity (f=29 and 85% for table, f=25 and 74% for graphic, f=21 and 62% for algebraic expression). The frequency of using cognitive strategies in problem posing in the context of graphic representation given was the highest (f=111 and 27% for table, f=164 and 40% for graphic and f=127 and 31% for algebraic expression). The use of strategies for examining information given, finding correlations, estimating appropriate concepts, making sense of the components of the problem, making sense of information given, and using formulas were higher than other cognitive strategies in all three representations. There were also strategies that were commonly used in all three mathematical representations, but were more frequently used in one or both. For example, the strategy of associating with previous problems was more frequently used in the context of the table and the graph, writing without thinking was more frequently used in the context of the algebraic expression in problem posing. It was determined that the participants carried out metacognitive activities to decide on the components of the problem, be aware of the difficulties encountered in deciding the components of the problem and organizing the problem and overcome these difficulties, pay attention to the important elements while organizing the problem, be aware of the errors in the organized problem, monitor the errors in the organized problem, and assess the accuracy/plausibility of the solution and of the organized problem. The strategies used to perform these activities are defined as metacognitive strategies. The usage frequencies of the metacognitive strategies used to perform these metacognitive activities while posing problems in the context of different mathematical expressions are given in Table 2.

Table 2. The metacognitive activities and the frequency of using of the metacognitive strategies in problem posing

Metacognitive activities	Metacognitive Strategies	Table		Graphic		Algebraic expression		Total	
		f	%	f	%	f	%	f	%
Deciding on the components of the problem	Choosing the concepts according to the mathematical characteristics of the information given	5	4.39*	14	8.28*	10	9.01*	29	7.36
	Interpreting the information given with concepts	5	4.39*	8	4.73*	4	3.60	17	4.31
	Questioning	1	0.88	4	15.38	9	8.11*	14	3.55
	Total	11	9.65	26	1.18	23	20.72	60	15.23
Being aware of the difficulties encountered in deciding the components of the problem	Comparing the consistency of the information given with the concepts	1	0.88	2	15.38	0	0.00	3	0.76
	Questioning	7	6.14*	23	13.61*	12	10.81*	42	10.66
	Self-questioning	1	0.88	2	1.18	3	2.70	6	1.52
	Total	9	7.89	27	15.98	15	13.51	51	12.94
Overcoming difficulties in deciding on the components of the problem	Arranging the root of the question in accordance with the information given	0	0.00	1	0.59	0	0.00	1	0.25
	Associating with previous situations	1	0.88	1	0.59	0	0.00	2	0.51
	Changing the concepts associated with the information given	5	4.39*	9	5.33*	4	3.60*	18	4.57
	Changing the question root	1	0.88	0	0.00	0	0.00	1	0.25
	Choosing the concepts according to the mathematical characteristics of the information given	0	0.00	1	0.59	3	2.70	4	1.02
	Interpreting the information given with concepts	0	0.00	1	0.59	0	0.00	1	0.25
	Limiting the concepts with which the information given is associated	0	0.00	1	0.59	0	0.00	1	0.25
	Making additions	0	0.00	2	1.18	0	0.00	2	0.51
	Questioning	1	0.88	3	1.78	2	1.80	6	1.52
	Quitting	1	0.88	6	3.55*	7	6.31*	14	3.55
	Relating with different discipline issues	1	0.88	0	0.00	0	0.00	1	0.25
	Review	2	1.75*	4	2.37*	0	0.00	6	1.52
	Writing the problem conceived in the mind	1	0.88	0	0.00	0	0.00	1	0.25
	Total	13	11.40	29	17.16	16	14.41	58	14.72

Table 2. (Continued)

Metacognitive activities	Metacognitive Strategies	Table		Graphic		Algebraic expression		Total	
		f	%	f	%	f	%	f	%
Paying attention to the important elements while organizing the problem	Associating with daily life	0	0.00	1	0.59	0	0.00	1	0.25
	Choosing a solution according to the mathematical characteristics of the information given	0	0.00	1	0.59	0	0.00	1	0.25
	Comparing the consistency of the information given with the context of the problem	1	0.88	1	0.59	0	0.00	2	0.51
	Differentiating the question pattern	4	3.51*	0	0.00	0	0.00	4	1.02
	Distinguishing necessary /unnecessary information	1	0.88	1	0.59	0	0.00	2	0.51
	Highlighting key elements related to the problem	1	0.88	0	0.00	0	0.00	1	0.25
	Increasing the number of operation steps	0	0.00	1	0.59	1	0.90	2	0.51
	Interpreting key elements related to the problem	7	6.14*	11	6.51*	3	2.70*	21	5.33
	Interpreting the difficulty of the problem	1	0.88	0	0.00	0	0.00	1	0.25
	Questioning	0	0.00	1	0.59	0	0.00	1	0.25
	Relating the context of the problem to its solution	0	0.00	3	1.78	2	1.80	5	1.27
	Trying different solutions	0	0.00	1	0.59	0	0.00	1	0.25
	Using explanatory statements	4	3.51*	6	3.55*	6	5.41*	16	4.06
	Visualization	1	0.88	0	0.00	0	0.00	1	0.25
	Total	20	17.54	27	15.98	12	10.81	59	14.97
Being aware of the difficulties encountered in organizing the problem	Questioning	5	4.39*	2	1.18	0	0.00	7	1.78
	Self-questioning	2	1.75	3	1.78*	0	0.00	5	1.27
	Total	7	6.14	5	2.96	0	0.00	12	3.05
Overcoming difficulties in organizing the problem	Adding variables	1	0.88	0	0.00	0	0.00	1	0.25
	Assigning symbolic representations to concepts in the problem	2	1.75*	0	0.00	0	0.00	2	0.51
	Associating with previous situations	1	0.88	0	0.00	0	0.00	1	0.25
	Changing the context of the problem	1	0.88	0	0.00	0	0.00	1	0.25
	Changing the question root	2	1.75*	1	0.59*	0	0.00	3	0.76
	Limiting the concepts with which the information given is associated	0	0.00	1	0.59*	0	0.00	1	0.25
	Limiting the number of conditions added to the problem	1	0.88	0	0.00	0	0.00	1	0.25
	Self-questioning	1	0.88	0	0.00	0	0.00	1	0.25
	Total	9	7.89	2	1.18	0	0.00	11	2.79
Assessing the accuracy/ plausibility of the solution	Comparing the consistency of the answer with the expected answer	2	1.75	0	0.00	0	0.00	2	0.51
	Comparing the consistency of the answer with the root of the problem	2	1.75	0	0.00	0	0.00	2	0.51
	Crosschecking	1	0.88	0	0.00	3	2.70*	4	1.02
	Free from calculation errors	1	0.88	2	1.18	3	2.70*	6	1.52
	Interpreting the answer in real life context	0	0.00	1	0.59	2	1.80	3	0.76
	Interpreting the answer with concepts	0	0.00	0	0.00	2	1.80	2	0.51
	Interpreting the solution process	4	3.51*	7	4.14*	3	2.70*	14	3.55
	Quitting	0	0.00	1	0.59	0	0.00	1	0.25
	Self-questioning	4	3.51*	5	2.96*	3	2.70*	12	3.05
	Trying different solutions	2	1.75	2	1.18	1	0.90	5	1.27
	Total	16	14.04	18	10.65	17	15.32	51	12.94

Table 2. (Continued)

Metacognitive activities	Metacognitive Strategies	Table		Graphic		Algebraic expression		Total	
		f	%	f	%	f	%	f	%
Being aware of the errors in the organized problem	Comparing question root with solution consistency	1	0.88*	0	0.00	1	0.90	2	0.51
	Comparing the consistency of the information given with the context of the problem	1	0.88*	0	0.00	3	2.70*	4	1.02
	Comparing the consistency of the solution and the context of the problem	1	0.88*	0	0.00	0	0.00	1	0.25
	Questioning	0	0.00	1	0.59*	0	0.00	1	0.25
	Review	0	0.00	1	0.59*	0	0.00	1	0.25
	Total	3	2.63	2	1.18	4	3.60	9	2.28
Monitoring the errors in the organized problem / Debugging	Adding conditions to the problem	0	0.00	1	0.59*	0	0.00	1	0.25
	Changing the context of the problem	1	0.88	0	0.00	0	0.00	1	0.25
	Making inferences	1	0.88	0	0.00	0	0.00	1	0.25
	Organizing the components of the problem	2	1.75*	1	0.59*	3	2.70*	6	1.52
	Review	1	0.88	0	0.00	0	0.00	1	0.25
	Total	5	4.39	2	1.18	3	2.70	10	2.54
Assessing the accuracy/ plausibility of the organized problem	Adding different conditions to the problem	0	0.00	2	1.18	0	0.00	2	0.51
	Adding thought-provoking expressions	0	0.00	2	1.18	1	0.90	3	0.76
	Associating with daily life	0	0.00	0	0.00	2	1.80	2	0.51
	Changing the context of the problem	0	0.00	1	0.59	0	0.00	1	0.25
	Changing the question root	1	0.88	0	0.00	1	0.90	2	0.51
	Comparing the consistency of the information given with daily life	2	1.75	0	0.00	0	0.00	2	0.51
	Comparing the consistency of the information given with the context of the problem	1	0.88	2	1.18	3	2.70*	6	1.52
	Converting the unit	0	0.00	1	0.59	0	0.00	1	0.25
	Distinguishing necessary/unnecessary information	2	1.75	1	0.59	0	0.00	3	0.76
	Highlighting key elements related to the problem	0	0.00	1	0.59	0	0.00	1	0.25
	Increasing the number of operation steps	0	0.00	1	0.59	0	0.00	1	0.25
	Interpreting key elements related to the problem	0	0.00	1	0.59	5	4.50*	6	1.52
	Making additions	4	3.51*	11	6.51*	4	3.60*	19	4.82
	Making changes in the expressions in the problem	2	1.75	3	1.78*	0	0.00	5	1.27
	Making the operation difficult	0	0.00	1	0.59	0	0.00	1	0.25
	Questioning	2	1.75	2	1.18	2	1.80	6	1.52
	Rereading	2	1.75	0	0.00	0	0.00	2	0.51
	Review	2	1.75	0	0.00	2	1.80	4	1.02
	Self-questioning	3	2.63*	2	1.18	0	0.00	5	1.27
	Visualization	0	0.00	0	0.00	1	0.90	1	0.25
	Total	21	18.42	31	18.34	21	18.92	73	18.53
	General Total	114	100	169	100	111	100	394	100

** It shows that the metacognitive strategies frequently used in each metacognitive activity category for each representation.*

In Table 2, it is seen that the number of metacognitive strategies used to perform each metacognitive activity differed. For example, two different strategies for being aware of the difficulties encountered in organizing the problem, and twenty different strategies to assess the accuracy/plausibility of the organized problem were identified. Furthermore, it was determined that some of the metacognitive strategies were used to perform only one metacognitive activity, and some to perform more than one metacognitive activity. For example, the strategy of adding variables was used only to overcome the difficulties encountered in the problem posing, and the strategy of choosing concepts according to the mathematical characteristics of the information given was used both in deciding the components of the problem and overcoming the difficulties in deciding on the components of the problem. Moreover, it was observed that the frequency of using of some strategies, such as the strategy of choosing concepts according to the mathematical characteristics of the information given in order to decide on the components of the problem was high in performing in all three mathematical representations. The variety of metacognitive strategies used in problem posing in table representation given was the most and the least for algebraic expression (*f*=39 and 73.5% table, *f*=34 and 64% for graphic, *f*=25 and 47% for algebraic expression). The frequency of using metacognitive strategies for graphic representation given was highest, and it was least for algebraic expression (*f*=114 and 29% for table, *f*=169 and 43% for graphic and *f*=111 and 28% for algebraic expression). The frequency of using *choosing the concepts according to the mathematical characteristics of the information given, questioning, changing the concepts associated with the information given, interpreting the key elements of the problem, using explanatory statements, interpreting the solution process, self-questioning, organizing the components of the problem and making additions,* was higher than the other metacognitive strategies in all three representations. It was determined that a strategy was specific to only one or two mathematical representations. For instance, visualization was specific to only in the context of table, crosschecking strategy was used in the context of both table and algebraic expression.

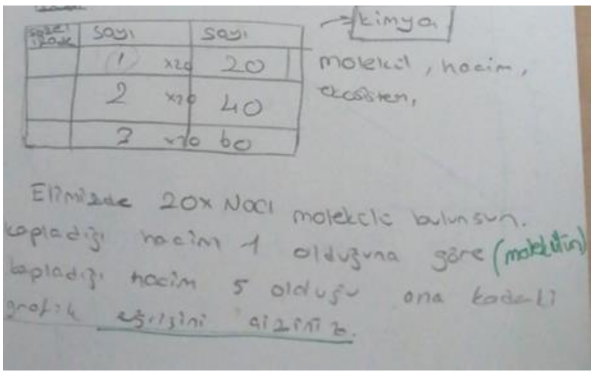
The problem-posing question regarding the context of tabular expressions in the problem-posing test is given in Figure 3.

Verbal expression	Number	Number
	1	20
	2	40
	3	60

2. Using the data in the table on the side, pose a verbal problem about science subjects.

Figure 3. Tabular expressions example

The paper of the problem posed by P5 was shown in Figure 4.



(Suppose we have 20X NaCl molecules. Since the volume occupied by this molecule is 1, draw the graph curve until the volume occupied by the molecule is 5.)

Figure 4. An example of p5's paper about the problem-posing in the context of table given

The sample section regarding the mental activities and various cognitive and metacognitive strategies used by P5 who had a low score from this test is given below:

P5: *... again, there are 4 rows and 3 columns [[here]]. [[There is]] a ratio, a proportion. For instance, from 20 to 40, the constant increases by 20, that is, there is an increase. 1, 2, and 3 increase by [[/in increments of]] 1.* [Understanding the information that is given - Finding Correlations (CS)] *How can we pose this problem? I thought of an increase in diversity as the number of living beings increases. When [[the numbers of]] plants and animals increase, the number of living animals increases, our ecosystem is [[/becomes]] broader, [[it is described that]] [[it]] becomes the number 60. Can it be like this? You know, they say there are more animals in rainforests but fewer animals in deserts.* [Making sense of the components of the problem - Associating with prior knowledge and experiences, Questioning, Making sense of the information that is given (CS)] (Observation – Thinking aloud protocol)

R: *What way did you go about when writing the problem down? Why did you include the concept of molecules in chemistry?*

P5: *...because I thought I could associate the numbers with chemistry. There was a ratio between the numbers, a regular proportion. You see, 1, 2, 3… it was increasing by 20 on the other side. This is why I thought [[about it]] like this.* [Overcoming the difficulties encountered in deciding on the components of the problem - Choosing the concepts according to the mathematical characteristics of the information that is given (MCS)] (Interview)

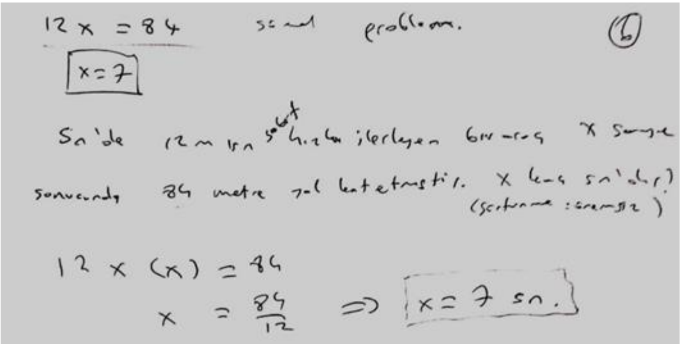
It may be stated that P5 had difficulty in defining the root of the question and changed the concepts to overcome this, and they chose the concept according to the mathematical characteristics of the information that was given. The task of posing a problem in the context of science and algebraic expressions is given in Figure 5.

7. 12.x = 84

Using the data in the equation above, pose a verbal problem about science subjects.

Figure 5. Algebraic expressions example

The paper of the problem posed by P2 was shown in Figure 6.



(A vehicle moving at a constant speed of 12 m/s covered a distance of 84 meters in x seconds. What is x? (Friction is negligible)

Figure 6. An example of p4's paper about the problem-posing in the context of algebraic expression given

The sample section regarding the mental activities and various cognitive and metacognitive strategies used by P2 who had a high score from this test is given below:

R: *Why did you choose the subject of speed?*

P2: *Because there were two multiplication operations side by side in the equation. From the simplest, the speed formulas came to my mind directly. The distance traveled is equal to time times speed. X=V.t. Since there are 2 multiplication operations here, I said that this question can be written directly.* [Deciding on the components of the problem - Choosing the concepts according to the mathematical characteristics of the information given (MCS)].

R: *Well, when you look at your problem, are there parts that you would like to make corrections or missing parts?*

P2: *There is no problem with the problem, but for example, it could have been asked graphic… just changing the form of my problem would have been better. I also verbally said that the thing is moving at a speed of 12 m/s, but I should have stated that it was moving steadily there. For example, I did not write. Friction is negligible. It had to be mentioned as well.* [Assessing the correctness / plausibility of the organized problem - Changing the question root, Adding different conditions to the problem (MCS)]

It may be stated that P2 used the strategy of choosing the concepts according to the mathematical characteristics of the information that is given to perform the activity of deciding on the components of the problem. It may be concluded that they used the strategies of changing the question's root and adding different conditions to the problem to assess the correctness/plausibility of the organized problem.

4. DISCUSSION and CONCLUSION

In this study, three main results were reached. The first of these was that the participants used various cognitive and metacognitive strategies to activate their mental activities. This situation can be explained by the possibility that the participants had the strategy repertoire (Hartman, 2001a) and prior knowledge and experience about learning the usage of strategies. Learning to use strategies can take place through teacher modeling (Van Keer, 2004) or interaction with a teacher, peer, family member, or an older person (Paris & Hamilton, 2009).

The second result of the study was that cognitive strategies such as finding correlations, examining the information that is given, estimating the appropriate concepts for the information that is given and metacognitive strategies such as questioning, choosing the concepts according to the mathematical characteristics of the information given, self-questioning, and interpreting the key elements of the problem were used more than other strategies. Some other studies in the literature on reading, problem-solving, and problem-posing also reported that students use these strategies (e.g., Gonzales, 1998; Meijer, Veenman & van Hout-Wolters, 2006; Silver et al., 1996). The high usage frequencies of some strategies can be explained by that these strategies are both domain-specific and general-specific (Hartman, 2001b). Learners can adapt the strategies they use to complete other tasks to the problem-posing task. Moreover, some strategies such as questioning and associating with previous situations were used to perform both cognitive and metacognitive activities. There are studies showing that strategies can be both cognitive and metacognitive depending on their purposes of usage (e.g., Kumlu, 2012). Furthermore, the variety and frequency of using metacognitive strategies are higher than the variety and frequency of using cognitive strategies. This is because problem-posing is not just about completing the mathematical activity. It focuses more on the relationships between mathematical ideas, and as a result, it triggers high-level thinking, different thinking, and metacognitive skills (Ghasempour et al., 2013).

The third result of this study was that the strategies used to perform each mental activity differed in diversity. This may be because there are many potential processes in problem-posing, and these vary depending on the type of problem that is being addressed (Cai et al., 2015). Moreover, the nature of the task (Duncan & McKeachie, 2005), the learner's perceptions of the difficulty of the task (Meijer et al., 2006; Oxford, 1990), and the learner's need to complete the task (Alavi & Kaıvanpanah, 2006) affect their usage of strategies.

To summarize the results of the study in general, the pre-service mathematics teachers used both cognitive and metacognitive strategies to perform various mental activities during the problem-posing process. Since problem-posing is a high-level skill, the use of metacognitive strategies is more common. Using a large number of strategies also indicates that individuals have a repertoire of strategies for problem-posing. While some of these strategies are general strategies such as those used in reading and problem-solving, some are specific to problem-posing.

This study was limited to semi-structured problem-posing, pre-service mathematics teachers, and cognitive and metacognitive activities and strategies in this context. Moreover, three different mathematical expressions, tabular, graphical, and algebraic expressions, were focused on in the study. Similar studies can be performed with different types of mathematical expressions, e.g., symbols, concrete objects, and pictures. This study can be implemented with primary and secondary school students and pre-service science teachers. By making use of the findings of this study, a metacognitive awareness scale for problem-posing can be developed.

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Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Research Ethics Committee of Sinop University with the decision dated 18/12/2020 and numbered 2020/135.

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Abstract

Lifelong learning starts in childhood and youth, continuing throughout adulthood and old age. It encompasses formal learning in settings such as schools and training centers, informal and non-formal learning derived from colleagues and workplace trainers, and unintentional learning stemming from spontaneous social interactions. In today's fast-paced world, students need to acquire 21st-century skills and be lifelong learners. Therefore, it is crucial to understand the relationship between students' perceptions of 21st-century skills and their effective lifelong learning levels. This research aims to investigate the following questions: "What are the students' levels of success in lifelong learning and their perceptions of 21st-century skills? Is there a relationship between them?" and "Do students' perceptions of 21st-century skills predict their levels of success in lifelong learning?". The results indicated that students' levels of success in lifelong learning and 21st-century skills have a strong correlation. Students have high characteristics that will enable effective lifelong learning, and their perceptions of 21st-century skills are moderate. In addition, students' perceptions of 21st-century skills predict their success levels in lifelong learning at a high rate.

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Research Article

The Importance of Investigating Students' Lifelong Learning Levels and Perceptions of 21st-Century Skills*

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Abstract

Lifelong learning starts in childhood and youth, continuing throughout adulthood and old age. It encompasses formal learning in settings such as schools and training centers, informal and non-formal learning derived from colleagues and workplace trainers, and unintentional learning stemming from spontaneous social interactions. In today's fast-paced world, students need to acquire 21st-century skills and be lifelong learners. Therefore, it is crucial to understand the relationship between students' perceptions of 21st-century skills and their effective lifelong learning levels. This research aims to investigate the following questions: "What are the students' levels of success in lifelong learning and their perceptions of 21st-century skills? Is there a relationship between them?" and "Do students' perceptions of 21st-century skills predict their levels of success in lifelong learning?". The results indicated that students' levels of success in lifelong learning and 21st-century skills have a strong correlation. Students have high characteristics that will enable effective lifelong learning, and their perceptions of 21st-century skills are moderate. In addition, students' perceptions of 21st-century skills predict their success levels in lifelong learning at a high rate.

Keywords: Lifelong learning, 21st-century skills, perception

1. INTRODUCTION

In today's ever-changing and competitive world, it is important to prioritize lifelong learning to excel and succeed. Lifelong learning refers to the desire and ability to keep learning throughout one's life. It facilitates continuous growth and adaptability in a world that is rapidly changing. Believing in oneself and having the confidence to perform tasks is crucial for individuals to acquire and effectively utilize new skills. Factors such as technological advancements, globalization, environmental changes, digitalization, and unforeseen events like the COVID-19 pandemic make lifelong learning significant (Organisation for Economic Co-operation and Development [OECD], 2021).

Develop a new skill by taking a personal course through online education or class-based course (e.g., learning a new language, cooking, programming, etc.), learning a new sport or activity (such as cycling, diving, gym activities, etc.) or learning to use new technology (smart devices, new software applications, etc.) can be shown as some examples to lifelong learning (Boeren, 2017). At the same time, to succeed in today's society, people need various skills. These 21st-century skills include critical thinking, collaboration, creativity, communication, and technological proficiency. These competencies are essential for solving complex problems, adapting to new ideas, and thriving in a job market that is constantly evolving (Gonzales, 2020).

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Digital literacy is one aspect of 21st-century skills that supports the development of other competencies. However, it is not the sole determinant of developing 21st-century skills in students. Digital competence is a supporting factor for mastering these skills, which should be introduced and taught in schools (Rizaldi, Nurhayati & Fatimah, 2020). This highlights the importance of integrating digital literacy into educational curricula to enhance student's overall skill set. Furthermore, collaborative teaching and learning approaches are effective in developing 21st-century skills. These approaches emphasize problem-solving, self-regulated learning, collaboration, and information literacy (Chelliah & Clarke, 2011).

This study will explore how lifelong learning is connected to acquiring and using 21st-century skills. We will also examine how students' self-belief and ability to develop these abilities are linked. To prepare students for success in today's world, we have to understand what skills are necessary and improve the education system accordingly. To achieve our goals, we will analyze the titles "Lifelong Learning" and "21st-Century Skills and Competencies" separately.

1.1. What is Lifelong Learning?

Multiple authors have discussed and defined the concept of lifelong learning. Field's (2011) definition pertains to the ongoing learning process and personal growth throughout an individual's lifetime. This type of education is self-initiated and not associated with formal institutions like schools or universities. Boeren (2017) adds that this process is driven by personal interests and goals and is a voluntary, self-directed pursuit of knowledge and skill development. Merriam, Caffarella, and Baumgartner (2007) provide a comprehensive guide to learning in adulthood, including lifelong learning. They define lifelong learning as "the ongoing, voluntary, and self-motivated pursuit of knowledge for personal or professional reasons." They highlight that lifelong learning is not limited to a specific age or stage of life but encompasses learning opportunities that can be pursued at any point.

The European Commission (2001) states that lifelong learning is "all learning activities undertaken throughout life, to improve knowledge, skills, and competencies within a personal, civic, social and/or employment-related perspective." United Nations Educational, Scientific and Cultural Organization [UNESCO] (2015) defines lifelong learning as "the continuous building of skills and knowledge throughout a person's life, to promote personal development and fulfillment, and to contribute to society's social and economic development." While no standardized definition of lifelong learning exists, these authors agree it is a self-initiated and continuous personal development process. It is not limited to formal education but can occur through various means such as reading, attending workshops or seminars, engaging in online courses, or participating in community-based learning activities.

Lifelong learning has become increasingly important in today's knowledge-based economy, where technological advancements and work changes require individuals to upgrade their skills and knowledge continually. It has numerous benefits, both for individuals and society as a whole. For individuals, it can lead to increased employability, higher earnings, improved health, and personal fulfillment. On the other hand, it can increase productivity, innovation, and social cohesion in society. Despite its benefits, lifelong learning poses challenges, particularly for disadvantaged groups such as low-income individuals and disabilities. Financial constraints, geographic location, and lack of awareness or motivation limit access to lifelong learning opportunities (Field, 2011).

1.2. 21st-Century Skills and Competencies

The 21st-century skills and competencies refer to skills and knowledge deemed essential for success in today's rapidly changing and increasingly interconnected world. These skills and competencies are often grouped into three broad categories: learning and innovation skills, digital literacy skills, and life and career skills (Trilling & Fadel, 2009). Some key skills and competencies that fall under these categories include critical thinking and problem-solving, creativity and innovation, communication and collaboration, information literacy, media literacy, technological literacy, adaptability, initiative, self-direction, social and cross-cultural skills, and leadership and responsibility.

To achieve success in both the professional and personal realms, students must embrace the concept of lifelong learning. This involves selecting areas where they can improve their proficiency and demonstrating a readiness to acquire new skills as needed. Students can maintain competitiveness and adaptability in an ever-changing environment by adopting a proactive approach to self-directed learning. Because due to fast technological advances, globalization, and immigration, twenty-first-century skills have become more critical. These skills should help citizens become lifelong learners who flexibly respond to change, proactively develop their competencies, and thrive in collaborative learning and working environments (Gijsbers & van Schoonhoven, 2012; Kaya & Mertol, 2022; Scott, 2015).

There is a growing consensus among universities and employers that these 21st-century skills and competencies are critical for individuals to succeed in a rapidly changing and increasingly complex world. As such, there has been a push to integrate these skills and competencies into educational curricula and workforce development programs. Therefore, it is crucial to understand the relationship between students' self-efficacy perceptions of 21st-century skills and their effective lifelong learning levels. This research investigates the following questions:

- What are the student's levels of success in lifelong learning and their perceptions of 21st-century skills? Is there a relationship between them?
- Do student's perceptions of 21st-century skills predict their levels of success in lifelong learning?
- Do student's learning and renewal skills predict their levels of success in lifelong learning?
- Do student's life and career skills predict their levels of success in lifelong learning?
- Do student's information, media, and technology skills predict their levels of success in lifelong learning?

2. METHOD

2.1. Research Design

This research was designed with the predictive correlational research model. In correlational research, the relationships among two or more variables are studied without any attempt to influence them (Fraenkel & Wallen, 2009).

2.2. Study Group

The research study included 66 pre-service teachers majoring in Computer Education and Instructional Technologies at a state university in Turkey. There were 30 male and 36 female participants aged between 18 and 21.

2.3. Data Collection Tools

The introduction of the online scales includes confidentiality statements, ensuring that answers will only be used for this study and not shared with anyone. The scales were voluntarily answered by 68 out of 100 people who received the forms through a link. Data collection tools are as follows:

2.3.1. Personal information form: The personal information form prepared by the researchers included two questions about the gender and age of the students.

2.3.2. Effective lifelong learning scale (ELLS): The effective lifelong learning scale was developed by Günüç, Odabaşı, and Kuzu (2014) to measure the lifelong learning success of teacher candidates and the level of having the characteristics that will enable an individual to realize effective lifelong learning. The scale consists of 33 items and a single structure. Based on a five-point Likert scale (1= completely disagree, 5= completely agree), the lowest score obtained from the scale is 33, and the highest score is 165. Low scores indicate that pre-service teachers have a low propensity for effective lifelong learning, while high scores show that these tendencies are high. There is no negative item on the scale. The Cronbach's alpha value of the scale, which could explain 41.68% of the variance in the target structure, was calculated as .96. With the data obtained within the scope of this research, the internal consistency coefficient of the scale was calculated as 0.94.

2.3.3. 21st-Century skills and competences scale: The scale developed by Anagün, Atalay, Kılıç, and Yaşar (2016) aims to measure the perceptions of teacher candidates about 21st-century skills. Consisting of 42 items and three sub-factors, the "Learning and Renewal Skills" factor is measured with 16 items, the "Life and Career Skills" factor with 18 items, and the "Knowledge, Media and Technology Skills" factor with eight items. The scale is a five-point Likert type (1= Never, 5= Always). The lowest score that can be obtained from the scale is 42, and the highest score is 210. Low scores indicate a low perception of skill competence for the relevant factor, while high scores indicate a high perception of competence for these skills. There is no reverse item in the scale, and it can explain 51.30% of the variance of the target structure. While the Cronbach alpha value of the scale was found as 0.89 in the reliability study, this value was calculated as 0.85 for the "Learning and Renewal Skills" factor, 0.83 for the "Life and Career Skills" factor, and 0.81 for the "Knowledge, Media and Technology Skills" factor. In this study, the internal consistency coefficient Cronbach's alpha value was calculated as 0.91 for the whole scale and 0.88, 0.80 and 0.84 for the factors, respectively.

2.4. Data Analysis

Analysis of data was done using IBM SPSS 23.0. Normal distribution was confirmed through Kolmogorov-Smirnov tests and histograms. Two outliers were removed from the data set, and analysis was conducted on the remaining 66 participants using various techniques, including ANOVA, Pearson product-moment correlation, and simple linear and multiple regression analysis. The assumptions of Pearson product-moment correlation and simple linear and multiple regression analyzes were tested.

3. FINDINGS

This study examined the relationships between university students' 21st-century skills and competencies (21CSC) and levels of Effective Lifelong Learning (ELL) characteristics. Also, it investigated the impact of 21CSC and its sub-factors on their ELL characteristics. The results are presented question-wise.

3.1. What are the Students' Levels of success in Lifelong Learning and their Perceptions of 21st-century skills? Is there a Relationship between them?

Table 1 shows that students' ELL average (4.08) is higher than the 21CSC average (3.98) based on total scores (N=66). The students got the highest score of 165 (full score) and the lowest score of 102 from ELL. While no students get a full score from the 21CSC scale, the highest score is 204, and the lowest is 131.

Table 1. Descriptive statistics for study variables

	Items	Min	Max	X	Sd	Item average.
ELL	33	102.00	165.00	134.50	14.84	4.08
21CSC	42	131.00	204.00	167.17	15.21	3.98
L&IS	16	43.00	76.00	59.83	7.86	3.74
L&CS	18	55.00	88.00	73.08	6.95	4.06
IM&TS	8	25.00	40.00	34.26	3.95	4.28

ELL: Effective Lifelong Learning, 21CSC: 21st Century Skills and Competences, L&IS: Learning and Innovation Skills, L&CS: Life and Career Skills, IM&TS: Information, Media and Technology Skills.

An ELL average of 4.08 out of 5 indicates that students have a high level of characteristics that will enable effective lifelong learning. A 21CSC average of 3.98 means that students' perceptions of 21st-century skills are moderate. Upon examining the sub-factors of the 21CSC scale, it is found that students consider themselves most competent in Information, Media, and Technology Skills (IM&TS), followed by Life and Career Skills (L&CS) and Learning and Innovation Skills (L&IS).

Table 2. Correlations for study variables

	1	2	3	4	5
1. ELL	-				
2. 21CSC	.77**	-			
3. L&IS	.69**	.81**	-		
4. L&CS	.59**	.86**	.46**	-	
5. IM&TS	.53**	.72**	.32**	.65**	-

Note. N=66. **p<.01

As a result of Pearson Product-Moment Correlation Analysis, positive significant relationships were found between all the study variables with a confidence interval of .01 (Table 2). ELL and 21CSC had a strong correlation at the r=.77 level regarding total scores. When the sub-factors were examined, it was seen that L&CS had the strongest relationship with 21CSC (r=.86), L&IS had a relationship at the level of r=.81, and IM&TS at the level of r=.72. L&IS had the strongest correlation with ELL (r=.69), followed by L&CS (r=.59) and IM&TS (.53), respectively.

3.2. What are the Students' Levels of Success in Lifelong Learning and their Perceptions of 21st-century Skills? Is there a Relationship between them?

A simple linear regression was calculated to predict ELL based on 21CSC. A simple linear regression determines the amount of variance in a dependent variable explained by an independent variable (Field, 2009). Preliminary analyses were performed to ensure no violation of assumptions (normality, linearity, and multicollinearity).

Table 3. Linear regression result predicting ELL based on 21CSC

Predictors	**Unstandardized coefficients**		**Standardized coefficients**	**t**
	B	**Std. Error**	**Beta**	
(Constant)	9.43	13.14		.72
21CSC	.75	.08	.77	9.56*
R^2	.59			
Adjusted R^2	.58			
F	91.29*			

Note. N=66. **p<.01

The results of the regression (see Table 3) suggested that 21CSC explained 59% of the variance, R2 = .59, F (1,64) = 91.29, p<.01. 21CSC significantly predicted ELL, β = .77, t=9.56, p<.01.

3.3. What are the Students' Levels of Success in Lifelong Learning and their Perceptions of 21st-century skills? Is there a Relationship between them?

This study was also interested in examining the impact of sub-factors of 21CSC on ELL to figure out which sub-factors were significantly contributing to the outcome of 21CSC. A multiple linear regression was calculated, and preliminary analyses were performed to ensure no assumptions were violated (normality, linearity, and multicollinearity).

Table 4. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.69[a]	.48	.47	10.77	.48	59.41	1	64	.00
2	.77[b]	.59	.58	9.64	.11	16.87	1	63	.00

[a]Predictors: (Constant), L&IS [b] Predictors: (Constant), L&IS, IM&TS

Based on the stepwise multiple linear regression analysis, it can be deduced that two factors, namely L&IS and IM&TS, have a substantial impact on ELL. The adjusted R2 value of .58 (as shown in Table 4) further reinforces this observation. However, it is worth noting that the software employed for the analysis excluded the L&CS sub-factor as it did not contribute to the model's overall effect.

Table 5. Anova

Model	Sum of Squares	Df	Mean Square	F	Sig.
1	6891.27	1	6891.27	59.41	.00[b]
	7423.23	64	115.99		
	14314.50	65			
2	8459.19	2	4229.59	45.51	.00[c]
	5855.31	63	92.94		
	14314.50	65			

a. Dependent Variable: ELL b. Predictors: (Constant), L&IS c. Predictors: (Constant), L&IS, IM&TS

Based on the data presented in Table 5, it appears that the regression equation has produced a statistically significant outcome at a level of p<.01 (F (2,65) =45.51).

Table 6. Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	**(Constant)**	56.13	10.253		5.48	.00
	L&IS	1.31	.17	.69	7.71	.00
2	**(Constant)**	23.75	12.10		1.962	.05
	L&IS	1.10	.16	.58	6.87	.00
	IM&TS	1.31	.32	.35	4.11	.00

a. Dependent Variable: ELL

According to the findings obtained through stepwise multiple linear regression analysis, it was observed that there is a positive correlation between the increase in L&IS and IM&TS scores and the ELL of students. Specifically, for each point increase in L&IS and IM&TS, the ELL of students increased by 0.58 and 0.35, respectively. These results are presented in Table 6 for reference.

4. DISCUSSION and CONCLUSION

In today's rapidly changing world, lifelong learning and acquiring modern skills are crucial for personal and professional growth. This study explored how university students' perceptions of 21st-century skills affect their lifelong learning characteristics. After analyzing the data, we gained valuable insights that explain the relationship between these essential concepts.

As supported by several studies, our findings underscore the positive correlation between 21st-century skills and lifelong learning. Darling-Hammond, Flook, Cook-Harvey, Barron and Osher (2019) discuss the implications for educational practice based on the science of learning and development. They emphasize the importance of well-vetted strategies that support relationships and learning opportunities to promote children's well-being, healthy development, and transferable learning. This suggests that developing 21st-century skills can contribute to lifelong learning by providing individuals with the necessary tools and abilities to continuously learn. Zorlu and Zorlu (2021) conducted a study on preservice science teachers and found a positive correlation between their 21st-century learner skills and science learning self-efficacy beliefs. This suggests that individuals who possess 21st-century skills are more likely to have higher self-efficacy in their ability to learn and succeed in science education. Additionally, the study found that the preservice science teachers' 21st-century skills and science learning self-efficacy beliefs predicted each other, indicating a reciprocal relationship between these factors.

Furthermore, Mawas and Muntean (2018) discuss various pedagogies that contribute to developing and mastering 21st-century competencies and skills. These pedagogies, such as Problem-Based Learning, Flipped Classroom, and Self-Directed Learning, support lifelong learning by fostering critical thinking, collaboration, and adaptability (Mawas & Muntean, 2018). As students cultivate their proficiency in Learning and Innovation Skills, Life and Career Skills, and Information, Media, and Technology Skills, they are better positioned to engage in a dynamic and rapidly changing world. The strong predictive power of 21st-century skills in determining lifelong learning characteristics echoes the significance of integrating forward-thinking competencies into educational curricula.

In conclusion, there is a positive correlation between 21st-century skills and enhanced lifelong learning. The development of 21st-century skills can provide individuals with the necessary tools and abilities to engage in continuous learning throughout their lives. Studies have shown that individuals with 21st-century skills have higher self-efficacy in learning and succeeding in various domains. Additionally, pedagogies that promote the development of 21st-century skills have been found to support lifelong learning by fostering critical thinking, collaboration, and adaptability. Therefore, it is important for educational institutions to prioritize the development of 21st-century skills to ensure that individuals are equipped with the necessary competencies to thrive in a rapidly changing world and engage in lifelong learning.

While this study provides valuable insights into the intricate relationship between 21st-century skills and lifelong learning, it also paves the way for further exploration. Furthermore, findings will help educators design curricula and instructional practices that enhance students' self-efficacy perceptions of 21st-century skills and effective lifelong learning levels. Future research endeavors could explore the impact of various educational interventions on these constructs and their influence on diverse demographic groups across different contexts. One area of further exploration could be the examination of changes in students' use of lifelong learning skills during problem-based learning projects. Problem-based learning is a teaching methodology that develops learners' capacity for and disposition toward lifelong learning (Dunlap, 2008). By studying how students' use of lifelong learning skills evolves during such projects, educators can gain a deeper understanding of how to effectively foster lifelong learning in their students.

Another avenue for future research could be the exploration of the relationship between goal orientation, information literacy self-efficacy, and lifelong learning outcomes among adult learners. Adult learners play a crucial role in the development of the country's socio-economy and are recognized as potential contributors to the generation of a knowledge-based economy (Hee, Ping, Rizal, Kowang & Fei, 2019). Understanding how goal orientation and information literacy self-efficacy influence lifelong learning outcomes can inform the design of educational programs and interventions targeted at adult learners. Additionally, it would be valuable to investigate the impact of team-learning behaviors on employees' self-efficacy and perception of individual learning in teams. A study conducted in a retail firm found that employees' individual-level self-efficacy was positively associated with their perception of individual learning in teams (Yoon & Kayes, 2016). This suggests that fostering team-learning behaviors can enhance employees' self-efficacy and promote individual learning within teams.

Ethics Committee Decision

Ethical approval and written permission for this study were obtained from the Social and Human Sciences Scientific Research and Publication Ethics Committee of Uşak University with the decision dated 11/02/2022 and numbered 2022-33.

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Abstract

The aim of this study was to determine effectively teaching acquisitions which algebraic expressions sub-learning take place in algebra learning field to sixth-grade students by using educational games in addition available teaching methods and the student perspectives on the mathematics lesson. The research's study group consisted of 31 sixth graders from two village middle schools in the province of Niğde's central district. One of the mixed research approaches, exploratory sequential design, was selected since it was better in accordance with the study's objectives. Both groups took the attitude scale as a pre-test before the application. The experimental group was then taught mathematics using educational games, whereas the control group received no intervention and was simply taught using the techniques found in the present curriculum. Both groups were given the attitude scale as a post-test after the application. Qualitative information was acquired by asking the experimental group's students their opinions of the method after it had been used. Since the collected quantitative data had a normal distribution, comparisons between groups were made using the independent sample t-test, while comparisons within groups were made using the dependent sample t-test. The qualitative data that was collected was analyzed using content analysis. The results of the study showed that employing educational games to teach mathematics significantly changed the attitudes of the experimental group members toward the topic, or, to put it another way, positively impacted them. After taking into account the students' perceptions of the process, it was determined that the use of educational games during the lesson raised interest, motivated students, increased their participation in the lesson, helped them understand the subject, and the students enjoyed the process.

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Research Article

The Effect of Teaching Algebraic Expressions with Educational Games on Sixth-Grade Students' Attitudes towards Mathematics*

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Abstract

The aim of this study was to determine effectively teaching acquisitions which algebraic expressions sub-learning take place in algebra learning field to sixth-grade students by using educational games in addition available teaching methods and the student perspectives on the mathematics lesson. The research's study group consisted of 31 sixth graders from two village middle schools in the province of Niğde's central district. One of the mixed research approaches, exploratory sequential design, was selected since it was better in accordance with the study's objectives. Both groups took the attitude scale as a pre-test before the application. The experimental group was then taught mathematics using educational games, whereas the control group received no intervention and was simply taught using the techniques found in the present curriculum. Both groups were given the attitude scale as a post-test after the application. Qualitative information was acquired by asking the experimental group's students their opinions of the method after it had been used. Since the collected quantitative data had a normal distribution, comparisons between groups were made using the independent sample t-test, while comparisons within groups were made using the dependent sample t-test. The qualitative data that was collected was analyzed using content analysis. The results of the study showed that employing educational games to teach mathematics significantly changed the attitudes of the experimental group members toward the topic, or, to put it another way, positively impacted them. After taking into account the students' perceptions of the process, it was determined that the use of educational games during the lesson raised interest, motivated students, increased their participation in the lesson, helped them understand the subject, and the students enjoyed the process.

Keywords: Mathematics teaching, educational game, attitude towards mathematics, algebraic expressions

1. INTRODUCTION

Mathematics, which has been in our lives since the first days of human history, has been the cornerstone for individuals, nations and states to develop themselves. So much so that the ability to provide answers for the issues at the core of all forms of technology and personal development is crucial. This is exactly where mathematics and the ability to do mathematics come into play. Many different definitions have been made for mathematics, which has a place in people's lives from the day they are born until the last moment of their lives. As Baykul (2009) states, the definitions made were in line with people's interest and needs. The common point of these definitions is that mathematics is a universal language and we encounter it at every moment of life. Particularly when schooling is taken into account, it is evident that students find mathematics, a fundamental course, to be abstract and challenging to learn (Köğce, 2021). According to Aydın (2018), who states that research on

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mathematics reveals that it is difficult to break such prejudices because the dominant thought in most of the students is that mathematics is a course that is difficult or even impossible to do, assuming that the reason for the failure is due to the student without looking at the root of the existing problem causes the understanding of the mathematics course to become more complicated. It can be said that the main reasons underlying the existence of these thoughts are that students are not eager to learn, try to learn by memorising, do not actively participate in the learning process, get bored with the lesson because they cannot perform meaningful learning, and give their attention elsewhere. It is the main desire of mathematics teachers to attract the energy of students to the lesson.

A large part of a person's life is spent in school, in education and training. Early introduction to school allows students to play off their built-up energies, which they then expend by playing games. For some, play is thought to be laughing, having fun, having a pleasant time, while for others it is thought to look at life from different perspectives, discovering while having fun, and developing intelligence (Güneş, 2015). According to Yavuzer (2019), who defines the game in the focus of education, the game is that the child learns the subjects that he cannot learn with the help of someone else, thanks to hisown acquisitions, without thinking about the result, thanks to the movements he makes with the aim of having fun.

While teaching mathematics, which is seen as difficult and complex by students, environments should be created to enable students to participate actively and willingly in the process, to internalise the acquired knowledge, and especially to concretise the concepts that remain abstract. Because, thanks to these environments, students can learn the content that they cannot make sense of by hearing from others, and they can make it meaningful by having fun (Aykaç & Köğce, 2019). One of the ways to create such an environment is to bring the games that students enjoy greatly into the school boundaries as educational games. Açıkgöz (2003) stated that including games during the lesson will make the lessons interesting, and at the same time, students' motivation towards the lesson will increase. Aykaç and Köğce (2021), on the other hand, defined the educational game as a set of activities that lead to the targeted achievements of the lesson in a pleasant way that enables students to actively participate in the learning process physically and spiritually. In this way, the student will achieve learning by feeling happier and enjoying himself with active participation and by discovering the information through hisown experiences instead of receiving it directly from the teacher. At the same time, since the student will realise that he can access the information himself and concretise the abstract mathematical concepts through the game, he will get rid of the negative perceptions he has against the mathematics course (Yeşilkaya, 2013).

One of the points emphasised in the mathematics curriculum (Ministry of National Education [MoNE], 2018), which has a constructivist education approach at its centre, is the preparation of environments where students can discover knowledge, interact with each other and share their ideas while searching for solutions to questions and problems. Educational games to be used in learning environments are among the activities that serve this purpose. These activities are very important in terms of helping students discover the fun side of mathematics by enjoying the process in line with the understanding adopted by the current mathematics curriculum, as well as enabling students to learn the subjects in the mathematics course by participating in the process mentally and physically.

Since algebra, which is one of the fields of mathematics, is a difficult field to be understood by students, it is very important to enrich the learning process in order to understand and make sense of the subject. Because algebra is encountered in many areas of our lives and it is necessary to learn algebra both to progress in mathematics education and to continue higher education (Ersoy, 1997). In other words, we can say that algebra is the key to success in mathematics and other courses. While defining algebra, Altun (2016) used the expression of language built on equations written with variables whose value is not certain but can be expressed with the help of symbols. In more general terms, we can say that algebra is a branch of mathematics that enables the use of numbers and symbols to transform the relationships between them into equations and general expressions in mathematics (Ünlü, 2021). The reason why algebra is so important in mathematics teaching is that it enables students to analyse mathematical situations and helps them to know and understand the world (National Council of Teachers of Mathematics [NCTM], 2000).

When the mathematics curricula at all levels in our country are examined, it is seen that the development of affective characteristics is as important as the acquisition of mathematical knowledge and skills, and therefore it is also important that the attitude to be developed towards mathematics is positive. In other words, it is very important for students to see mathematics as a field worth dealing with, useful and perceptible. Students' caring about mathematics, believing that mathematics develops thinking skills, appreciating the benefits it provides, enjoying dealing with mathematics and being willing to learn mathematics can be considered as the reasons for their positive attitude towards mathematics. It can be concluded that the fact that students who show all these positive characteristics are successful in mathematics lessons is the result of this mutual relationship between success and attitude (Tarım & Artut, 2016).

Most of the students do not favour mathematics activities because they are afraid of making mistakes. In studies on fear and anxiety towards mathematics, it is observed that as children's experiences in mathematics increase, their negative attitudes decrease. Although the role of the school and the teacher is very important in this, it is not possible to increase mathematics achievement unless this negative attitude changes (Altun, 2014).

The measures that teachers can take to help students develop positive attitudes towards mathematics can be listed as follows.

- Instead of making students memorise the concepts of operations and solution methods, emphasis should be placed on their understanding of these concepts.
- Homework in maths lessons should not be long and tedious; short assignments that encourage students to do research should be preferred.
- The teacher should make it clear that there are many ways to arrive at the correct answer and should find the different solutions of the students valuable.
- Sufficient time should be given for students to perform operations, draw shapes and solve problems, and students should not be worried about not being able to complete the task.
- The mistakes made by the students while performing operations should be tolerated, and studies should be carried out to show the correct way to correct these mistakes without offending or hurting the students.
- Students should be given opportunities and environments should be prepared for them to express their own thoughts.
- Care should be taken to ensure that students who learn faster and have good achievement do not block students who learn more slowly.
- Student groups should be formed in a heterogeneous way and students should be given the opportunity to discuss the topics with each other, and each student should be ensured to participate in the lesson.
- Students should be made aware of the enjoyable and relaxing side of mathematics and gamified activities should be allowed in mathematics teaching (Altun, 2014).

When the definitions for attitude are analysed, it is seen that there is no common acceptance. This is because researchers are influenced by different theories, which has led to the emergence of different definitions. However, if we focus on the common point of the definitions, attitude can be defined as a person's positive or negative emotional, mental, behavioural reaction to a concept, another person, a situation or an object. Since attitude has the ability to affect and change behaviours, its effect on success has also been focused on. In other words, it was deemed worthwhile to investigate how important it is for a person to develop a positive attitude towards a subject at the point of being successful in a subject. In this context, students' attitudes towards courses have been considered as one of the factors affecting their success in those courses (Tarım & Artut, 2016).

Uysal-Koğ (2007) stated that students' attitudes towards mathematics are a factor that has a significant effect on their academic achievement and that an individual's negative attitude towards a field such as mathematics, which has a connection between its subjects, will reduce the student's interest in this course. Bayturan (2004), on the other hand, stated that students' attitudes towards mathematics is an important factor that shapes their behaviours towards the course, has a share in motivating them and can be considered as a determinant of personal impressions such as liking or disliking mathematics.

In the light of all this information, it is thought that teaching algebraic expressions, which is one of the first subjects that students encounter with abstract thinking when considering their education life, with educational games can positively affect students' attitudes towards mathematics course. In this context, in this study, it was aimed to determine the effect of teaching the acquisitions in algebraic expressions sub-learning area of algebra learning area by using educational games on sixth-grade students' attitudes towards mathematics and students' opinions about the process. Along with this aim, it is thought that the result to be obtained will be useful for teachers and mathematics educators who want to benefit from educational games in educational environments in order to set an example.

The problem of this research seeks an answer to the question "What is the effect of educational game-supported teaching of algebraic expressions in the mathematics curriculum on students' attitudes towards mathematics?" based on this problem, the aims of the research are shaped as follows.

1. Are the pre-attitude scores of the experimental group students who received educational game support compared to the control group students who received instruction in line with the current curriculum significantly different?
2. Is there a discernible difference in the students' final attitude ratings between the experimental group, who got educational game-supported instruction, and the control group, who received instruction in line with the current curriculum?
3. Do the pre- and last-Attitude scores of the experimental group pupils who got game-supported instruction geared toward mathematics courses significantly differ from one another?
4. Do the pre-attitude and last-Attitude scores of the control group pupils, who were taught using the current curriculum, show a statistically significant difference?
5. What thoughts do the experimental group students have regarding the application procedure after receiving game-based learning?

2. METHOD

2.1. Research Model

One of the mixed research approaches, exploratory sequential design, was applied in this study. Researchers gather and analyze quantitative data first in the exploratory sequential design, and then they gather qualitative data to supplement the quantitative data they have already collected (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2021; Creswell, 2021). To supplement these data, qualitative data were then obtained after the quantitative data, for this reason. Quantitative data were obtained using a semi-experimental methodology with an unequalized control group for the pretest and posttest. A questionnaire for interviews was used to gather qualitative data.

2.2. Universe and Sample

The sixth graders enrolled in Niğde public secondary schools for the 2022–2023 academic year are the study's target audience. The study's sample consists of sixth graders from two secondary schools in the central area of Niğde province with equivalent physical conditions. This study featured a total of 31 sixth graders, with 12 students in the experimental group and 19 students in the control group.

2.3. Data Collection Tools

Within the scope of this study, quantitative and qualitative data were collected.

Quantitative information was gathered using the Attitude Scale towards Mathematics Course (ASTMC) created by Yetgin (2019). The ASTMC employed in the study has six sub-factors and 29 scale items. According to professional assessments, the sub-factors are avoidance, optimistic attitudes, prejudice and anxiety, system, observation, and experience. The table below lists the sub-factors under which each of the scale's 29 items is classified.

Table 1. Distribution of the items in ASTCM according to sub-factors

Sub Factor	*Scale Item Number*
Avoidance	7, 10, 14, 16, 17, 19, 20, 24, 25
Positive Attitudes	1, 2, 27, 28
Anxiety and Prejudice	5, 12, 13, 15, 18, 21, 23, 29
System	9, 11, 22
Observation	3, 26
Experience	4, 6, 8

Prior to the use of the ASTMC in the study, the researcher carried out a pilot study with 19 seventh-grade students and the reliability coefficient was calculated. While analysing the data, the items in the scale that indicate positive expressions were scored as "strongly disagree" option 1, "disagree" option 2, "agree" option 3, "strongly agree" option 4 points; while the items that indicate negative expressions were scored as "strongly disagree" option 4, "disagree" option 3, "agree" option 2, "strongly agree" option 1 point. The scale's Cronbach's Alpha value was computed as 0.782 as a result of the study performed using the scores received, and it was decided that the scale was valid and reliable. By receiving the required authorization from the scale owner, the ASTMC was utilized in this context as a pre- and post- test in both the experiment group and the control group prior to and after the implementation in the study. While analysing the scale items, scoring was done as in the pilot study. As a result, the score that was lowest on the 29-item attitude scale was 29, and the score that was highest was 116.

In the collection of qualitative data, the eight-question Student Opinion Form (SOF) developed by Can (2022) in consultation with experts and teachers in the field of mathematics education was used. This form is given in Table 2 below.

Table 2. Student opinion form (SOF)

	Student Opinion Form Questions
1	Did the teaching with games contribute to you? If you think it contributed, what kind of contributions did it make?
2	Were you happy to teach maths with games? Why?
3	How did teaching mathematics with games affect your interest and attitude towards mathematics?
4	Have you ever taught mathematics with games in your lessons? How are mathematics lessons in which mathematics is taught with games different from mathematics lessons in which mathematics is not taught with games?
5	Would you like mathematics teaching with games to be done in other mathematics subjects? If you want it to be done in other subjects, briefly explain which subject you would like this subject to be.
6	How did the maths lessons taught with games affect your participation and motivation?
7	Did the maths lessons with games give you different perspectives?
8	How do you think maths lessons supported by games will affect your success in your lessons?

With the quantitative data from the ASTMC, it was intended to support the qualitative data from the SOF. In this instance, the SOF was used with the experimental group of students once the application was completed in the research with the requisite approval from the form owner.

2.4 Data Collection

In the study, the sixth-grade algebraic expressions topic was taught with the help of educational games in the experimental group and with the methods in the current curriculum in the control group. In both experimental and control groups, the teaching of 3 objectives of the algebraic expressions topic in the mathematics curriculum was completed in 10 lesson hours and the study lasted for 2 weeks.

Prior to application to the experimental and control groups, the ASTMC was employed as a pre-test. After the application was finished, ASTMC was administered once more to both groups as a post-test. Additionally, Can's SOF was made available to students in the experimental group so that their thoughts of the process could be ascertained.

2.5. Analysing the Data

After carrying out a normality analysis in the SPSS program to solve the sub-problems of the research, it was discovered that the pre- and post-test attitudes results were normally distributed. This was accomplished by contrasting the pre and post-test scores' skewness and kurtosis scores with those found in the Shapiro-Wilk test. It was concluded that parametric tests can be used in comparisons between groups or within groups. As a result, the results of the pre- and post-tests within the groups were compared using the dependent sample t-test, and the control and experimental groups were compared using the independent sample t-test. With a 95% confidence interval, the analyses were performed using the SPSS 27 package program ($p < 0.05$).

While analysing the qualitative data, content analysis was performed with the data obtained from the SOF developed for the opinions of the students in the experimental group towards educational games. The data obtained from the SOF were coded first by the researcher and then by two academicians. In order to determine the reliability of these data coded by different people, the percentage of agreement between the coders was calculated with the formula [Similar opinion / (Similar opinion + Different opinion) x 100] (Miles & Huberman, 1994). The percentage of agreement calculated in the study was found to be 79% and since this rate was more than 70%, it was concluded that the results of the analysis would be reliable. After the categories were determined according to the similarities or differences between the codes, the sub-codes expressed by each code were created. Instead of using the names of the 12 students in the experimental group in the study, each of them was labelled as: S1, S2, S3,..., S12. The results were tabulated by looking at the frequency percentage of the data obtained in line with the answers given by the students.

3. FINDINGS

3.1. Descriptive Statistics of the tests Used in the Research Process

In the studies conducted, firstly, it is checked whether the scores obtained on a continuous variable show a normal distribution or not. One of the methods used for this is to look at the values of descriptive statistics such as skewness coefficient (skewness) and arithmetic mean. The analysis's premise is that the results shouldn't differ from average in terms of scores. When the skewness coefficient is between -2 and +2, which is the range for this purpose, it is assumed that the scores do not stray considerably from normal. In addition, another method of determining whether the data is normally distributed is to utilise the tests applied by looking at the size of the groups. Kolmogorov-Smirnov test is used if the group size is greater than 50, while Shapiro-Wilk test is used if the group size is less than 50. If the p value produced from the analysis using these tests is higher than 0.05, it is assumed that the data acquired are normally distributed and do not significantly deviate from normal. Depending on the sub-problems of the study, it is decided whether to use parametric or nonparametric tests depending on whether the distribution is normal or not (Büyüköztürk, 2021; George & Mallery, 2010).

In this context, in line with the information above, the Shapiro-Wilk test was used in the normality value calculations since the number of students in the study was less than 50. In the research process, the arithmetic averages ($\overline{X}$), standard deviation (SD), kurtosis and skewness values of the scores obtained from the Attitude Scale Towards Mathematics Lesson (ASTMC) applied to the experimental and control groups as pre-test and post-test and the p values obtained from the normality test were calculated and these values are given in the tables below.

Table 3. Descriptive statistics of experimental and control groups

Groups	*Test*	$\overline{X}$	*SD*	*Kurtosis*	*Skewness*	*Shapiro-Wilk (p)*
Experiment (N=12)	ASTMC Pre-attitude	73,25	7,605	-,381	-,844	,128
	ASTMC Last-Attitude	94,67	7,512	,184	-,125	,990
Control (N=19)	ASTMC Pre-attitude	72,47	9,800	-,850	-,177	,584
	ASTMC Last-Attitude	70,16	10,095	1,511	-,088	,354

Table 4. Descriptive statistics of attitude scale sub-factors of experimental and control groups

Test	*Groups*	*Attitude Scale Sub Factors*	$\bar{X}$	*SD*	*Kurtosis*	*Skewness*	*Shapiro-Wilk (p)*
ASTMC Pre-attitude	Experimental Group (N=12)	Positive Attitudes	9,08	1,832	-,953	-,253	,269
		Observation	4,75	1,138	,425	,139	,158
		Experience	7,17	1,899	-1,255	,193	,087
		Anxiety and Prejudice	21,00	4,243	,428	-,926	,196
		Avoidance	24,42	3,343	-,735	-,086	,893
		System	6,83	1,801	-,666	,409	,287
	Control Group (N=19)	Positive Attitudes	9,21	2,275	,377	-,290	,402
		Observation	4,00	1,856	-,430	,543	,055
		Experience	7,00	2,285	-,130	,406	,815
		Anxiety and Prejudice	18,05	3,979	-,647	,217	,750
		Avoidance	25,68	3,728	-1,359	,234	,080
		System	8,53	2,195	-,965	,084	,309
ASTMC Last-Attitude	Experimental Group (N=12)	Positive Attitudes	13,67	1,073	,905	,804	,146
		Observation	5,83	1,403	-1,097	,351	,187
		Experience	7,25	1,960	,474	-,679	,264
		Anxiety and Prejudice	27,83	3,040	-,260	-,393	,822
		Avoidance	30,08	2,937	1,923	-1,389	,059
		System	10,00	1,758	-,504	-,602	,133
	Control Group (N=19)	Positive Attitudes	8,37	2,891	-1,298	,082	,214
		Observation	3,95	1,649	,441	,675	,062
		Experience	7,37	1,950	,867	,774	,223
		Anxiety and Prejudice	18,00	4,372	,192	,348	,839

	Avoidance	25,00	3,972	-1,046	-,143	,458
	System	7,47	1,926	,318	,436	,556

In line with the statistical information in Table 3 and Table 4, it is seen that the p values are greater than 0.05 as a result of examining the pre-test and post-test scores applied to the groups and the sub-dimensions in the attitude scale. For this reason, it was concluded that the data showed normal distribution, and in the analysis of the data in accordance with the sub-problems, independent (unrelated) sample t-test was used in comparisons between the experimental and control groups, and dependent (related) sample t-test was used in cases requiring comparison of the groups within themselves. According to the p value obtained from the t-test, it was decided whether there was a significant difference between the compared quantities.

While the p value obtained from the tests used is less than 0.05 indicates that the result is a significant difference, this does not provide information about the degree of significance. Another statistic utilised in the interpretation of the results when comparing the mean scores is the effect size. The Cohen-d value, which allows interpretation of how far the compared averages diverge from each other, is the value commonly used in effect size calculations. The d value, which can potentially take values between $-\infty$ and $+\infty$, is expressed as small, medium and large effect size with values of 0.2, 0.5 and 0.8, respectively, regardless of its sign (Büyüköztürk, 2021).

For this reason, if the p-value obtained from the tests used showed a significant difference, Cohen-d value was also calculated in order to reveal the effect size of the difference and to make more accurate comments, and answers to the sub-problems were sought and comments were made accordingly.

3.2. Findings of the first sub-problem

The data to be used to answer the first sub-problem of the study, "Is there a significant difference between the pre-test attitude scores of the experimental group students who received educational game supported education and the control group students who received education according to the current curriculum towards mathematics course?", were obtained from the pre-test of ASTMC applied to both groups, and since the data conformed to the normal distribution, the independent sample t-test was used to compare the pre-test attitude scores. The results of the analyses are given in Table 5.

Table 5. Independent sample t-test analysis of experimental and control group students' pre-attitude scores of ASTMC

Groups	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*
Experiment	12	73,25	7,605	29	,233	,817
Control	19	72,47	9,800			

*p < 0,05

When Table 5 is analysed, it is seen that the experimental group ASTMC pre-attitude mean score is 73.25, while the control group ASTMC pre-attitude mean score is 72.47. Since the p value indicated as the significance level was greater than 0.05, it was found that the ASTMC pre-attitude scores between the groups did not differ significantly [t (29) = ,233 and p> 0.05]. With the findings obtained here, it can be concluded that the attitudes of the experimental group students and the control group students towards mathematics before the application were equivalent to each other.

The change in the scores of the sub-factors in the attitude scale was also analyzed in order to more thoroughly investigate the impact of the applied method on students' attitudes toward mathematics. The pre-attitude sub-factor scores of the experimental and control group students in the ASTMC were compared using an independent sample t-test. The results of the analyses are given in Table 6.

Table 6. Independent sample t-test analysis of the experimental and control group students' sub-factors of the pre-attitude test sub-factors of the ASTMC

Attitude Scale Sub Factors	*Groups*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*
Positive Attitudes	Experiment	12	9,08	1,832	-,163	29	,872
	Control	19	9,21	2,275			
Observation	Experiment	12	4,75	1,138	1,307	29	,202
	Control	19	4,00	1,764			
Experience	Experiment	12	7,17	1,899	,211	29	,835
	Control	19	7,00	2,285			
Anxiety and Prejudgement	Experiment	12	21,00	4,243	1,959	29	,060
	Control	19	18,05	3,979			
Avoidance	Experiment	12	24,42	3,343	-,958	29	,346
	Control	19	25,68	3,728			
System	Experiment	12	6,83	1,801	-2,235	29	,073
	Control	19	8,53	2,195			

*p < 0,05

When Table 6 is carefully analyzed, it can be observed that the p value, which indicates the significance level of the disparity in the results of the control and experimental group of students on each sub-factor of the attitude scale, is greater than 0.05 for each sub-factor. This indicates that there is not a significant disparity in the pre-attitude ratings of the ASTMC between the groups.

In accordance to the analyses, there was no discernible difference between the control and experimental groups of students' attitudes towards mathematics prior to instruction in terms of positive attitudes, observation, experience, anxiety and prejudice, avoidance, and system sub-factors, or put another way, the groups' attitudes were comparable.

3.3. Findings of the second sub-problem

The data to be used to answer the second sub-problem of the study, "Is there a significant difference between the post-test attitude scores of the experimental group students who received educational game supported education and the control group students who received education according to the current curriculum towards mathematics course?" were obtained from the post-test of ASTMC applied to both groups, and the independent sample t-test was used to compare the post-test attitude scores since the data conformed to the normal distribution. The results of the analyses are given in Table 7.

Table 7. Independent sample t-test analysis of experimental and control group students' ASTMC final attitude scores

Groups	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*	*Cohen-d*
Experiment	12	94,67	7,512	29	7,224	,000	2,664
Control	19	70,16	10,095				

*p < 0,05 ; **d > 0,8

When Table 7 is analysed, it is seen that the mean final attitude score of the experimental group ASTMC was 94.67, while the mean final attitude score of the control group ASTMC was 70.16. Since the p value indicated as the significance level was less than 0.05, it was determined that the ASTMC final attitude scores between the groups differed significantly [t (29) = 7.224 and p <0.05]. Since the result was found to be significant, the Cohen-d value, which reveals the effect size, was also calculated and found to be 2.664.

With regard to last-Attitude scores, the experimental group in the ASTMC significantly outperformed the control group (d > 0.8), favoring the experimental group, according to all of these findings. This finding suggests that using educational games to teach mathematics significantly and favorably influences students' attitudes toward the subject.

The change in the results of the component factors in the scale for attitude was also analyzed in order to more thoroughly investigate the impact of the applied method on students' attitudes toward mathematics. The overall attitude sub-factor results of the control and experimental group students were compared using an independent sample t-test. Table 8 presents the findings of the analyses.

Table 8. Independent sample t-test analysis of the sub-factors of the final attitude test sub-factors of the final attitude test of the experimental and control group students

Attitude Scale Sub-Factors	*Groups*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*	*Cohen-d*
Positive Attitudes	Experiment	12	13,67	1,073	6,059	29	,000	2,234
	Control	19	8,37	2,891				
Observation	Experiment	12	5,83	1,403	3,278	29	,003	1,209
	Control	19	3,95	1,649				
Experience	Experiment	12	7,25	1,960	-,164	29	,871	
	Control	19	7,37	1,950				
Anxiety and Prejudice	Experiment	12	27,83	3,040	6,803	29	,000	2,508
	Control	19	18,00	4,372				
Avoidance	Experiment	12	30,08	2,937	3,814	29	,001	1,406
	Control	19	25,00	3,972				
System	Experiment	12	10,00	1,758	3,676	29	,001	1,355
	Control	19	7,47	1,926				

*p < 0,05 ; **d > 0,8

When Table 8 is closely examined, it becomes clear that there is a significant difference in the final attitude scores of the ASTMC between the groups because the p value, which indicates the significance level of the difference between the scores of the experimental and control group students on the positive attitudes, observation, anxiety and prejudice, avoidance, and system sub-factors of the attitude scale, is less than 0.05 for each sub-factor. The Cohen-d values indicating the effect size were also calculated because the result was significant, and it was discovered that these values were larger than 0.8, indicating that the effect size was at a high level. It was determined that there was no discernible difference in the scores between the groups for the experience sub-factor.

In light of the results, it can be concluded that using educational games to teach mathematics made a significant and effective difference in favor of the experimental group in the sub-factors of positive attitudes, observation, anxiety and prejudice, avoidance and system, but did not make any difference at all in the sub-factors of negative attitudes, avoidance and system, avoidance, and system.

3.4. Findings of the third sub-problem

The data to be used to answer the third sub-problem of the research, "Is there a significant difference between the pre-attitude and last-Attitude scores of the experimental group students who received educational game supported education towards mathematics course?" were obtained from the pre and last-Attitude test of ASTMC applied to the experimental group, and since the data conformed to the normal distribution, the dependent sample t-test was used to compare the pre and post-test attitude scores. The results of the analyses are given in Table 9.

Table 9. Dependent sample t-test analysis of experimental group students' pre-attitude and last-attitude scores of ASTMC

Tests	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*	*Cohen-d*
Pre-Attitude	12	73,25	7,605	11	-7,716	,000	2,227
Last-Attitude	12	94,67	7,512				

*p < 0,05 ; **d > 0,8

When Table 9 is analysed, it is seen that the mean pre-attitude score of the experimental group ASTMC is 73,25 and the mean last-Attitude score is 94,67. Since it is seen that the p value specified as the significance level is less than 0.05, it is concluded that the pre and last-Attitude scores of the experimental group students' ASTMC pre and last-Attitude scores show a significant difference [t (11) =-7.716 and p <0.05]. Since the result was found to be significant, the Cohen-d value, which reveals the effect size, was also calculated and found to be 2,227. From all of these results, it can be inferred that the ASTMC pre-attitude and last-Attitude scores of the experimental group students differ in favor of the last-Attitude and have a significant effect at a high level (d> 0.8), favoring the last-Attitude. This finding suggests that using educational games to teach mathematics has a positive and beneficial effect on improving the students' attitudes toward the subject among the experimental group.

The change in the scores of the sub-factors in the attitude scale was also analyzed in order to more thoroughly examine the impact of the applied method on students' attitudes toward mathematics. The ASTMC pre and last-Attitude sub-factor scores of the experimental group students were compared using a dependent sample t-test. Table 10 presents the analysis' findings.

Table 10. Dependent sample t-test analysis of the experimental group students' sub-factors of ASTMC

Attitude Scale Sub-Factors	*Tests*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*	*Cohen-d*
Positive Attitudes	Pre-Attitude	12	9,08	1,832	-6,004	11	,000	1,733
	Last-Attitude	12	13,67	1,073				
Observation	Pre-Attitude	12	4,75	1,138	-1,946	11	,078	
	Last-Attitude	12	5,83	1,403				
Experience	Pre-Attitude	12	7,17	1,899	-,108	11	,916	
	Last-Attitude	12	7,25	1,960				
Anxiety and Prejudice	Pre-Attitude	12	21,00	4,243	-5,250	11	,000	1,515
	Last-Attitude	12	27,83	3,040				
Avoidance	Pre-Attitude	12	24,42	3,343	-5,696	11	,000	1,644
	Last-Attitude	12	30,08	2,937				
System	Pre-Attitude	12	6,83	1,801	-7,181	11	,000	2,073
	Last-Attitude	12	10,00	1,758				

*p < 0,05 ; **d > 0,8

When Table 10 is examined in detail, it is seen that the p value showing the significance level of the difference between the scores of the experimental and control group students in the positive attitudes, anxiety and prejudice, avoidance and system sub-factors in the attitude scale is less than 0.05 for each sub-factor, so it is seen that the final attitude scores of the ASTMC between the groups show a significant difference. Since the result was significant, Cohen-d values showing the effect size were also calculated and it was seen that these values were greater than 0.8, that is, the effect size was at a large level. For the sub-factor of experience by observation, it was concluded that the scores between the groups did not differ significantly.

Considering the findings obtained, it can be concluded that, as a result of the examination of the pre and last-Attitude scores of the experimental group students towards mathematics on the basis of sub-factors, it can be concluded that mathematics teaching with educational games created a significant and effective difference in favour of the last-Attitude in the sub-factors of positive attitudes, anxiety and prejudice, avoidance and system, but it did not create any effect in the sub-factors of observation and experience.

3.5. Findings of the fourth sub-problem

The data to be used to answer the fourth sub-problem of the study, "Is there a significant difference between the pre-attitude and last-Attitude scores of the control group students who received education according to the current curriculum towards mathematics course?", were obtained from the pre and last-Attitude test of the ASTMC administered to the control group, and since the data conformed to the normal distribution, the dependent sample t-test was used to compare the pre and post-test attitude scores. The results of the analyses are given in Table 11.

Table 11. Dependent sample t-test analysis of control group students' pre-attitude - last-attitude scores of ASTMC

Tests	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*
Pre-Attitude	19	72,47	9,800	18	,888	,386
Last-Attitude	19	70,16	10,095			

*p < 0,05

When Table 11 is analysed, it is seen that the mean pre-attitude score of the control group ASTMC is 72,47 and the mean last-Attitude score is 70,16. Since the p value specified as the level of significance is greater than 0.05, it is seen that the control group students' pre-attitude and last-Attitude scores of the ASTMC do not differ significantly [t (18) = ,888 and p > 0.05]. With this finding, it can be thought that mathematics teaching with the applications in the current curriculum did not have any effect on the attitudes towards mathematics of the students in the control group.

As a result of the analysis, it was found that mathematics education according to the current curriculum had no effect on the mathematics attitudes of the control group students; however, in order to see whether there was any change between the scores of the sub-factors in the attitude scale, the score changes between the sub-dimensions were also analysed. Dependent sample t-test was used to compare the ASTMC pre and last-Attitude sub-factor scores of the control group students. The results of the analyses are given in Table 12.

Table 12. Dependent sample t-test analysis of the control group students on the sub-factors of ASTMC

Attitude Scale Sub-Factors	*Tests*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*
Positive Attitudes	Pre-Attitude	19	9,21	2,275	1,068	18	,300
	Last-Attitude	19	8,37	2,891			
Observation	Pre-Attitude	19	4,00	1,764	,112	18	,912
	Last-Attitude	19	3,95	1,649			
Experience	Pre-Attitude	19	7,00	2,285	-,552	18	,588
	Last-Attitude	19	7,37	1,950			
Anxiety and Prejudice	Pre-Attitude	19	18,05	3,979	,045	18	,965
	Last-Attitude	19	18,00	4,372			
Avoidance	Pre-Attitude	19	25,68	3,728	,817	18	,425
	Last-Attitude	19	25,00	3,972			
System	Pre-Attitude	19	8,53	2,195	1,617	18	,123
	Last-Attitude	19	7,47	1,926			

*p < 0,05

When Table 12 was examined in detail, it was found that the p value showing the significance level of the difference between the pre-test and post-test attitude scores of the control group students in all sub-factors in the attitude scale was greater than 0.05 for each sub-factor, and it was found that the pre and last-Attitude scores of the control group students for all sub-factors did not differ significantly.

In line with the analyses, as a result of the examination of the control group students' pre-attitude - last-attitude scores towards mathematics on the basis of sub-factors, it was determined that mathematics teaching in accordance with the current curriculum did not have any effect on positive attitudes, observation, experience, anxiety and prejudice, avoidance and system sub-factors.

3.6. Findings of the fifth sub-problem

The data to be used to answer the fifth sub-problem of the research, “What are the opinions of the experimental group students who received educational game supported education about the application process?” were obtained with the Student Opinion Form applied to obtain the opinions of the experimental group students about the process of mathematics teaching with educational games. Content analysis was made in line with the answers received from the students and the results are given in Table 13.

Table 13. Content analysis of data obtained from SOF

Category	*Codes*	*f*	*%*
Impact on / contribution to learning	Being fun and catchy	12	%100
	Gaining a different perspective	11	%92
	Ensuring effective learning	12	%100
Contribution to interest / motivation	Ensuring happiness	12	%100
	Increasing motivation	12	%100
	Increasing participation in the lesson	11	%92
The effect / contribution of teaching with educational games	Making the lesson more fun and understandable	12	%100
	Requesting the teaching of other subjects with educational games	11	%92

When Table 13 is analysed, it is seen that only three of the responses of the twelve experimental group students to the SOF consisting of eight questions were negative. These opinions were "Honestly, I cannot say that I gained a different perspective. Because I already liked mathematics.", "I do not participate in the lesson much. But when the games were played, I gave all my excitement to the game." and "I don't want all subjects to be done with games. I usually like to solve questions in the mathematics lesson." It is seen that both of the negative opinions stated here are actually due to the student's love for the mathematics lesson, and one opinion shows that the student does not want to participate in the lesson because he is timid, but he is excited during the lesson taught with educational games. Considering all these situations, it shows that the students enjoyed the mathematics teaching using educational games, had fun during the process, were more active and felt happy.

When we look at the opinions of the students about the mathematics lessons using educational games, it is seen that almost all of them have positive opinions. We can think that all these positive opinions are also related to the increase in students' attitudes towards mathematics. For this reason, it can be said that educational games reflect positively on students' thoughts and attitudes towards the course.

4. DISCUSSION and CONCLUSION

The purpose of this study was to ascertain the impact that employing educational games while teaching mathematics had on the attitudes of the pupils. The ASTMC used as the pre-attitude revealed that the experimental group’s students had a mean attitude of 73.25, whereas the control group's students had a mean attitude of 72.47. The p value indicating the significance level of the pre-attitude scores was 0.817. When pre-attitude scores are taken into account, these results indicate that there is no significant difference between the groups; in other words, the groups' attitudes were similar before the program was implemented. The mean attitude of the experimental group students was 94,67, while that of the control group students was 70,16, according to the ASTMC used as the final attitude after application. The p value indicating the significance level of the final attitude scores was 0,000, and the Cohen-d value indicating the effect size was 2,664. These results demonstrate that mathematics instruction utilizing educational games improved the attitude scores of the experimental group while mathematics instruction following the current curriculum resulted in a decline in the attitude scores of the control group's students. The results of this study show that instructional games can improve students' attitudes toward mathematics in a short amount of time, whereas emotional traits like attitude require time to develop.

When the literature was analyzed, it became clear that other research had produced outcomes comparable to those of this one. Çopur (2021) conducted a study to investigate the impact of virtual game-supported mathematics teaching on 54–66-month-old children's mathematics liking levels and to reveal how it had an effect on children's liking for mathematics and their thoughts towards mathematics. They came to the conclusion that the experimental group's kids felt positively about math while it was being used, which means that the process had a positive impact on kids' math enthusiasm. Similar to this, in Galiç' (2020) study, learner profiles of the students were established, and the impact of mathematics activities enhanced with game elements chosen in accordance with these profiles on students' attitudes and motivation toward the course was examined. After data gathered from the application were analyzed, it was found that mathematics activities enhanced with game elements had a positive impact on students' attitudes. When the test results from the experimental and control groups were compared, it was found that using educational games to teach mathematics had a positive impact on people's attitudes toward this subject. Soydan (2019) conducted a study in which he examined the effect of teaching the acquisitions in the seventh-grade mathematics course on operations with integers using educational games on students' attitudes toward mathematics.

Analyzing the studies from the worldwide literature revealed that the outcomes were consistent. In the study carried out by Van Putten, Blom, andVan Coller (2022), they investigated the impact of mathematics teaching to sixth-grade students by creating game-based worksheets on students' performance in mathematics courses as well as the effect on students' attitudes. It was found that the experimental group students' understanding of the course was positively affected by the study at the conclusion of the study. Similarly, Chen, Jamiatul Husnaini and Chen's study (2020) found that using cooperative games to teach students helped them establish favorable attitudes toward the subject.

On the other hand, studies whose findings did not coincide with those of this study were also discovered when the literature was examined. For instance, Can (2022) examined the impact of teaching the seventh-grade polygons subject with educational games enriched on math achievement as well as the change in students' attitudes, and came to the conclusion that the use of games in math instruction had no impact on students' attitudes toward the subject after implementation. Similar findings were made by Demir and Bilgin (2021), who discovered that using games to teach arithmetic had little impact on students' views toward the subject. Again, when results relating to attitude were analyzed at the conclusion of the study done by Dönmez, Dönmez, Kolukısa and Yılmaz (2021) utilizing a game-based teaching strategy, no appreciable change in the attitudes of individuals in the experimental-control groups was discovered. There was no discernible variation in the attitudes of students throughout the studies of Gün, Işık and Şahin (2021), and Çalışkan (2019) it was determined.

The variations in the attitude scale's sub-dimensions were also examined in this study in order to more precisely pinpoint how students' attitudes changed. When the students' pre-attitude scores were analyzed, it became clear that the experimental and control group students had similar attitudes in the sub-dimensions of the attitude scale dealing with positive attitudes, observation, experience, anxiety and prejudice, avoidance, and system. When the final attitude scores were analyzed, it was found that the experimental group students' higher scores revealed a significant change in the positive attitudes, observation, anxiety and prejudice, avoidance, and system sub-dimensions compared to the scores of those in the control group, but did not produce a significant difference in the experience sub-dimension. It was also determined that the effect size value in the sub-dimensions exhibiting significant differences was high. With the exception of the experience sub-dimension, it was determined that teaching mathematics to students using educational games had a favorable impact on their views in all other aspects. Similar to this outcome, Can (2022) explored the impact of educational games on students' attitudes toward mathematics and also sought to ascertain how the impact on sub-dimensions was. The analyses revealed that while there was no significant difference between the experimental-control groups' attitude ratings and their scores for the anxiety sub-dimension, there was a significant difference between the two groups' scores in this sub-dimension. In light of this, it was determined that educational games lessen pupils' anxiety levels.

After the arithmetic lessons were taught via educational games, the experimental group students' opinions of the procedure were gathered by using the SOF to ask open-ended questions of the students.

Regarding the influence of educational games on learning, it was observed that all students reported finding the process enjoyable, memorable, positive, and that they understood the subject better. Only one student reported that they were unable to gain a different perspective, whereas the opinions of all other students were that they did. This case demonstrates that almost all of the students agree that educational games have a good impact on learning. Similar to this, Baki (2022) also used game-based mathematics instruction and came to the conclusion that the students thought the method was enjoyable and helpful. In order to teach students about the coordinate system, Martin, Mendoza and Martin (2016) created a game. At the conclusion of the process, instructor and student opinions were gathered. The students claimed that learning was efficient because of the game, despite the teachers' claims that the games used to teach the subject were an effective learning design.

Regarding the impact of educational games on interest and motivation, it was noted that every student said the process made them happy and boosted their motivation. Only one student said it had no impact on my participation in the lesson, whereas every other student said their participation in the lesson increased. This situation demonstrates that practically all students hold positive perceptions regarding their interests and motivations. This outcome is consistent with Baki's (2022) findings that group game play helped students encourage one another's learning and that game-based mathematics instruction boosted students' engagement in the lesson. At the conclusion of his investigation into the use of educational games in the classroom, Özden (2022) sought teacher comments. He came to the conclusion that educational games can be used and used in the classroom. Similar findings were made by Çubukluöz (2019), who used mathematical games to help students overcome their learning challenges. Some of his pupils even began to enjoy the course as a result of the greater course success, according to Çubukluöz (2019).

Only one student responded that they did not want to teach every subject with games, whereas all of the other students expressed the opinion that they would like to teach every subject with games. It was observed that all of the students thought the lesson was more enjoyable and intelligible. Additionally, it is important to note that in the interview with the student who did not want to cover every subject using games, the student stated that he did not want to do so since he loved mathematics so much and wanted to solve problems all the time. All of these viewpoints demonstrate that the majority of students are in favor of teaching mathematics lessons through educational video games. According to Yağmur (2020), who sought to determine the impact of the game he designed, the students found the games to be both educational and enjoyable, and they expressed a desire for more game-based activities to be included in the lessons. His findings are similar to those of this study.

As a consequence, it is clear that the students have good opinions and that the use of educational games in the lesson stimulates their interest, motivates them, promotes their involvement in the lesson, and enhances their understanding of the material. Students were playing instructive games throughout the process and did not even want to go outside for recess. In this direction, it is concluded that teaching mathematics through educational games increases participation in the lesson, allows students to pay attention to the lesson, allows students to learn by doing and experiencing since it makes the student active in the process, allows students to learn the benefits of the lesson by having fun, and as a normal result of all these situations, it actively contributes to increasing students' attitudes towards mathematics.

In the light of these results, the following suggestions are presented in order to provide ideas for researchers who will conduct studies related to the subject;

- This study was conducted in the sixth-grade algebraic expressions subject and it was concluded that educational games significantly benefited students' attitudes. For this reason, the effect of educational games on student attitudes in other subjects in the mathematics course and at different grade levels can be investigated.
- In this study, mathematics teaching using educational games was compared with mathematics teaching using the methods in the current curriculum. Educational games can be compared with other methods and their effects on students' attitudes can be compared.
- This study was carried out with 12 students because the school where the researcher worked was a small village school. In another study where the number of students in the experimental group is higher, the effect of educational games can be re-examined by making use of the educational games used in this study.
- The educational games used in this study are in concrete form. In another study, digital games can be developed and a study can be conducted on the same subject and the effect on students' attitudes can be analysed.
- Considering that the opinions received from the students at the end of the process in this study included positive statements such as that they found the process fun, their willingness to participate in the lesson increased, and they were always willing to have games in the lessons, it can be suggested that teachers should include educational games in their lessons.

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Ethics Committee Decision

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Abstract

The purpose of this research is to develop guide materials on "Features of Birds", to apply the materials and to get students' opinions about the materials. The participants of the study consisted of 28 students studying in the 5th grade of a public secondary school in the 2022-2023 academic year. In the study, the development and application processes of the guide materials used are explain in detail. After the application, an interview form consisting of five questions was applied to 28 students in order to get the opinions of the students about the guide materials. Descriptive analysis was used to analyze the interviews. As a result of the research; It was determined that the guide materials enriched with digital contents increased the students' interest in the subjects, aroused curiosity, they learned by having fun, and they wanted similar applications in other subjects.

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Research Article

Guidance Materials Enhanced with Digital Content to Understand the Characteristics of Birds and Student Opinions *

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Abstract

The purpose of this research is to develop guide materials on "Features of Birds", to apply the materials and to get students' opinions about the materials. The participants of the study consisted of 28 students studying in the 5th grade of a public secondary school in the 2022-2023 academic year. In the study, the development and application processes of the guide materials used are explain in detail. After the application, an interview form consisting of five questions was applied to 28 students in order to get the opinions of the students about the guide materials. Descriptive analysis was used to analyze the interviews. As a result of the research; It was determined that the guide materials enriched with digital contents increased the students' interest in the subjects, aroused curiosity, they learned by having fun, and they wanted similar applications in other subjects.

Keywords: Augmented reality, coding, concept cartoon, features of birds

1. INTRODUCTION

In the last century, where information and technology have rapidly developed, it is seen that great changes have occurred in many different fields. In order to keep up with these changes and adapt to the age, the education system needs to be reorganized according to the changing conditions (İşçi & Yazıcı, 2023). The updated new education system aims to enable students to construct their own knowledge. In this direction, constructivism has become one of the prominent philosophies in our education system. According to Dewey (1996), one of the pioneers of the constructivist approach, the teaching process should move away from rote memorization and instead involve active participation of students. The provided information should match the content of life. Students should be active in the field of thinking and practical application. The learning process should be based on individual experience because human consciousness is a product of their individual experiences. Today, it is accepted that learning by doing and experiencing is more effective in terms of permanence.

In this context, by engaging students actively, they use their minds and experiences and enter into the process of learning. The constructivist approach applied in science education enables individuals to learn concepts more meaningfully and permanently by moving away from memorization and building on their past learning (Lee & Fraser, 2000). Constructivism is an educational approach designed to enable students to actively carry out the process of learning and apply the information they

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have learned, and it is used in science education to provide students with a more effective learning experience. Such theories should be included for meaningful learning to occur and for learning to be permanent (Jonansen, 1999). In this regard, in order for learning to take place, an environment and educational activities that will arouse students' curiosity and increase their desire to learn should be provided. Science lessons enable students to understand the natural world and better grasp scientific concepts. One of the science topics that involve the natural world is the "Let's Get to Know Living Things" unit. When the literature on the classification of animals is examined, it is seen that students have many misconceptions about the classification of animals (Özdemir & Çalışkan, 2018; Yen, Yao & Mintzes, 2007). However, there is no study in the literature that develops guidance materials on this subject. The present study is important in terms of detecting and eliminating misconceptions by developing guidance materials for birds. Thus, the study will fill this gap in the relevant literature. Based on this situation, the use and implementation of relevant guide materials in the subject is important for students to understand and grasp science concepts, and acquire the necessary knowledge and skills. As a result of the advancement of today's technologies, individuals of Generation Z who are closely intertwined with the internet have emerged. Generation Z mostly desires to learn through games and funy methods (Büyükuslu, 2017). Therefore, it is important to take this into account when developing guide materials for science classes. Based on this, a fictionalized example event about the characteristics of birds from vertebrate animals was enriched with different activities such as QR codes, concept cartoons, coding, and augmented reality to bring a different perspective to the topic. Additionally, this guide material was designed to help fifth-grade students recognize birds and develop an interest in science topics. It is thought that it will help students to gain more knowledge about birds and better understand the characteristics of the birds around them. The purpose of this study is to determine the opinions of fifth-grade students on materials enriched with digital content prepared to help them understand the characteristics of birds in the Living World unit of the Science course.

2. METHOD

2.1. Research Model

In the study, case study design from qualitative research methods was used. In the case study, the current situation is examined and defined in depth through observations, interviews, documents and/or reports carried out in a certain period (Merriam & Tisdell, 2015). In this context, single-case holistic research design was used to examine the students' opinions about the activity in the present study. A single-case holistic study aims to present a thorough and in- depth analysis of the case as a whole, without segmenting it into subunits or subcases (Yin, 2009).

2.2. Participants

The activity was conducted with 28 fifth grade students in a public secondary school. The participants of the study were determined by convenience sampling method, one of the purposeful sampling methods. In this sampling, the researcher selects individuals or groups that are easy to access (Fraenkel et al., 2012). While examining the data, student names were coded as S1, S2… and S28 in order to keep students' personal information confidential.

2.3. Data Collection Tool

An interview form consisting of five open-ended questions was directed to 28 students who participated in the application in order to determine the students' views on the activities developed. The open-ended interview questions were adapted from the interview questions prepared by Varinlioğlu, Öner Armağan, and Bektaş, (2022), and Yazıcıoğlu and Çavuş-Güngören (2021). The authors obtained feedback from a Turkish teacher, two science teachers and two science educators about the content and readability of the questions. The interview form was analyzed using descriptive analysis, with the steps being followed and presented in tables (e.g., coding the data and creating categories; Corbin & Strauss, 2007).

2.4. Planning and Implementation Process of the Activity

In this section, the ways followed for the planning and implementation process of the study are presented in stages.

2.4.1. Examining the objectives of the unit:

When the fifth-grade Science curriculum implemented by the Ministry of National Education in 2018 is examined, it can be seen that 12 lesson hours are allocated to the unit “Let's Recognize Living Things”. In this unit, it is aimed for students to gain knowledge and skills about classifying living things based on their similarities and differences, microscope, microscopic organisms, fungi, plants, and animals. In this regard, it is desired to gain a single learning outcome as “Classifies living things according to their similarities and differences by giving examples”. Hovewer, it is thought that it will be difficult to teach the unit with a single leraning outcomes. Therefore, in this study, it is desired to narrow the subject and design activities for recognizing the characteristics of birds.

2.4.2. Literature review

When the literature on the topic is examined, it is found that students have many misconceptions regarding the classification of living organisms (Özdemir & Çalışkan, 2018; Ural Keleş & Aydın, 2012; Yen et al., 2007). Some of the conceptual misconceptions identified in studies on the classification of living organisms are presented in Table 1.

Table 1. Conceptual misconceptions in the literature regarding the classification of living organisms.

Misconceptions	Studies in which misconceptions were identified
Every living creature that flies is a bird	Özdemir & Çalışkan, 2018
Penguin is in the group of fishes	Çardak, 2009
Penguin is in the class of mammals	Çardak, 2009; Kubiatko & Prokop, 2011; Trowbridge & Mintzes, 1985
Bat is in the class of birds	Chen & Ku, 1998; Çardak, 2009; Kubiatko & Prokop, 2011
Butterfly is in the class of birds	Ural Keleş, Çepni, Aydin & Haşıloğlu, 2011

Taking into account the misconceptions in the field of ecology, it has been decided to prepare activities supported by digital content to help students better understand the characteristics of birds and make the subject more interesting. It is emphasized in many studies that the integration of technology into education improves student learning experiences (Stec, Smith, & Jacox, 2020).

2.4.3. Development of guide material

While designing the activity, the learning outcomes in the science curriculum were taken into account. In the activity, attention was paid to enable students to learn the subject in a meaningful way and have fun throughout the lesson. In order to ensure content validity, two science teachers, two science educators and a Turkish teacher were asked to evaluate the guide materials prepared. According to the feedback received in this process, the readability of the material was ensured and corrections were made in the sentences. The prepared guide material is given in the Appendix.

2.4.4. Obtaining necessary permissions

Necessary permissions have been obtained from the Erciyes University Institute of Educational Sciences for the research titled 'Guide Materials Enriched with Digital Content to Grasp the Characteristics of Birds and Student Opinions' with issue date and number 31/01/2023-49, and throughout the study process, scientific and ethical principles have been followed, and all resources utilized have been cited in the references.

2.4.5. Implementation of the activity

The guide material activities were conducted by the first researcher who is a teacher in the school where the activity was applied. One day before the activity, students were informed about how the application will be carried out, including the use of QR codes, augmented reality application, video watching, and filming related to the subject, and it was demonstrated practically. During the implementation of the application, those who had access to smartphones and tablets were asked to bring their devices and headphones and to install the necessary applications, and the school administration was informed and permission was obtained. The activity lasted for two class hours (40min + 40min). A class hour (40min) was allocated for interview questions prepared to learn students' opinions about the application. The activity was distributed to students in writing, and the activity was opened from the smart board. Firstly, they were asked to read the sample case and then, using the QR codes, they would watch the videos to gain in-depth knowledge about the topic. Then, they were informed about how they would progress in the activity sheets, and the application was started.

The students who did not have the opportunity to use smartphones or tablets carried out the activities without using the applications.

Figure 1. An image of the participation process of the event

During the process and the break between two class hours, it was not allowed for more than one student to go outside at the same time in order to prevent students from interacting with each other. In the last 15 minutes of the second class, the final stage of the activity, which was about taking a video on the characteristics of birds, was carried out with volunteer students. At this stage, students scanned the QR code on the activity paper. https://www.google.com/search?hl=tr&q=Kaya%20Kartal%C4%B1 The event was ended by making a 3D video introducing the features of the eagle by providing a link to the address.

Figure 2. An image of video shooting event

In the third lesson hour, a form consisting of five open-ended questions was distributed to the students and their opinions about the application were taken.

2.5. Data Analysis

In this research, which was carried out to determine the opinions of the participants about the activity, the analysis of the data was carried out with descriptive analysis. Descriptive analysis is defined as describing the data and explaining the descriptions (Merriam & Tisdell, 2015).

3. FINDINGS

Some of the students used tablets/mobile phones in the activities and some students did not. The findings regarding the tablet or mobile phone usage status of the students during the implementation of the activities are given in Figure 3.

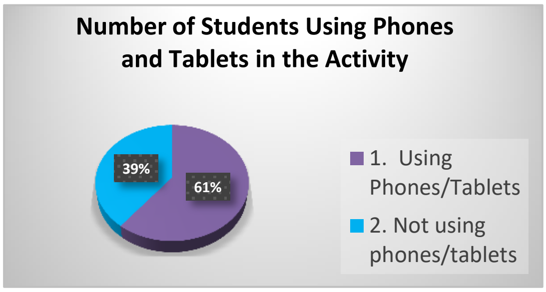

Figure 3. Number of students using phones and tablets in the activity

According to Figure 3, 17 (61%) of the 28 students who participated in the activity used phones or tablets, while 11 (39%) did not use phones or tablets. In the research, the first question posed to students was"Do you think that the activities of "Let's get to know the characteristics of birds are beneficial for you?" The answers given to the question are given in Figure 4.

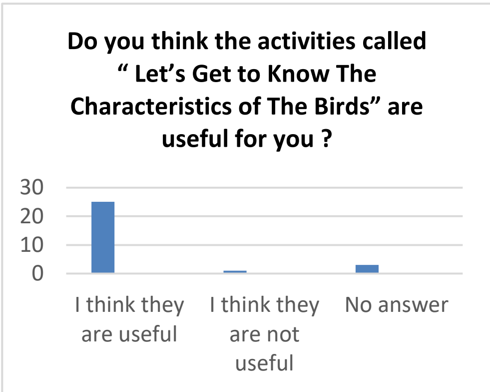

Figure 4. Let's get to know the characteristics of birds do you think the activities are beneficial for you?

According to Figure 4, 25 students who participated in the activity found the activity useful, while three people left the question blank and one did not find it useful. S14 among those who found it helpful *"Yes, I think because I learned more about birds."* S25, who did not find it useful, explained the reason for this situation by saying, *"I don't think it happened. I couldn't get into the application, even though it's good, I don't know."* They have stated as. In the research, the second question posed to students was "Do you think it would be beneficial for you to carry out these activities in other Science course subjects?" The answers to the question are given in Figure 5.

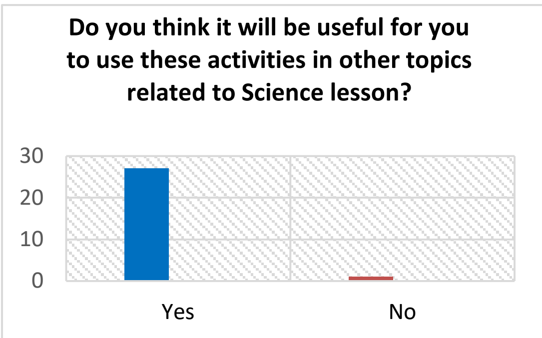

Figure 5. Do you think it would be beneficial for you to carry out these activities on other science subjects as well?

According to Figure 5, 27 of the students who participated in the activity participated in these activities. While stating that it would be beneficial to do it in the subjects of Science course, one person stated that he did not think it would be beneficial. Answering yes, S26 said "*Yes, I think so. Because it heightened my interest in animals." S11 "Yes, I think so. Because we can understand the topics in a fun way*." S6 who answered No, the reason for this was "*No, I don't think so. Because I like other subjects more*." stated as. In the research, the third question posed to students was "How did you find the activity?" The answers to the question are given in Table 2.

Table 2. Opinions on the question "How did you find the activity?"

Entertaining	S2,S3,S4,S9,S12,S15,S16,S17,S18,S20,S24,S25
Intriguing	S1,S7,S8,S10,S11,S14,S19,S22
Exciting	S6,S13,S21,S22,S26
Annoying	S5
Other	S27,S28

In Table 2, among the students who participated in the activity, 12 people stated that the activities were fun, eight people were interesting, five people were excited, one was annoying, and two people did not state any situation. S16, one of the students who found the activity fun, said, "*It was very fun, and it was fun to have barcodes and to bring a phone and watch the videos there*." One of the students who found it intriguing said, "S22 "*There were interesting parts during the activity. Because I got curious about the barcode sections*.". S21, one of the students who found it exciting, said, "*I was very excited when I got to know the animals. It aroused curiosity for me at other events*." S5 of the students who found it boring said, "*It was boring in some places. I did not understand some parts*". In the research, the fourth question posed to students was "Which activity do you enjoy the most?" The answers to the question are given in Table 3.

Table 3. Opinions on the question "Which activity do you enjoy the most?"

We know right wrongs	S6,S15,S19, S23,S27
Coding	S1,S3,S7,S9,S11,S13,S18,S28
Concept cartoon	S5,S12,S16,S20,S21,S24,S26
Let's write and introduce what we have learned	S2,S8,S10,S14,S17,S22
All	S25

In Table 3, five of the students who participated in the activity answered what we know to be true, mistakes were made by eight, coding by eight, concept cartoons by seven, and let's introduce what we learned, and one answered as all. S23, who stated that they enjoyed the activity of "*What we know right and wrong, I like what we know is right and wrong because it was nice to do the right thing for the animal we knew wrong*." S1 among those who stated that they enjoyed the coding activity said, "*I didn't like the coding activity very much, it was very different.*" S16, who stated that she enjoyed the concept cartoon activity, said, "*The concept cartoon activity based on argumentation was very entertaining because there were cartoon characters*." S8, who stated that she enjoyed the event, "*Let's write what we learned, let's promote it*" said, "I liked 3D because it was amazing." Stating that she liked all the activities, S25 said, "*I think they were all good because it was my first experience*." They replied in the form. In the research, the fifth question posed to students was "Do you think that doing such practical activities on subjects that you do not understand will make it easier for you to understand the subject?" The answers given to the question are given in Table 4.

Table 4. Opinions on the question "Do you think doing such hands-on activities will make it easier for you to understand the subject?"

Yes	S1,S2,S3,S4,S5,S6,S7,S10, S11,S13.S14,S15, S16, S17, S18, S21, S22, S23, S24, S25, S26, S28
No	S20

In Table 4, it is seen that 22 of the students who participated in the activity stated that such practices would make it easier to understand the subject, and one student answered no to this question. One of those who thought that similar applications would be beneficial on subjects that were not understood, S1 said, "*Yes, seeing it in 3D and having fun is very logical. It would be nice if it was about microscopic creatures*." S10 "*I think I don't understand the friction force. I would like this done*." S2 stated that "*These activities make it easier to understand, we repeat what we learned in the lesson*."

4. DISCUSSION AND CONCLUSIONS

In this study, guide materials enriched with digital contents prepared to comprehend the characteristics of birds in the fifth grade Living World unit, let's get to know living things, were developed. Developed activities were implemented and student opinions were taken. At the end of the study, almost all of the students stated that the activities were useful, and one student who did not find it useful stated this as not being able to reach digital content even though he had a phone. It is thought that the emergence of this situation may be due to the old phone of the student or the inability to use the technology. All students, except one student, think that it would be beneficial to carry out similar activities in other Science course subjects. The student, who thought that it would not be useful, stated that he liked other lessons more. It is also supported by many research results that guide materials are effective in learning the subjects in terms of their benefits (Çetinkaya & Taş, 2018; Kızılaslan, Aslan, Karakoç & Kapucu, 2022; Varinlioğlu et al., 2022). It has been concluded that the activities are fun, intriguing and exciting for students, but annoying for a student. According to the results of many studies, teaching with activities is fun for students (Kızılaslan et al., 2022). When the findings related to the problem of the activity that is most enjoyable in the study are examined, the coding activity comes first. Coding education is included in the 5th Grade Information Technologies and Software course (Ministry of National Education [MoNE], 2018). Therefore, it is thought that the students are familiar with the coding activity. The majority of those who like the coding activity are students who do not have a phone or tablet. It can be said that the reason for this is that digital content is not used in the coding activity or that they have encountered such an activity for the first time in science class. According to the results of the study on student views on coding education, coding activity is one of the activities that students find enjoyable (Sırakaya, 2018). The primary school students who participated in the study of Sırakaya, (2018) stated that they learned that coding is not only an activity performed on a computer or tablet, but also that they can be coded on paper. The second most popular activity is the concept cartoon activity. Although digital content was not used in this activity, it was determined that the majority of those who preferred this activity were students who had phones and tablets. The reason for this situation may be the use of common cartoon characters in concept cartoons due to the small age range of the student group. In the literature, many studies have been found in which students enjoy the use of concept cartoons (Kaçar et al., 2020) and positively affect students' attitudes towards Science (Atasoy, Toksoy & Calik, 2020; Norfarah, Mohd Ali, & Chong, 2019). In the third most popular event, let's write what we learned with augmented reality content and promote it. Except for one of the students who prefer this activity, the others are students with phones and tablets. As a result of many studies in the literature, it has been concluded that the application of augmented reality increases the interest and motivation in the lesson and the lesson is more enjoyable for students (Han, Jo, Hyun & So, 2015; Zhang, Sung, Hou, & Chang, 2014). In the study, it was also concluded that most of the students stated that such practices facilitate understanding of the subjects, as they found the activities entertaining, intriguing and interesting. In line with these results, it is recommended to develop the digital competence infrastructure of the students in the activity applications enriched with digital contents and to prepare the guide materials that can be applied for different learning levels and subjects of the Science course by integrating them with digital contents.

Ethics Committee Decision

This research was carried out with the permission of Erciyes University Scientific Research and Publication Ethics Committee with the decision numbered 2023/49 dated 31.01.2023.

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THE LITTLE SWALLOWER'S ADVENTURES ON THE MIGRATION ROAD

The little swallow was born in Turkey. Summer is over and the season is autumn. It was time to migrate to warm lands before winter came. The little swallow was going on a long journey for the first time. From the day she hatched, her mother had taken good care of her, her feathers had grown and her wings had grown stronger. Her heart shuddered as she thought about what kind of journey awaited her. With the preparations completed, they set out. When the little swallow looks back, he sees that the sparrows have not come, he stays there, and he asks his mother in curiosity. Mom, why don't they come? His mother: "Baby, not all birds migrate, so they stay here. They will spend the winter here." Along the way they cross mountains, hills, plains. It was a lot of fun to pass through the fallen trees along the way without hitting the leaves. After a long time, the little swallow tells his mother that he is tired. Then they take a break on the branch of a tree. The weather was warmer now. They had come to Africa. While the little swallow watches around, what can he see, an ostrich rising from the huge eggs. It was the first time he had seen such a creature. In fact, he thought he was wearing us out. It has two legs, it lays eggs, it has feathers, it has a beak. Biran wondered if it could be such a big bird and asked his mother. Mother yes baby. This bird's name is ostrich, he said, just then a cheetah started chasing the ostrich. The little swallow was very excited. He started yelling. Fly quickly, save yourself. But his effort was in vain. The little swallow was surprised to see that the ostrich could not fly. He was also very upset when he saw that the cheetah had caught the ostrich. "Friends, if you are wondering about the ostrich, if you want to watch the view I saw, scan the QR code on your phone.

Ostrich video

The long journey had exhausted the little swallow. One day they would spend time here and continue on their way. While watching around, he saw many birds such as crows, starlings, parrots, pigeons, eagles and vultures. Butterflies and bees flying in the air caught his attention. They could fly, too, but they didn't look much like themselves except for their wings. I wonder if butterflies and bees were also a species of bird? It was about to be evening and suddenly he sees black birds like themselves making very fast sudden movements around. Mom, these look a lot like us, what's their name? The little swallow's mother answers with a smile. They are bats, not birds. They are mammals and reproduce by giving birth to their young. They feed their young with milk, and at the same time, their bodies are covered with hairs, not feathers like us. The little swallow was so surprised that he thought he still had a lot to learn. "Friends, if you're curious about bats, scan the QR code on your phone."

Bats video

It was morning, it was time to go. Before they reach their destination, they encounter a sandstorm. They change their course to avoid being caught in a sandstorm. The sandstorm had passed, but they were lost. After traveling for a long time, the air begins to cool in the direction they are going. Snow and ice were starting to appear, I wonder if they were returning to Turkey by mistake. No, no, they accidentally got to the south pole when they lost their way. The little swallow couldn't believe his eyes as he stared intently at the landscape below. He was seeing penguins for the first time, and thousands of them together. When her mother sees the curious eyes of the little swallow, look, my child, these are a bird species. Like the ostrich, they cannot fly, their wings are tiny, and look, they also have eggs in the snow. The little swallow's beak remained open in surprise when he saw penguins walking slowly on land moving so fast through the water. Do mother birds swim by turning to mother? Yes, baby, some birds such as penguins and ducks can swim. "Friends, if you are curious about penguins, scan the QR code on your phone."

Penguins video

The little swallow, read out of her amazement, was very cold. They are on their way to where they are going. Finally, the long and adventurous journey was over and they had reached their destination. The little swallow had learned many things on this journey. Did you learn new things like the little swallow? If you want to take a closer look at some bird species, click the 3D display section by scanning the QR code.

Penguin **Parrot** **Eagle**

Misconcepted Activities That We Thought Were True

1) Identify the mistakes in the statements about the living organisms whose characteristics are listed in the table below and write the correct ones in the dotted spaces.

	**Penguin:** I am a fish swimming in water. I reproduce with eggs.	…………………………………………………………………
	**Ostrich:** I can run very fast, but I cannot fly. I reproduce by giving birth.	…………………………………………………………………..
	**Butterfly:** I have wings so I can fly I am a bird.	………………………………………………………………....
	**Bat:** I reproduce by giving birth. I am a bird species because I fly around.	…………………………………………………………………
	**Chicken:** My body is covered with feathers. Although my species reproduces by eggs, I am not a bird species because I cannot fly.	…………………………………………………………………

2) Imagine that you are a naturalist. While wandering in nature, you saw an undiscovered bird species. Utilizing the information you have learned about the subject, describe the bird species you saw using your imagination or draw a picture of it.

Coding Activity

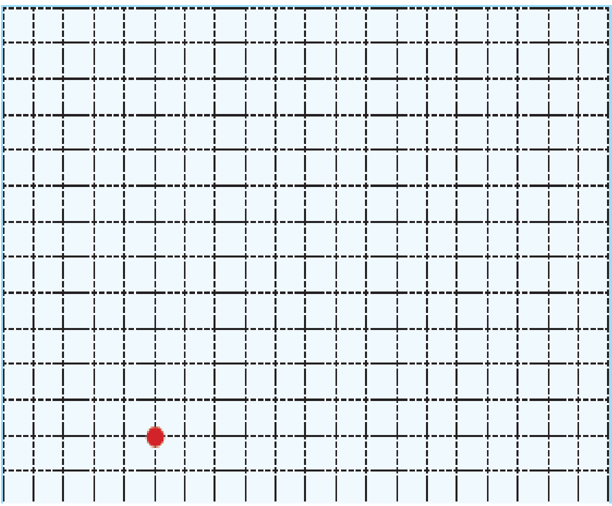
Hey Ahmet, I know the characteristics of birds but can you help me with the following instructions for coding?

Coding is my job, Emre. As long as you answer the questions correctly, we can find the right code.

CODING INSTRUCTIONS

Circle the number and arrow below of the living organism that has the following characteristics. In one question, you may make more than one marking. Then, starting from the starting point on the gridded table, draw a line in the direction of the arrow next to the number as many as the circled number in the same question, starting from the left in the order of the questions. After the coding drawing is complete, write a bird species name starting with the letter of the resulting code.

Features	Ostrich	Eagle	Bat	Duck
I reproduce with eggs	1 ↑	2 ↑	4 →	2 ↑
I can fly	5 ↓	1 →	1 →	1 →
My body is covered with feathers	1 ↑	1 ↑	1 ↓	2 ↑
I swim in water	2 ↓	3 →	4 ↑	3 ←
I am not a bird	3 ↓	5 ←	4 ↓	4 →

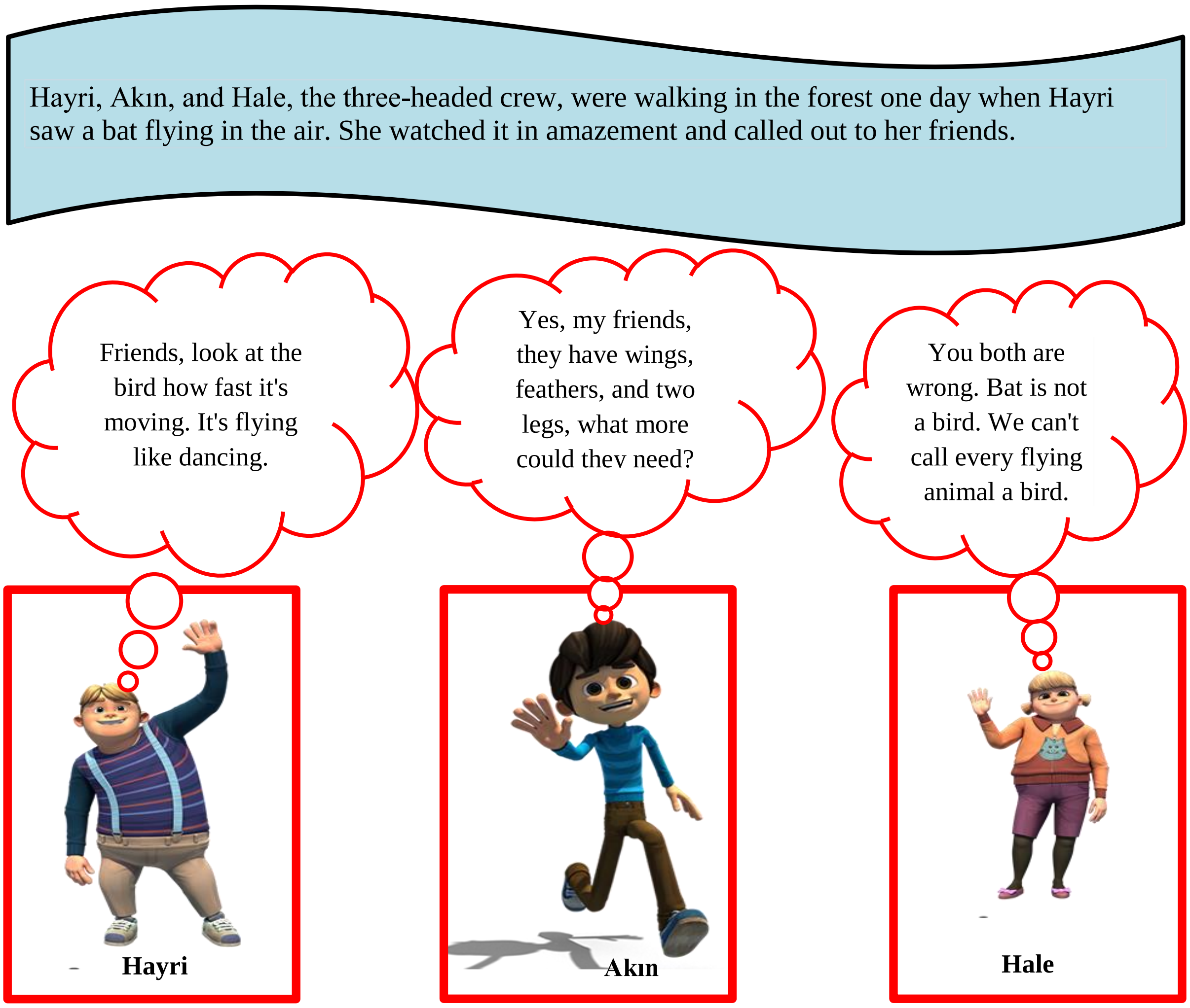


I found the code, Emre. Tell me the bird species before the other friends do.

So, what did you find?

…………………………………………………………

Argumentation-Based Concept Cartooning Activity "Characteristics of Birds"



What do you think, which one is right?

I agree with Hayri. Because:………………………………………………………………………...

I disagree with Hayri. Because:……………………………………………………………………..

I agree with Akin. Because:…………………………………………………………………………

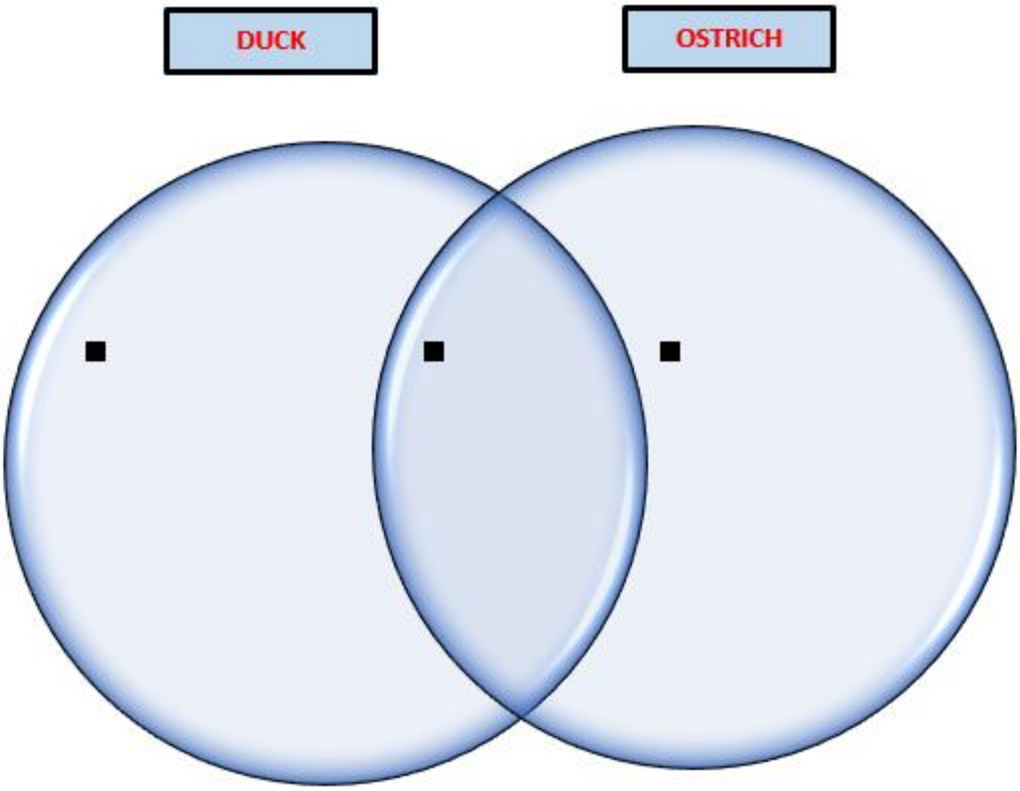
I disagree with Akin. Because:……………………………………………………………………...

I agree with Hale. Because:………………………………………………………………………….

I disagree with Hale. Because:……………………………………………………………………….

Let's Write and Introduce What We Have Learned

A- Write the common and different characteristics of duck and ostrich in the diagram given below?



B- Write down the features of the eagle in the 3D model provided by scanning the QR code. Then, stand next to the 3D model and shoot a video to promote it by mentioning these features.

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Article Name	An Analysis of the Place of the History of Science in Chemistry Textbooks

Author Contribution Statement

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Abstract

Many science educators have expressed the role and importance of the history of science in promoting scientific literacy. It is generally acknowledged that students should understand the social and cultural structure of science knowledge, in which students learn not only the concepts and principles offered by science but also the application areas of the information provided by science and the scientific knowledge they have created. From this point of view, the history of science emerges as a potential resource and a meaningful teaching strategy that can be used both in the teaching of scientific content and the nature of science. On the other hand, it is clear that textbooks are one of the essential components of science education, given their role in education. Textbooks are the primary source of information in the learning environment. It is the most important educational resource for students outside and beyond the teacher, and for the teacher, it is often the representative of the teaching program. Many teachers, especially novice teachers, construct the content and course of lessons according to the textbooks in their hands. From this point of view, this study investigates how much history of science is integrated in high school textbooks. For this purpose, appropriate textbooks (grades 9-12) taught by the Ministry of Education (MoNE) as a textbook in high school were examined. A qualitative research approach was followed in the study and document analysis was chosen as the study design. When each course book is examined, the sections containing the science history information are identified and taught carefully read. The quality of these sections in learning and teaching has been analyzed. Of the analyses, a scoring key was used, which allows scoring using a total of 13 criteria in conceptual, procedural, and contextual areas of the quality of science historical stories. As a result of the research, the history of science for conceptual, procedural, and contextual understanding has been included in high school chemistry textbooks, but this use is limited. While more importance is attached to scientific history for procedural understanding in books, it has been found that the use of the history of science is worthless for conceptual and contextual understanding.

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Research Article

An Analysis of the Place of the History of Science in Chemistry Textbooks [*]

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Abstract

Many science educators have expressed the role and importance of the history of science in promoting scientific literacy. It is generally acknowledged that students should understand the social and cultural structure of science knowledge, in which students learn not only the concepts and principles offered by science but also the application areas of the information provided by science and the scientific knowledge they have created. From this point of view, the history of science emerges as a potential resource and a meaningful teaching strategy that can be used both in the teaching of scientific content and the nature of science. On the other hand, it is clear that textbooks are one of the essential components of science education, given their role in education. Textbooks are the primary source of information in the learning environment. It is the most important educational resource for students outside and beyond the teacher, and for the teacher, it is often the representative of the teaching program. Many teachers, especially novice teachers, construct the content and course of lessons according to the textbooks in their hands. From this point of view, this study investigates how much history of science is integrated in high school textbooks. For this purpose, appropriate textbooks (grades 9-12) taught by the Ministry of Education (MoNE) as a textbook in high school were examined. A qualitative research approach was followed in the study and document analysis was chosen as the study design. When each course book is examined, the sections containing the science history information are identified and taught carefully read. The quality of these sections in learning and teaching has been analyzed. Of the analyses, a scoring key was used, which allows scoring using a total of 13 criteria in conceptual, procedural, and contextual areas of the quality of science historical stories. As a result of the research, the history of science for conceptual, procedural, and contextual understanding has been included in high school chemistry textbooks, but this use is limited. While more importance is attached to scientific history for procedural understanding in books, it has been found that the use of the history of science is worthless for conceptual and contextual understanding.

Keywords: History of science, textbook, chemistry education

1. INTRODUCTION

The development of scientific literacy is among the main objectives of science education. Scientific literacy has come to cover many purposes of science teaching (Laugksch, 2000). In today's chemistry curriculum, the acquisitions that allow students to acquire general scientific and chemistry literacy are included (Ministry of National Education [MoNE], 2013). It is assumed that scientifically literate individuals can understand the nature of science and scientific knowledge, fundamental scientific concepts, principles, laws, and theories and use them appropriately (MoNE, 2013).

Many methods, such as inquiry-based learning, problem-based learning, argumentation, and -scientific issues, have been introduced to actively involve students in scientific activities in educational contexts similar to scientists' social and cultural contexts and to provide them with new understandings of scientific literacy (Köseoğlu, Tümay & Budak, 2008). Along with these, one of the critical approaches that can be used in gaining scientific literacy is the historical approach.

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The history of science is the story of the birth and development of scientific thought, culture, and all mental activities of human beings (Doğan & Özcan, 2010). The history of science is the story of an exciting adventure about where the history of humanity started and where it reached (Erdem, 2005). Again, according to Erdem (2005), the achievements of scientists, the difficulties they experienced, and the imagination that inspired inventions are essential milestones in this story. History of science is a discipline that should be taught at every education level, as it fills a significant gap in understanding the nature of science, as successes enable people to know what happened in the past and shed light on the scientific developments of today and the future (Doğan & Özcan, 2010). It is claimed that teaching science with a historical approach will contribute to the successful learning of both the concepts of the nature of science and the subject area (Ayvacı, 2007). The historical approach encourages students to learn how scientific ideas emerged in the social and cultural context and how scientific developments progressed from past to present in a historical development order (McComas & Oslon, 2000); cited in (Doğan & Özcan, 2010). In addition, through the history of science, when students understand how scientific knowledge develops and how the historical, philosophical, and technological context affects this development, they will have a more comprehensive view of science. Therefore, they will be more interested in science learning (Jussi & Gilbert, 2000); cited in (Laçin & Şimşek, 2011).

Poincare (1989) argues that the nature of science can be explained by looking at the history of science, while Kuhn (2008) argues that science cannot be taught without explaining the history of science. However, it is stated that the history of science should not be seen only as a timeline and a narrative warehouse (Kuhn, 2008) and that the history of science is not a story of discovery (Sarton, 1995). At the same time, it was pointed out that the discoveries are temporary and that new ones will replace the old ones (Sarton, 1995). In this context, a scientist interested in the history of science is not responsible for keeping a record of inventions or discoveries but for explaining the development of thought according to science. Individuals observing the changes in the history of science can realize how scientific developments are. In this respect, it can be said that the history of science is quite suitable for use in science education (Laçin-Şimşek, 2009).

The use of the history of science in science teaching contributes to the development of students' understanding of the nature of science (Ayvacı, 2007; Craft & Miller, 2007; Lin & Chen, 2002; Irwin, 2000; Klopfer & Cooley, 1963), creating an image of science and scientist (Matthews, 1994; Şeker, 2012; Şen-Gümüş, 2009), increasing their interest in lessons (Solbes & Traver, 2003; Şeker & Welsh, 2006) and learning concepts (Ayvacı, 2007; Stinner & Williams, 1993). In addition, using the history of science in science education helps students acquire a science culture (Güney & Şeker, 2012). The concept of scientific culture defines the values involved in the change and development of science, its effects on society, and the place people working for this purpose take in society. Students' putting themselves in the place of a scientist can be given as an example of empathy established with scientific culture (Güney & Şeker, 2012).

On the other hand, textbooks are one of the most critical tools in effectively bringing the history of science to the classroom environment. A textbook is the essential educational element that explains the information on the subjects in the relevant curriculum in a particular order and plans and guides students and teachers towards the achievements of the course (Ünsal & Güneş, 2004). It is seen that elements related to the history of science are not included sufficiently in textbooks, which are among the written and visual materials most used by students (Kahraman, 2013; Kılıç, 2010; Yıldız, 2013). In addition, while textbooks include statements about the conceptual structure of science, statements about scientific methods and processes are less common (Laçin-Şimşek, 2009). Designing curriculum materials that only emphasize conceptual understanding is insufficient for students to learn science and the nature of science (McNeill, Lizotte, Krajcik & Marx, 2004).

For this reason, it should be stated not only what the information is in the textbooks but also how it was accessed over time (Gallagher, 1991). In this context, this study aims to reveal how much and how much space is included in the history of science in high school chemistry textbooks and to investigate the adequacy of the current usage. This study will examine how much space is included in the history of science in high school chemistry textbooks and how the history of science is used. Within the framework of this primary purpose, answers were sought to the following sub-questions:

1. How much space is given to the history of science in high school chemistry textbooks?
2. How is the history of science integrated in high school chemistry textbooks?
3. What are the characteristics of the sections on the history of science in high school chemistry textbooks?
4. Are the sections on the history of science included in high school chemistry textbooks balanced throughout the book?

2. METHOD

2.1. Research Model

In this study, a qualitative research approach was adopted in connection with the research question. Qualitative research is research in which qualitative data collection methods such as observation, interview, and document analysis are used, and a qualitative process is followed to reveal perceptions and events in a natural environment realistically and holistically (Yıldırım & Şimşek, 2008). In this research, using document analysis, one of the qualitative research design methods, high school chemistry textbooks (9th, 10th, 11th, and 12th-grade textbooks) approved by the Ministry of National Education and free for students as textbooks in Kastamonu province were examined. Document analysis includes the analysis of written materials containing information about the case or cases that are aimed to be investigated (Yıldırım & Şimşek, 2008). Content analysis of documents, which have an essential place in social trends, historical documents, and cultural studies, has started to be used in parallel with the search for multiple methods in educational research (Çeken & Eş, 2013).

2.2. Determination of Textbooks

Teaching tools are needed for teaching to take place. Instructional tools fulfill the most extreme function in acquiring the necessary behavior of the learners. In this context, teaching tools are used to ensure that learning takes place on time, that it is permanent, and that the learning environment is formed healthily (Kılıç, 2010). Conversely, books are one of the most essential tools and materials that help students in education (Duman & Çakmak, 2004). Textbooks are the most widely used among books. Textbooks are the primary documents that examine and explain the information on the subjects in the curriculum in a planned and regular way and guide and train the students in line with the course's objectives as a source of information (Ünsal & Güneş, 2004).

Qualifying a book as a textbook means that it coincides with the curriculum of the relevant course. Therefore, the textbook is suitable for applying the strategies, methods, and techniques required by the program's goals and behaviors (Kılıç, 2010). One of the critical factors affecting the program's success in education programs is the textbooks. In this respect, textbooks are the primary material that builds a bridge between the program and the student (Demirel & Kıroğlu, 2005). When we look at it from these perspectives, we can see the textbook as one of the complementary elements of the program.

Textbooks are a resource that determines what students will learn and what teachers will teach during teaching. They also have essential effects on decisions regarding classroom learning and teaching activities. In general, many teachers determine the course's objectives, the tests to be applied to the students, the teaching strategies, and the assignments according to the textbooks used.

It is essential to choose the textbooks to be examined in studies where textbooks are examined in different dimensions. This study selected four chemistry textbooks approved by the Ministry of

National Education to be used as textbooks in high school chemistry courses and distributed free of charge to students. Information about these books is included in Table 1.

Table1. Textbooks reviewed

Class	Writer	Publication Year	Printing house	ISBN
9th grade	Commission	2015	MEB	978-975-11-3770-8
10th grade	Commission	2015	MEB	978-975-11-3919-1
11th grade	Commission	2015	MEB	978-975-11-3386-1
12th grade	Commission	2015	MEB	978-975-11-3571-1

2.3. Review Criteria

After the selection of the textbooks to be examined, a literature review was conducted to determine according to which criteria the history of science texts in the books would be examined. As a result of the literature review, it has been determined that the best scale that can be used to evaluate the use of the history of science in textbooks is the "History of Science Instructional Scale" developed by Wang and Marsh (2002) in 2002 and adapted into Turkish by Yıldız (2013). The scale is presented in Table 2.

Table 2. History of science instructional scale

Size Name	History of Science Instructional Scale	Points 1	2	3	4	5
	Helping students learn scientific content and ideas					
History of Science for Conceptual Understanding	Helping students learn scientific model explanations					
	Helping students learn scientific explanations, theories, and laws					
	Helping students understand the volatile nature of scientific knowledge					
	Helping students develop their systematic thinking skills					
History of Science for Procedural Understanding	Helping students develop their habit of asking questions					
	Helping students increase their research habits (observation, measurement, evaluation, etc.)					
	Helping students see the purpose, motivation, and motivation in connecting scientific studies					
	Help students understand how scientific endeavors, social factors, and political forces are closely related.					
History of Science for Contextual Understanding	Help students understand how scientific research affects human well-being.					
	Help students understand that scientists also function in a community where others produce knowledge through their efforts.					
	Help students understand that scientists are also individuals and human beings.					
	Helping students recognize the distinction between cultural heritage and role models					

Within this scale, the history of science is divided into three main frameworks: conceptual, procedural, and contextual understanding. From these frameworks, conceptual understanding consists of four criteria, procedural understanding consists of three criteria, and contextual understanding consists of six criteria. For each criterion, a Likert-type scoring key was created to give a score between 1 and 5 (5 representing perfect, 4 good, 3 medium, 2 passing, and 1 poor score). At the same time, as Yıldız (2003) did in his study, separate keywords were given for each of the analyzed criteria for ease of analysis. In addition, if there is no information about any of the criteria examined in the history of science stories in the books examined, zero (0) points were given to that criterion.

2.4. Data Analysis

Qualitative data analysis is a process where the researcher organizes the data, divides it into units of analysis, synthesizes it, reveals patterns, discovers essential variables, and decides which information to reflect in the report (Bogdan & Biklen, 1992); cited in (Özdemir, 2010). Miles and Huberman (1984) examine the qualitative data analysis process in a three-stage classification following each other (as cited in Özdemir, 2010). The first of these stages is the "data reduction" stage, which is collected by various techniques such as observation, interview, and document analysis; the second is the "data visualization" process; and the third is the process of "reaching and confirming the result."

Many techniques, such as Phenomenological Analysis, Content Analysis, Descriptive Analysis, Established Theory and Fixed Comparison Analysis, Discourse Analysis, and, Ethnomethodology are used in qualitative data analysis (Özdemir, 2010). In this study, descriptive analysis of these techniques was used. The description technique is the first step in explaining and understanding events, objects, and problems. This technique tries to understand and describe the "what" of events, objects, entities, institutions, groups, and various fields. Descriptive research aims to explain the interaction between current events, considering their relationships with previous events and conditions (Kaptan, 1998). According to this approach, the data obtained are summarized and interpreted according to previously determined themes. Descriptive analysis is defined by Yıldırım and Şimşek (2008) as follows:

"…The data obtained are grouped according to themes, and categories are created by giving names to each group. Direct quotes are frequently used to reflect the views of individuals interviewed or observed. This type of analysis aims to present the findings to the reader in an organized and interpreted form" (Yıldırım & Şimşek, 2008, p.33).

In this research, texts related to the history of science in the textbooks were described according to the criteria on a predetermined scale.

The examination of high school chemistry textbooks in terms of the history of science was realized at the end of a three-stage process. In the first stage, chemistry textbooks were used in secondary education institutions, and electronic versions of these books were obtained. The researcher read these books. As a result of the general examination of the textbooks, it has been determined that the parts giving information about the history of science are not included in the text and that there is information about the history of science in the parts that are primarily included as "reading text" or "reading text" and provide additional information to the lectures. For this reason, the page numbers of these textbook sections were determined, and detailed reading was started. In the second stage, the researcher read and scored the determined texts according to the criteria in the "History of Science Instructional Scale." In the third stage, another researcher took part in the descriptive analysis as the second coder to determine the reliability of the coding made by the researcher. Then, the consistency between the analyses of the two encoders was examined, and the measurement reliability coefficient between the two encoders was calculated as 0.87 using the reliability formula suggested by Miles and Huberman (1994) as Reliability = Consensus / (Agreement + Disagreement) x 100.

3. FINDINGS

3.1. Distribution of the Parts Containing the History of Science in the Textbooks by Classes

The units' names in the 9th, 10th, 11th, and 12th-grade chemistry textbooks are in the table below. These units are as follows:

Table3. Units in chemistry textbooks

Class	Units				
	Unit 1	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**
9th grade	Chemical Science	Atom and Periodic System	Interactions Between Chemical Species	States of Matter	-
10th grade	Acids, Bases and Salts	Mixtures	Energy in Industry and Living Things	Chemistry is Everywhere	-
11th grade	Chemical Reactions and Energy	Reaction Rates and Chemical Equilibrium	Equilibrium in Solutions	electrochemistry	Nuclear Chemistry
12th grade	Elements Chemistry	Introduction to Organic Chemistry	Organic Reactions	Classes of Organic Compounds	-

Information about the history of science has been given more or less a place in each book examined. Information about the history of science is given at the beginning or in the lectures, in notes such as "Did you know" and "interesting point," and in sections such as evaluation questions. The information contained in these sections is usually one sentence at maximum. For example, in the first "interesting point" information of the 1st unit of the 9th-grade chemistry book, " *Hippocrates (460-370 BC) used the powder obtained from the leaves and bark of the willow tree for the treatment of febrile diseases, as a pain reliever and antipyretic* ." statement is included. Therefore, the study should have included the information in these sections.

On the other hand, in the sections called "reading text" or "reading piece" in the book, information about the history of science is given in more detail and in addition to the subject narration. Therefore, these texts were included in the study. 1 from the 9th-grade textbook, 2 from the 10th-grade textbook, 7 from the 11th-grade textbook, and 4 from the 12th-grade textbook were examined in terms of conceptual, procedural, and contextual aspects. The number distribution of the sections related to the history of science examined according to classes and units are given in Table 4.

Table4. Distribution of the sections related to the history of science examined by classes

Class	Examined Texts				
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
9th grade	0	1	0	0	-
10th grade	1	0	0	1	-
11th grade	1	2	0	0	4
12th Grade	3	1	0	0	-

3.2. Reviewing the 9th Grade High School Chemistry Textbook

The 9th-grade high school chemistry textbook consists of four units. These units are Chemistry Science, Atomic, Periodic Systems, and Interactions between Chemical Species and States of Matter. Only one reading text from the second unit was examined among these four units. In other units of the book, no section provides information about the history of science at a level that can be included in the analysis. The book consists of 220 pages. Among these pages, the number of pages containing reading texts related to the history of science and examined is 1. The scores of the reading passage in the 9th-grade high school chemistry textbook are summarized in Table 5 below.

Table5. Score table for the sections related to history of science in the 9th grade high school chemistry textbook

Dimension	Criterion	9th Class Chemistry Book 2. Unit 1. Text	Total Points	Arithmetic Average of Dimensions
Conceptual	Contents	4	4	3.75
	Model	3	3	
	Theory-Law	3	3	
	Variability	5	5	
Procedural	Thinking	5	5	5
	Asking question	5	5	
	Research	5	5	
Contextual	Connection	4	4	1.33
	social-political	1	1	
	welfare-development	1	1	
	scientific society	1	1	
	humanization	1	1	
	Common culture	0	0	
Total Points		38		
Arithmetic mean		2.9		

As seen in Table 5, the average score of the reading passage in the 9th-grade high school chemistry textbook is 3.75 in terms of conceptual understanding and the highest level in terms of procedural understanding (avg. 5). Remarkably, it can be said that the reading passage remained at a low average (mean 1.33) in terms of contextual understanding. The reading piece about the history of science in the book received total points from the “Variability,” “Thinking,” “Questioning,” and “Research” criteria of the “History of Science Instructional Scale.”

3.3. Reviewing the 10th Grade High School Chemistry Textbook

The 10th-grade high school chemistry textbook consists of four units. These units are Acids, Bases and Salts, Mixtures, Energy in Industry and Living Things, and Chemistry Everywhere. Among these four units, one reading text from the first unit and one from the fourth unit was examined. In the second and third units of the book, the section needs to include the history of science that can be included in the analysis. The book consists of 306 pages. Among these pages, the number of pages containing reading texts related to the history of science and examined is 2. The scores of the two reading passages in the 10th-grade high school chemistry textbook are summarized in Table 6. In addition, this table includes the total score and arithmetic average of each reading passage and the textbook’s total score and arithmetic average for each category.

Table 6. Score table for the sections related to history of science in the 10th grade high school chemistry textbook

Dimension	Criterion	Class 10 Chemistry Book Unit 1 1. Text	4. Unit 4. Text	A.O.	Arithmetic Average of Dimensions
Conceptual	Contents	5	5	5	3,5
	Model	0	4	2	
	Theory-Law	4	3	3,5	
	Variability	3	4	3,5	
Procedural	Thinking	1	4	2.5	2.33
	Asking question	2	2	2	
	Research	1	4	2.5	
Contextual	Connection	3	3	3	2.17
	social-political	4	3	3,5	
	welfare-development	4	3	3,5	
	scientific society	3	1	2	
	humanization	0	0	0	
	Common culture	0	2	1	
Total Points		30	38		
Arithmetic mean		2,3	2.9		

As seen in Table 6, it can be said that the average score of both texts in the 10th-grade high school chemistry textbook is 3.5 in terms of conceptual understanding and below the average value of 2.5 in terms of the use of history of science in terms of procedural understanding and contextual understanding (average point of view, respectively). 2.33 and mean 2.17). In the book, two reading passages containing elements related to the history of science received total points from the "Content" criterion of the examination scale used. The second reading piece scored higher than the first reading piece in the "Model" and "Variability" criteria of the conceptual understanding dimension and the "Thinking" and "Research" criteria of the procedural understanding dimension. When the total scores of the reading pieces from the scale are compared, it is seen that the second reading piece gets a higher score.

3.4. Review of the 11th Grade High School Chemistry Textbook

The 11th-grade high school chemistry textbook consists of five units. These units are Chemical Reactions and Energy, Reaction Rates and Chemical Equilibrium, Equilibrium in Solutions, Electrochemistry, and Nuclear Chemistry. Among these five units, 1 reading text from the first unit, 2 reading texts from the second unit, and 4 reading texts from the fifth unit were examined. The book consists of 312 pages. Among these pages, the number of pages examined and containing reading texts related to the history of science is 9.

Table 7. Score table for the sections related to the history of science in the 11th grade high school chemistry textbook

Dimension	Criterion	11th Grade Chemistry Book							A.O.	Arithmetic Average of Dimensions
		Unit1	Unit 2		Unit 5					
		1.Text	2.Text	4.Text	1.Text	2.Text	3.Text	4.Text		
Conceptual	Contents	3	4	one	3	2	3	2	2.6	1.3
	Model	0	one	0	one	one	one	one	0.7	
	Theory-Law	0	one	0	one	0	0	0	0.3	
	Variability	4	4	0	2	0	0	one	1.6	
Procedural	Thinking	2	2	0	3	2	2	2	1.9	1.76
	Asking question	one	2	0	2	one	2	2	1.4	
	Research	3	2	0	3	2	2	2	2.0	
Contextual	Connection	4	4	0	2	one	2	one	2.0	0.68
	social-political	4	0	0	0	0	0	0	0.6	
	welfare-development	4	2	0	0	0	0	2	1.1	
	scientific society	3	0	0	0	0	0	0	0.4	
	humanization	0	0	0	0	0	0	0	0.0	
	Common culture	0	0	0	0	0	0	0	0.0	
Total Score		28	22	one	17	9	12	13		
Arithmetic mean		2.2	1.7	0.1	1.3	0.7	0.9	one		

As seen in Table 7, when seven reading passages containing elements related to the history of science in the 11th grade high school chemistry textbook are evaluated together, the examination scale is evaluated in terms of conceptual understanding (mean 1.3) and procedural understanding (mean 1.76) and it is at a low level in terms of contextual understanding (average 0.68). All of the reading passages in the book received partial marks from the review criteria. The average score of the 1st text with the highest score is 2.2.

3.5. Reviewing the 12th Grade High School Chemistry Textbook

The 12th-grade high school chemistry textbook consists of four units. These units are Elements Chemistry, Introduction to Organic Chemistry, Organic Reactions, and Organic Compound Classes. Within these four units, 3 from the first and 1 from the second units, reading texts related to the history of science were examined. The book consists of 334 pages. Among these pages, the number of pages containing reading texts related to the history of science and examined is 5.

Table 8. Point table of the sections related to history of science in the 12th grade high school chemistry textbook

Dimension	Criterion	CLASS 12 CHEMISTRY BOOK				A.O.	Arithmetic Average of Dimensions
		Unit 1			2.Unit		
		1.Text	4.Text	7.Text	1.Text		
Conceptual	Contents	2	1	2	2	1.8	0.9
	Model	0	0	0	1	0.3	
	Theory-Law	0	0	0	0	0.0	
	Variability	1	1	1	3	1.5	
Procedural	Thinking	1	2	2	2	1.8	1.8
	Asking question	1	1	1	2	1.3	
	Research	2	2	3	2	2,3	
Contextual	Connection	2	0	3	3	2.0	1.3
	social-political	3	1	4	0	2.0	
	Well-being-development	3	3	3	0	2,3	
	scientific society	0	0	0	0	0.0	
	humanization	0	0	0	0	0.0	
	Common culture	1	1	2	2	1.5	
Total Points		16	12	21	17		
Arithmetic mean		1,2	0.9	1.6	1.3		

As seen in Table 8, when four reading passages containing elements related to the history of science in the 12th-grade high school chemistry textbook are evaluated together, the examination scale is evaluated in terms of conceptual understanding (mean 0.9) and procedural understanding (mean 1.8). It is at a low level in terms of contextual understanding (average 1.3). All of the reading passages in the book received partial marks from the review criteria. Only the third text received 4 points from the "social-political" criterion within the contextual understanding dimension. The highest score obtained from other criteria is 3. The mean scores of each reading passage obtained from the criteria are 1.2, 0.9, 1.6, and 1.3, respectively.

3.6. General Point Averages of the Sections Related to History of Science in High School Chemistry Textbooks

Table 10 below shows the total score and average score in 9th, 10th, 11th, and 12th-grade high school chemistry textbooks for each book review criteria in the scoring key.

Table 10. The general average of scores of the sections related to the history of science in high school chemistry textbooks

Dimension	History of Science Instructional Scale	9th grade	10th grade	11th grade	12th grade	Overall Average	Arithmetic Average of Dimensions
Conceptual	Contents	4	5	2.6	1.8	3,4	2.37
	Model	3	2	0.7	0.3	1.5	
	Theory-Law	3	3,5	0.3	0	1.7	
	Variability	5	3,5	1.6	1.5	2.9	
Procedural	Thinking	5	2.5	1.9	1.8	2.8	2.73
	Asking question	5	2	1.4	1.3	2,4	
	Research	5	2.5	2	2,3	3.0	
Contextual	Connection	5	3	2	2	3.0	1.63
	social-political	4	3,5	0.6	2	2.5	
	welfare-development	3	3,5	1.1	2,3	2.5	
	scientific society	1	2	0.4	0	0.9	
	humanization	1	0	0	0	0.3	
	Common culture	0	1	0	1.5	0.6	
Grade-Level Averages		3.38	2.62	1.12	1.29	2.11	

When Table 10 above is examined, it is seen that the highest average of 3.4 out of 5 belongs to the criterion that the history of science helps students learn scientific content and ideas. This average value is above the medium level. This criterion, coded as "content," is followed by "research" and "connection" criteria with an average value of 3. These two criteria have a medium level of value. It is observed that the mean values in other criteria continue to decrease from 2.9 to 0.3. In summary, this situation can indicate that even the reading passages directly associated with science use the history of science at the most moderate level. It was calculated as 2.37 in terms of conceptual understanding, 2.73 in terms of procedural understanding, and 1.63 in terms of contextual understanding . This shows that the use of the history of science is at the most moderate level.

Considering the number of texts in which elements related to the history of science are used on a class basis, there is 1 reading passage in the 9th-grade book, 2 in the 10th-grade book, 7 in the 11th-grade book, and 4 in the 12th-grade book. When the classes' averages are examined, it can be seen that the two highest averages are in the 9th and 10th-grade books (3.38 and 2.62, respectively). These averages are close to the average value of 2.5.

4. CONCLUSION, DISCUSSION AND SUGGESTIONS

History of science is a research activity that examines the development process of scientific knowledge (Topdemir & Unat, 2014). The purpose of the history of science is to examine the emergence, dissemination, and usage conditions of objective knowledge and techniques and, in a sense, to ensure the formation of a particular method, a type of thinking, and even a broad perspective (Yörükoğulları, 2013). According to Yıldız (2013), sections on the history of science in textbooks: What scientific knowledge means, how, when, and by whom it was created, how it developed and has survived to the present day, the individual characteristics of scientists, what they experienced during the scientific research process, what they were inspired by, their relationships with other scientists and their environments, the stages of the scientific process, the spirit of scientific research. It should support the development of students' understanding of both the content and the nature of science by reflecting on the characteristics of the time the research was conducted. In short, the history of science should be considered as a whole in terms of conceptual, contextual, and procedural aspects in textbooks. In this context, this research examined and evaluated high school chemistry textbooks from these perspectives.

According to the first result obtained from the research findings, the averages of the four books are at the most moderate level in terms of the analysis dimensions of the texts that can be associated with the history of science in the examined books. It can be said that this situation is equivalent to the studies that reveal the conclusion that the books used in chemistry courses in our country and around the world deal with different concepts and subjects in terms of the history and philosophy of science (Coştu & Niaz, 2012; Justi & Gilbert, 1999; Kılıç, 2010; Leite, 1996; Niaz, 2002; Yıldız, 2013). According to this situation, the average score of all the texts in the books decreases compared to the averages of the texts containing only the history of science elements.

When the books at each grade level are examined separately, results similar to this general result emerge. Firstly, when the 9th grade chemistry textbook was examined, a reading piece was determined in this book, and the science history average value of this reading piece was determined as 3.38. is similar to. In both studies, 9th grade books need to be more comprehensive regarding the elements examined. In terms of conceptual understanding, this text helps students understand scientific content and ideas, especially the variable nature of scientific knowledge.

Similarly, in terms of procedural understanding, it has been shown to the students that new information can be reached by questioning a scientific development, elaborating on it, or conducting different research. When this reading piece is examined in terms of contextual understanding, firstly, since it is clearly stated that scientific studies are related, 5 total points were given from this sub-category. However, only 1 point was given because the relationship between scientific efforts and social and political factors, their impact on human welfare, the individuality of scientists, and cultural heritage were not included enough.

As a result of the examination of the 10th-grade chemistry textbook, the 2 texts in the book are close to the average level of 2.5 in terms of conceptual understanding, procedural understanding, and contextual understanding in terms of use of history of science (means 2.3 and 2.9). When the two reading passages in the book, which contain elements related to the history of science, are evaluated together, it can be said that both reading passages are at a good level of conceptual understanding.

Although seven of the 11th-grade high school chemistry textbooks contain various elements in terms of conceptual, procedural, and contextual understanding in terms of the use of history of science, they remained low (means 2.1 and below). When the seven reading passages in the book containing elements related to the history of science are evaluated together, it is sufficient to present scientific content in the conceptual understanding category.

At the same time, there are intermediate-level elements about the variability of scientific knowledge in the same category. In terms of procedural understanding, the reading passages contain sufficient elements to develop students' questioning, thinking, and research habits. On the other hand, in terms of contextual understanding, the reading passages are insufficient.

When four reading passages containing elements related to the history of science in the 12th-grade high school chemistry textbook are evaluated together, it is likely insufficient to present scientific content in the conceptual understanding category. At the same time, it can be said that there are intermediate-level elements about the variability of scientific knowledge in the same category. In terms of procedural understanding, it can be said that the reading passages contain sufficient elements to develop students' questioning, thinking, and research habits. Especially in terms of contextual understanding, it can be stated that reading passages are at a higher level than other understandings.

4.1. Suggestions

According to the research findings and results, high school chemistry textbooks are at a low level in terms of history of science. It has been emphasized in research that science education strengthened with the history of science increases the awareness of students, teachers, or candidates about the nature of science (Ayvacı, 2007; Can, 2008; Beşli, 2009; Kaya, 2007; Kıral, 2010). However, it can be thought that courses that are limited in terms of the history of science may cause students to have difficulty understanding the nature of science. Therefore, individuals with low levels of scientific literacy will be raised.

The following suggestions can be made to prevent these and similar problems:

1. The number of reading passages on the history of science can be increased at each grade level.
2. In addition to the existing reading passages, examples from the history of science related to the subject can be given.
3. Courses on the history of science or the nature of science may take place in high schools and equivalent institutions.
4. It may be more appropriate to present the history of chemistry as a separate chapter in the textbooks, in sections within each subject.

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Abstract

This study aims to investigate mentor teachers' task implementation and instructional dispositions from the perspective of preservice mathematics teachers. Twelve preservice mathematics teachers examined four mentor teachers' task selection and implementation in terms of cognitive demand and instructional dispositions that affect their cognitive demand. The data were gathered from detailed observation notes and focus group interviews of preservice teachers. The results indicated that only one teacher selected most of the tasks at a high level and maintained them without declining their cognitive demand. His instructional dispositions showed us that he displayed an approach that allowed students to explore the tasks, reason, and discuss ideas. Launching fewer problems per lesson, he enabled students to examine the tasks in depth. He discussed student-invented strategies and sometimes focused on multiple solutions and misconceptions. Instead of algorithmic solutions, he emphasized underlying concepts, multiple representations, and daily life situations. On the other hand, other teachers mostly implemented tasks at low-level, however, they had different instructional dispositions towards student explorations, classroom discussions, and utilizing multiple representations. Based on these results, this study highlights the importance of mentor teachers for the professional development of preservice teachers.

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Research Article

How do Mentor Teachers Implement Mathematical Tasks?: The Perspective of Preservice Mathematics Teachers *

Osman BAĞDAT [1]

Abstract

This study aims to investigate mentor teachers' task implementation and instructional dispositions from the perspective of preservice mathematics teachers. Twelve preservice mathematics teachers examined four mentor teachers' task selection and implementation in terms of cognitive demand and instructional dispositions that affect their cognitive demand. The data were gathered from detailed observation notes and focus group interviews of preservice teachers. The results indicated that only one teacher selected most of the tasks at a high level and maintained them without declining their cognitive demand. His instructional dispositions showed us that he displayed an approach that allowed students to explore the tasks, reason, and discuss ideas. Launching fewer problems per lesson, he enabled students to examine the tasks in depth. He discussed student-invented strategies and sometimes focused on multiple solutions and misconceptions. Instead of algorithmic solutions, he emphasized underlying concepts, multiple representations, and daily life situations. On the other hand, other teachers mostly implemented tasks at low-level, however, they had different instructional dispositions towards student explorations, classroom discussions, and utilizing multiple representations. Based on these results, this study highlights the importance of mentor teachers for the professional development of preservice teachers.

Keywords: Cognitive demand, instructional dispositions, mathematical task, mentor teachers, preservice teachers

1. INTRODUCTION

Preservice teachers (PSTs) as learners make a great effort to attain competencies in the teaching profession by taking many theoretical and practical courses at university. Eventually, they experience the teaching last years of their teaching practice. One of the most crucial courses at the undergraduate level is teaching practice, which provides the behaviors required by the teaching profession and includes the theoretical and practical dimensions of educational sciences (Schatz-Oppenheimer, 2017). Therefore, it should be managed comprehensively within the university-school collaboration, ensuring the most beneficial professional development for PSTs. According to the Journal of Announcements, which is the official publication of Turkish Ministry of Education, the goal of the teaching practice course is "to prepare PSTs for the teaching profession, to develop the competence to use the knowledge, skills, attitudes, and habits related to the general culture, special field education, and teaching profession in a real school setting" (Ministry of National Education [MNE], 1998, p.1360). As a part of this course, "PSTs gain a better understanding of school structure, administration, and daily life in schools, examine educational settings, engage in extracurricular activities, observe experienced teachers, work with students practicum in the individually or in small groups, and gain

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short-term teaching experience". During this period, mentor teachers have an important role in PSTs' identity, skill, and competence development (Loughran, 2006; van Es & Sherin, 2008).

Mentors are expert teachers who provide assistance to PSTs within the scope of teaching practice. They play a significant role in the training of PSTs both inside and outside of the classroom. Butler and Cuenca (2012) emphasized the three important roles of mentors. First, as emotional supporters, helping them gain their teacher identity. PSTs "often enter student teaching unsure of their abilities. Novice teachers also have uncertainties about what it means to be a teacher, and from a supportive perspective, the mentor's purpose is to help the novice teacher move past these fears (p. 300). Second, as socializing agents, influencing PSTs' educational views. The third and the most significant, is as instructional coaches, they "observe and evaluate instructional practice and provide constructive feedback aimed at improving the methods and techniques of PSTs" (p. 299). For instance, they can support PSTs with daily and annual planning, effective classroom practice, assessment, and classroom management. Previous studies have shown that experienced mentor teachers can greatly contribute to PSTs' professional growth (Hudson, 2012). PSTs may gain valuable experience from the classroom setting and instructional decisions of mentors. They should therefore pay close attention to mentors' practices during the lessons.

One of the factors affecting the practices in the classroom is undoubtedly the quality of the mathematical tasks selected and implemented by mentor teachers. Studies indicated a deep relationship between implemented tasks and students' understanding of mathematics. In this context, mentor teachers' task preference, the nature of their classrooms while implementing these tasks, and embedded classroom norms directly affect their teaching quality (Hiebert & Wearne, 1993; Stein & Lane, 1996), and consequently, the professional development of PSTs under their mentorship. Based on this importance, this study aimed to reveal the instructional dispositions of mentor teachers by examining their task selection and factors affecting task implementations from PSTs' perspectives.

1.1. Theoritical Framework

1.1.1. Mathematical tasks framework

A mathematical task is defined as a classroom activity or problem that focuses students' attention on an important mathematical idea (Stein, Grover, & Henningsen, 1996). In terms of the level of reasoning required by students, Stein et al. (1996) classified mathematical tasks into four categories, two of which are high-level (doing mathematics (DM) and procedures with connections (PwC) and two of which are low-level (procedures without connections (PwoC) and memorization (Mm) (Stein, Smith, Henningsen, & Silver, 2000). This classification, named cognitive demand, is expressed as students' mental effort to accomplish a task (Boston, 2013). The cognitive demand of a selected mathematical task is related to the degree to which that task prompts the student to think. Mm tasks involve learning or reproducing facts, rules, formulas, or definitions which don't require relating to the underlying mathematical ideas of concepts. PwoC tasks often require recalling algorithms in order to complete a task with little cognitive effort. These tasks aim to find the correct answer rather than emphasize the meaning of mathematical ideas. PwC tasks require an effort to comprehend the underlying meanings of mathematical concepts in order to complete tasks and connections may be established between multiple representations, providing an opportunity for deep mathematical understanding. These tasks usually have general instructions that suggest a strategy for the solutions. DM tasks require complex and non-algorithmic thinking and mentally imbalanced situations for deep understanding. These tasks provide students to generalize a mathematical concept, solution process, and relationships (Stein et al., 2000). Table 1 presents examples of task classification.

Table 1. Sample examples for cognitive demand levels (Stein et al., 2000, p. 13).

Task level	Sample examples
Memorization	What are the decimal and percent values of ½ and ¼? (Students rehearse the known facts)
Procedures without connections	Convert the fraction $\frac{3}{8}$ to decimals and percentages. (Students use procedural operations)
Procedures with connections	Using a 10 x 10 table, determine the decimal and percentage values of $\frac{3}{5}$. (Student use table representation to focus on the meaning of the percentage idea)
Doing mathematics	Color 6 squares in a 4 x 10 rectangular table. Using the rectangle, find the percentage, decimal, and fractional value of the colored area. (Students may come up with multiple solution strategies)

The mathematical task framework (MTF) in Figure 1 (Stein et al., 1996, p. 459) represents the phases from task selection to task setup, implementation, and student learning. According to this framework, a teacher firstly selects a mathematical task from a curriculum material, then sets up the task in line with his goal, pedagogical and content knowledge or beliefs, and then implements it in the classroom, and finally, student learning occurs.

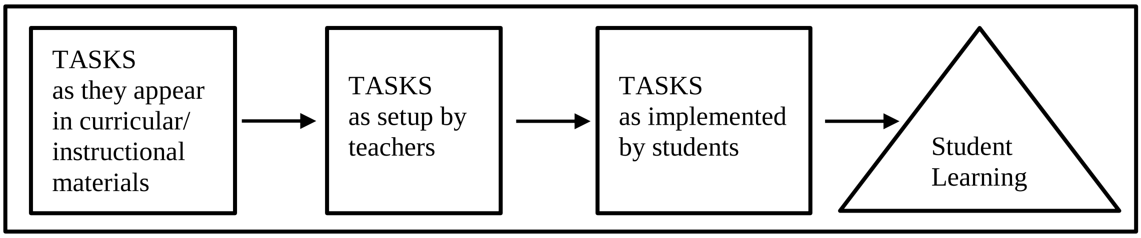

Figure 1. Mathematical tasks framework (Stein et al., 2000)

As seen in Figure 1, the cognitive demand of a mathematical task may change from selecting the task from the curriculum source to its implementation due to some factors depending on teacher knowledge, belief or attitude, student behaviors, or characteristics of the task. A level of a cognitively demanding task can be declined or maintained, or a low-level task can be raised to a high-level during implementation. There are several studies investigating teachers' implementation of mathematical tasks in the classroom (e.g. Ader, 2020; Henningsen & Stein, 1997; Stein et al, 1996; Stein & Lane, 1996), their impact on the learning opportunities of students (e.g., Hiebert & Wearne, 1993; Jackson, Garrison, Wilson, Gibbons, & Shahan, 2013; Ni, Zhou, Li, & Li, 2014; Özmantar & Aslan, 2017; Stein & Kaufman, 2010) examining the relationship between teacher-student behaviors, beliefs, content knowledge, pedagogical content knowledge, and implementation of tasks (e.g., Charalambous, 2010; Garrison, 2011; Wilhelm, 2014). Research has shown that the cognitive demand of mathematical tasks in the curriculum resources is mostly high (Ubuz, Erbaş, Çetinkaya, & Özgeldi, 2010), but the majority of teachers can't maintain the cognitive demand of the tasks at a high-level during implementation (Henningsen & Stein, 1997; Stein et al., 2000) because of various factors explained in the next section.

1.1.2. Instructional dispositions of teachers in task implementation phase

Many factors originating from the teacher, students, or classroom setting affect the cognitive demand of a mathematical task in the implementation phase. An important part of these factors are directly related to teachers' classroom practices. The cognitive demand of tasks is often declined by a teacher who routinizes tasks without focusing on the underlying meaning and does not give students enough time to think and reason (Henningsen & Stein, 1997). A teacher who implements mathematical tasks at a high level constructs a setting where students can think and reason, gives enough time for exploring tasks, takes into account the previous learning of students, pays attention to students' explanations and justifications in a classroom discussion, provides students opportunities to establish conceptual relationships and to make connections among multiple representations (Stein, Engle, Smith, & Hughes, 2008). To constitute such a classroom setting, a teachers should first select a cognitively demanding task that allows for multiple representations and solutions, and make detailed planning to implement and maintain it at a high level (Henningsen & Stein, 1997). These factors affecting the cognitive demand of mathematical tasks were framed as a result of the research carried out within the scope of the QUASAR project (Quantitative understanding: Amplifying Student Achievement and Reasoning) (Silver & Stein, 1997; Stein, et al., 1996). Teachers' instructional dispositions can be inferred from whether or not they have these factors that affect the cognitive demand of mathematical tasks. In the current study, these choices such as providing exploration time to solve the task, building task on prior knowledge, focusing on student solutions, setting a whole class discussion and making connections are considered as teachers' instructional dispositions. Subsequent studies (e.g., Ader, 2020; Boston & Smith, 2009) mostly focused to enhance teachers' task implementation to maintain cognitively demanding tasks and to change instructional dispositions through professional development programs. This study aims to investigate the tasks implemented by mentor teachers from the perspective of PSTs. For this purpose, firstly, cognitive demand levels of selected and implemented tasks were examined, and then the instructional dispositions of PSTs that affect the cognitive demand of tasks were analyzed.

2. METHOD

2.1. Research Design

This study utilized a qualitative case study method. Case studies, according to Yin (2003), should be centered on "how" and "why" questions. Merriam (2013), on the other hand, emphasizes the importance of thoroughly describing the phenomenon explored in case studies. This study aimed to seek mentor teachers' task implementation and the reasons for the factors affecting the tasks' CD in detail from thep perspective of PSTs.

2.2. The Context and Participants

This research was carried out as a part of a Teaching Practice course in an elementary mathematics education program at a Turkish university. Within the Teaching Practice course, PSTs in their last year observe mentor teachers for 4 hours per week for 12 weeks. During this period, they accomplish many objectives, such as interviewing with the principal, collecting curriculum information, their mentor's annual plan, and curriculum documents, examining the mentor teacher's lesson plan, observing methods, approaches, classroom management, and student interactions. The current study comprised 12 middle school PSTs and four mentor mathematics teachers, all of whom were given pseudonyms in Table 2. Teachers Akin and Ceren work in a rural part of the city, where they teach in a socioeconomically deprived school with a lower student population than other teachers. Duru and Ali, on the other hand, work in two different schools that are located in the urban part of the city, have a higher socioeconomic status, and have a larger student population. Parents are more involved in their children's lessons, and the majority of students in these schools attend private lessons in addition to their courses.

Table 2. The participants

Teacher	Experience (year)	PSTs paired with teachers
Akin	14	PST1, PST2, PST3
Ceren	14	PST4, PST5, PST6
Ali	23	PST7, PST8, PST9
Duru	7	PST10, PST11, PST12

2.3. Data Collection

In the current study, PSTs were trained by the researcher of this study on the CD levels, task implementation, and factors that affect the implementation of these tasks. In weekly meetings held with the PSTs, they characterized the CD levels of sample tasks and evaluated certain cases where situations caused the CD of the tasks to decline or maintain during the setup and implementation phases. During this time, their justifications were discussed in order to obtain a consensus on task characterization and case analysis. Following the training, PSTs used the observation form to observe their mentors' lessons, indicating how the teacher planned, from which source s/he selected the tasks, and whether he made any setups in the observations. They were expected to respond to such questions as best they could, incorporating as many dialogues as possible: How did the teacher launch the task during the implementation phase? How many tasks did he select on average? Were any student(s) selected to share their ideas? Was there a whole-class discussion? Did different solution strategies emerge, and how were these solutions shared? Was there a task exploration time? Was there any use of material, technology, or other means? They were, then asked to evaluate the CD of tasks during the selection, setup, and implementation phases, as well as the factors affecting the CD. They were required to give a detailed explanation of their reasoning. During this period, PSTs observed two different lessons, each of which had a different grade level and subject. Furthermore, focus group interviews with PSTs who observed the same mentors were done as part of the study's scope to reveal the general instructional dispositions of the mentors. These focus group interviews were also designed to provide triangulation of data to support trustworthiness and verification, which are critical for the validity and reliability of qualitative research.

2.4. Data Analysis

In the current study, the phases from selecting a mathematical task to the completion of implementation are determined as a unit of analysis and if a mathematical task has sub-items that are related to one another, they were all determined as a single task. However, if the sub-items were independent of one another, each task was evaluated as a separate task. Within this period, PSTs analyzed a total of 138 tasks. They characterized the CD of tasks selected and implemented by the mentors through the Task Analysis Guide (Stein et al., 2000) and explained the factors affecting the CD of the tasks with their reasons. On the other hand, as a researcher, I coded the CD of tasks described in detail in the observation forms and met with PSTs to reach a consensus on contradictions. By subjecting the summary of reasons of the PSTs in the observation forms to content analysis, I coded for the factors affecting the CD of the tasks and combined them under certain themes. A sample student observation and coding are shown in Appendix 1.

3. FINDINGS

3.1. Cognitive Demand of Selected and Implemented Tasks

In the current study, each of the mentor teachers was observed by three PSTs for a total of six hours. As shown in Table 3, Akin implemented an average of 2.5 Ceren 3.6, Ali 7.3, and Duru 9.5 tasks per lesson during these six-hour observations. He selected higher-level tasks (86.6%) than other teachers and almost maintained their cognitive demand. Furthermore, he implemented a DM task that wasn't observed in other teachers' classrooms. Although Ceren implemented more tasks (27.2%) at a high level than the other two teachers, she mainly selected and implemented PwoC level tasks. Duru selected a total of 24 high-level tasks (4 PwC, 5 DM, and 15 PwC) but was able to implement only 4 (7%) of them at the PwC level. In other words, while Duru was successful in selecting high-level tasks, she struggled to maintain them at a high level. Ali, on the other hand, almost completely selected low-level tasks (95.5%) and implemented them at a low level. Table 3 shows the cognitive demand levels of selected and implemented tasks.

Table 3. Teachers' task selection and implementation

		Task Selection	Task Implementation	Akin	Ceren	Duru	Ali
Implemented at a high level	Maintained the cognitive demand	DM	DM	1 (6.6%)	-	-	-
		PwC	PwC	11 (73.3%)	6 (27.2%)	4 (7%)	2 (4.5%)
	Increased the cognitive demand	PwoC	PwC	1 (6.6%)	-	-	-
	Total			13 (86%)	6 (27.2%)	4 (7%)	2 (4.5%)
Implemented at a low level	Declined the cognitive demand	DM	PwoC	-	-	5 (8.8%)	-
		PwC	PwoC	1 (6.6%)	3 (13.6%)	15 (26.3%)	-
	Maintained the cognitive demand	PwoC	PwoC	1 (6.6%)	12 (54.5%)	32 (56.1%)	40 (91%)
		Mm	Mm	-	1 (4.5%)	1 (1.7%)	2 (4.5%)
	Total			2 (13.3%)	16 (72.7%)	53 (93%)	42 (95.5%)
Implemented task per a lesson				2.5	3.6	9.5	7.3

3.1.1. Instructional dispositions of teachers

Teachers make many important decisions before and during the lesson such as giving time to solve the task, focusing on student solutions, and making connections. These instructional dispositions affect the level of implemented tasks. Table 4 shows the factors affecting the cognitive demand levels of the tasks implemented by the mentor teachers. These factors are supported by qualitative data and presented under sub-headings for each teacher.

Table 4. Factors affecting the cognitive demand of the tasks implemented by teachers

Factors affecting the cognitive demand of the tasks				Teacher (Number of implemented tasks (n))			
				Akin (n= 15)	Ceren (n= 22)	Duru (n= 57)	Ali (n= 44)
Exploring tasks	Providing exploration time	Providing adequate time	Giving feedback	5 (33.3%)	-	-	-
			No feedback	8 (53.3%)	5 (22.7%)	5 (8.8%)	2 (4.5%)
		No exploration time		2 (13.3%)	17 (77.2%)	52 (91.2%)	42 (95.5%)
	Building on prior knowledge			10 (66.7%)	6 (27.2%)	-	1 (2.2%)
Selecting solution	Selecting student-invented strategies	Focusing on one strategy		9 (60%)	3 (13.6%)	-	-
		Focusing on multiple strategies		3 (20%)	2 (9.1%)	-	2 (4.5%)
		Focusing on misconceptions		3 (20%)	-	-	-
	Selecting the expected correct solution strategy			-	2 (9.1%)	14 (24.5%)	16 (36.3%)
	Selecting no solution			3 (20%)	17 (77.2%)	43 (75.4%)	26 (59%)
Summarizing	Setting a whole class discussion			10 (66.7%)	13 (59.1%)	1 (1.7%)	13 (29.5%)
	Connection	Emphasizing underlying meaning behind concepts		13 (86.7%)	12 (54.5%)	5 (8.8%)	18 (40.9%)
		Connecting with representations		10 (66.7%)	12 (54.5%)	8 (14%)	19 (43.1%)
		Connecting with daily life situations		9 (60%)	6 (27.2%)	4 (7%)	-
	Focusing on a procedural solution without connecting			2 (13.3%)	9 (40.9%)	42 (73.6%)	24 (54.5%)

Akin teacher: "Student-oriented lessons"

> **PST1:** *Akin has a master's degree in creative drama. He has chosen drama training, being influenced by Brian Way's question, who is the pioneer of drama, of "why children run out when the bell rings".... He claimed that he used as well as other methods and strategies in his lessons. Most of the time, he uses a questioning technique that allows students to participate in the lesson and solve problems by reasoning.*

The above excerpt reveals PST1's views on Akin's approach. Compared to other teachers, Akin fulfills the requirements of a student-oriented approach, gives importance to student strategies, and discusses ideas. He encourages them to explore, selects high-level tasks, and implements these tasks at a high level (see Appendix 1). As shown in Table 4, In most tasks (86.7%), Akin allowed enough time for exploration, set 66.7% of the tasks on the students' prior knowledge, monitored students in 33.3% of the tasks, and provided feedback on their solutions. The following dialogue presents PSTs views:

PST1: *He waits so long (while monitoring solutions) that we feel bored, but eventually (students) come up with their own solutions.*
PST3: *He monitors students one by one while they are solving tasks. When they have challenges in solving the tasks, he changes the problem's context, provides clues or gives examples from their prior knowledge.*
PST2: *If the task is too abstract, he immediately sets it up by changing numbers, establishing an analogy, or simplifying it, and indeed, we noticed that he get better feedback from the students.*

As the dialogue shows, Akin examines the solutions while monitoring the task, provides formative feedback, and makes modifications to the problem's context as needed.

He frequently examined student solutions by launching a few activities (an average of 2.5 per lesson), and the majority of the time (66.7%) they were investigated jointly in a whole-class discussion. In 80% of the problems, he selected students' solutions, while in 20% of the tasks, he conducted the lesson without selecting a student solution. In 60% of the tasks, he selected a single student solution, and in 20% of the tasks, he selected multiple solution strategies. He also highlighted misconceptions in 20% of the tasks, even though this was never observed in other teachers' classrooms. Akin's approach to multiple solution strategies is outlined in the following excerpt:

PST3: *His enacted tasks usually have multiple steps and require detailed thinking. He usually opens the task on the smartboard, provides some time for students to explore it, and implements only one or two tasks in 40 minutes. He provides feedback to the students while monitoring their strategies, and they examine different strategies together. He builds lessons on their prior knowledge without giving information directly. I don't think he declined the cognitive demand of any tasks.*

The following excerpt explains Akin's view of classroom discussions:

PST3: *He purposefully let students explain their correct or incorrect solutions. There is often a discussion-based setting beyond show and tell. For example, he asks, "What do you think about your friend's solution? Is it correct or incorrect, and why?*

Except for the 2 tasks (13%), he made connections in all of the other tasks. He emphasized the underlying meaning of concepts in 86.7%, utilized multiple representations in 66.7%, and established connections with daily life in 60% of tasks. According to PST2 *"The students realize the generalization at the end of the discussion. He never explained a procedure, as our teachers did, like "equalize denominators when adding fractions"*. As stated, Akin aims for students to reach generalizations instead of giving routine procedures directly and frequently builds a setting to make connections.

Ceren teacher: "Discussion-based lessons"

PST5: *She doesn't wait long for the task to be explored.*
PST4: *However, she usually uses the questioning method. She asks how to do it; for example, when a student shares his idea, she usually asks if anyone else thinks about it.*
PST4*: She doesn't launch tasks requiring too much time to solve.*
PST6: *She obviously employs invention method. She frequently gives several examples, enabling students to notice the contrasts between them and, as a result, they build their conceptions.*

The above excerpt reveals PST4, PST5, and PST6's views about Ceren's lessons. Compared to Akin, Ceren mostly prefers directly discussing ideas without monitoring student-invented strategies, however, as shown in Table 3, she mostly selects low-level tasks.

Ceren provided exploration time in 22.7 % of the tasks, as seen in Table 4, but she just waited for student solutions without monitoring or providing feedback in these tasks. She built 27.2% of tasks on their prior knowledge, focused on a student-invented single solution for 13.6% and multiple solutions for 9.1% of tasks. While she selected expected correct student solutions to be shared on the board in 9.1%, this wasn't the case in 77.2%. For example, in a task where different strategies emerged, the teacher modeled the algebraic operation“$(2x+1).(2x+3)$”, then asked, "How do we do the multiplication?". One of the students applied the distributive property as “$(2x+1).(2x+3)=(2x+1).2x+(2x+1).3$”, while the other one applied as “$(2x+1).(2x+3)=2x.2x+2x.3+1.2x+1.3$”. As a result, both students explained their ideas, and they discussed how these two ideas had the same result.

Ceren built a discussion-based setting in 59.1% of the tasks, emphasized the underlying meaning behind concepts in 54.5%, made connections with representations in 54.5%, and with daily life in 27.2%. The following excerpt shows PSTs views about Ceren's lessons:

PST5: *She connected algebraic identities with the area of the square.*
PST6: *She proved the algebraic identities by using models.*
PST5: *The feature I like the most is her examples from daily life. For example, she brought a hula hoop to the classroom today to explain the intersection set.*
The PSTs stated that Ceren initiates discussions on establishing conceptual relationships and gives examples from daily life situations. However, as seen in Table 4, Ceren focused on algorithmic solutions in 40.9% of the tasks. Below is an excerpt about this situation:
PST4: *I like her lecturing. She utilizes concrete materials to make connections without giving direct formula. However, she may prefer more higher-level tasks or set a problem-based atmosphere.*
PST5: *Solving a lot of questions or focusing on a few? I think she should either select high-level tasks or set up these tasks to improve their cognitive demand level.*
PST4: *Instead of asking too many similar tasks, emphasizing meaning may be better.*
PST5: *There are a lot of questions based on reminding the algorithm or procedure.*

As stated, while Ceren generally selects high-level tasks for launching a new subject, she prefers low-level algorithmic tasks for reinforcing a subject. However, PSTs suggest that Ceren should give more emphasis on high-level tasks in her lessons.

Duru teacher: “Exam-based lessons”

PST8: *She immediately launches the subject and solves many questions.*
PST9: *She gives 100-150 questions per week as homework.*
PST8: *She wants all question types to be experienced, like memorizing solution paths.*

The above dialogue shows the views of PSTs about Duru's lessons. She usually aims to teach solution paths without allowing students to engage in high cognitive effort and gives high-level tasks as homework. While solving these tasks in the classroom setting, she mainly emphasizes routine procedures without focusing on the underlying meaning of these tasks.

As shown in Table 4, while Duru didn't provide any exploration time for the students in 91.2% of the tasks, she provides time in very few tasks (8.8%) without monitoring and giving any feedback. There wasn't any student-invented strategy and she get students to the board to write the correct solutions of tasks that aim to reinforce the algorithm in 24.5% of the tasks. Furthermore, in 75.4% of the tasks, she directly explained solutions without selecting any student to share his idea. The following excerpt shows PST9's views about Duru’s classes:

PST9: *She sometimes provides exploring time approximately 5 minutes, but mostly for routine low-level tasks. For example, she firstly demonstrated the solution method of a task, and students applied it to others. They then came up to the board to write solutions, but she explained these solutions one more time. Students who have erroneous solutions also come to the board as well, but she corrects them and explains them the correct solution.*

Duru set up whole-class discussions for only 1.7% of tasks. She emphasized underlying concepts in 8.8% of the tasks, employed multiple representations in 14% of the tasks, and made connections with real-life situations in 7% of tasks. She also focused on algorithmic solutions in 73.6 % of the tasks. Consider the following quote:

PST8: *There is no discussion in the classroom.*
PST9: *The majority of students haven't mentally been involved in classroom activities.*

As the quotation indicates, just a few students in Duru's class were participating in classroom activities, and they hardly participated in whole-class discussions. The following quotation reflects the PSTs' views on the extent of Duru's tendency to make connections.

PST8: *She usually instructs low-level tasks.*
PST9: *Tasks at the end of the units mostly had high cognitive demand, but she declined their level since she didn't make connections. Even if tasks require making connections, she declined their levels by attempting to solve many problems quickly and preferring to have students memorize solution types rather than conceptual learning. I hardly noticed her making connections with daily life or using multiple representations. I don't think she purposefully utilized models. She introduced modeling as an alternative solution once the solution was complete, rather than encouraging students to use the model to explore the task. For example, she instructed the rules of addition operations in algebraic expressions and then demonstrated using models as an alternative approach without reasoning.*
PST8: *When dealing with integer operations, students first performed routine procedures taught to them by their teachers, then drew number counters. For instance, the teacher calculated the result of +12:3 and then drew a suitable model for it. They should have examined the operation with models first, then generalized it, in my opinion.*

As the excerpts show, Duru's didactic approach limits her from establishing an atmosphere to build relationships. While the task requires making connections with models, Duru prefers to teach algorithmic procedures rather than focusing on the underlying meaning of the task and making connections.

Ali teacher: "Model it and solve"

PST10: *The teacher selects cognitively low demanding tasks, but instead of memorizing the rule, he explains it on the models. He recommends students to "model and solve".*

Ali prefers to spend more time on solutions on the smartboard, instead of allowing students to explore the tasks, As shown in Table 4, Ali did not allow time for students to explore tasks in 95.5 percent of tasks. In the tasks he spent time on (4.5%), he waited until the tasks were solved instead of monitoring student solutions and giving feedback. He also built 2.2% of the tasks on students' prior knowledge. In only 4.5% of the tasks, he allowed student-invented strategies, and in 36.3% of the tasks, he selected the expected correct solution strategies to be shared with the class. In 59% of the tasks, he selected no solution and solved the problems on the board himself. Consider the quote of PST10 below:

PST10: *First of all, he solves the task of ensuring that students comprehend the subject, without allowing exploration time to the students. In his demonstration, he focuses on the concept, uses models, and then moves on to solving too many low-level routine tasks.*

Ali, as mentioned by PST10, usually prefers to begin by presenting a task's solution method and then follow up with activities to reinforce his solution methods. As shown in Table 4, he provided a discussion-based setting in 29.5% of the tasks, emphasized the concept underlying the tasks in 40.9%, and used multiple representations in 43% of the tasks. In 54.5% of the tasks, on the other hand, he focused on algorithmic solutions.

4. DISCUSSION and CONCLUSION

In this research, one of our goals was to uncover mentor teachers' task selection and implementation routines in terms of cognitive demand. According to the findings, although teachers' task selection and implementation routines varied, three of the teachers (Ceren, Duru & Ali) either decreased the cognitive demand level of the high-level tasks during the implementation or already selected and implemented low-level tasks. Research has shown that the cognitive demand of mathematical tasks included in the curriculum materials are considerably high (Ubuz et al., 2010), but teachers either select low-level tasks or decline their level during the implementation phase (Henningsen & Stein, 1997; Stein et al., 2000). In this sense, their task selection and implementation behaviors are similar to those observed in studies (Güzel, Bozkurt, & Özmantar, 2021). On the other hand, unlike the other teachers, one of the teachers (Akin) mostly selected high-level tasks and maintained the cognitive demand of these tasks during the implementation phase. This approach is among the intended behaviors in teachers in many studies, recent research has focused on improving teachers' task selection and implementation quality through professional development (Ader, 2020; Arbaugh & Brown, 2006; Boston, 2013; Boston & Smith, 2009, 2011).

Stein et al. (1996) claim that “teachers' and students' habits and dispositions refer to relatively enduring features of their pedagogical and learning behaviors that tend to influence how they approach classroom events” (p. 461). From this point of view, it may be noted that even though Ceren, Duru, and Ali have various task preferences and implementation routines in the classroom, their instructional disposition can be identified as a "teacher-driven" approach. In teacher-driven classrooms, there are settings built on whole class discussion and making connections as well but these discussions tend to be more concerned with the solutions selected by the teacher than those emerged by the students. This is precisely why Akin's approach has been described as “student-oriented”.

4.1. Teacher-Driven Approach

In a teacher-driven setting, teachers usually adopt an approach in which their ideas and preferences are emphasized rather than a course based on student ideas. As shown in Table 4, various factors were observed affecting cognitive demand tasks implemented by these teachers in the study. For example, teachers mostly avoided giving sufficient time to explore the task, didn't base their tasks on students' prior knowledge, dismissed student-invented strategies, and accordingly didn't focus on misconceptions. They usually prompted students to write the desired correct solution when they were called to the smartboard, so they concentrated on instruction instead of discussing student-invented strategies. Teachers’ lack particular content knowledge or the ability to identify critical topical understandings (Wallin & Amador, 2018) or “teachers’ orientations-their beliefs, values, and preferences-influence their actions (Stockero, Leatham, Ochieng, Van Zoest, & Peterson, 2019). Therefore, in recent years, the number of professional development research such as improving teachers' noticing skills has been increasing (e.g., Guner & Akyuz, 2019).

Although Ceren, like the other two teachers, had a teacher-driven orientation, she favored a "discussion-based method" as pre-service teachers mentioned, and she strove to emphasize underlying concepts, multiple representations, and daily life situations throughout these discussions. However, selecting low-level tasks and not allowing students enough time to explore led teachers to implement these tasks at a low level. In fact, a discussion-based approach in a reform-oriented classroom is deemed important in studies (Stein, et al., 2008), but it was stated in interviews with pre-service teachers that Ceren's discussions are far from revealing students' ideas. Studies have emphasized the importance of quality of tasks for creating a rich classroom discussion atmosphere (Stein et al., 2008), higher-order questioning (Ni et al., 2014), and shaping students' mathematical thinking (National Council of Teachers of Mathematics [NCTM], 1991).

Duru, on the other hand, did not enable students to discuss their ideas or make connections, and she generally routinized tasks by removing their problematic parts, despite selecting cognitively demanding tasks. As a result, she declined the cognitive demands of tasks, as in earlier research (e.g., Hong & Choi, 2019). Although teaching procedures in mathematics is necessary, research has shown that focusing solely on procedures and ignoring mathematical meaning is ineffective in ensuring students' learning and mathematical progression (Stein & Lane, 1996; Stigler & Hiebert, 1999). Unlike Duru, Ali emphasized multiple representations and the meaning of concepts underlying tasks, but he used representations to make his instruction more understandable rather than as a tool for students to explore the task in a sufficient time.

4.2. Student-Oriented Approach

In this study, a student-oriented classroom is expressed as a classroom climate where the teacher mostly tries to reveal student ideas, set whole-discussions and tries to make connections between these ideas. Akin, compared to other teachers, launched fewer tasks per lesson and provided students to explore them in-depth. He constructed the majority of the tasks on students' prior knowledge, provided adequate time to explore tasks, and frequently gave formative feedback to students. He led to discuss student-invented strategies in the classroom and occasionally focused on multiple solutions and misconceptions. He focused students' attention on the underlying meaning of concepts, making connections with multiple representations and daily life situations, rather than algorithmic solutions. Accordingly, he mostly selected high-level tasks and maintained the cognitive demand of these tasks during the implementation phase. Akin's approach is in line with the approaches of teachers who implement the reform-based curriculum (Ader, 2020; Ni et al., 2014; Stein et al., 1996). In the current study, no research was conducted to measure students' learning, but it is stated that providing support and using their existing or prior knowledge can give students confidence (Hong & Choi, 2019) and ensure success (Stein & Lane, 1996), and there are quite a few evidence that CDTs provide all students with important learning opportunities (e.g., Stein & Lane, 1996; Zohar & Dori, 2003).

4.3. Summary and Implications

The results of the current study indicate that the mentor teachers observed by PSTs had a range of instructional dispositions in terms of factors such as task selection, giving task exploration time, selecting on student-invented strategies, building the task on students' prior knowledge, setting whole-class discussion and making connections. The level of cognitive demand of tasks in the implementation phase is directly impacted by these factors. While some of the PSTs gained experience in classrooms with teachers who primarily favor low-level tasks, pay little attention to student ideas, and concentrate on reinforcing algorithmic procedures; a number of PSTs gained experience in classrooms with mentors who select high level tasks and maintain their level by allowing students time to explore tasks, listening and discussing their ideas, and making connections. It should be no surprise that the second group of PSTs would notice a number of crucial abilities that qualified teachers' possess according to the literature on mathematics education. This finding highlights that each mentor teacher had different instructional orientations, which would generate lasting traces in the formation of PSTs' professional identities. Therefore, selecting a mentor teacher is crucial for PSTs who would have just experienced teaching before beginning the profession. It is of great importance for PSTs' training to have mentors who use reform-based activities, take into account strategies, recognize cognitively demanding tasks and can implement tasks without declining their cognitive demand. As a matter of fact, Akin's mentees acknowledged that this supervision provided them with a great experience. At this point, it is recommended that educational faculties may consider criteria for selecting mentor teachers, such as getting feedback from previous pre-service teachers, postgraduate-doctoral education status, participation in professional development programs, and experience.

The data for this study was gathered through observations and interviews conducted by pre-service teachers. Because detailed observations in a scientific study require professionalism, observations performed by novice teachers may be considered a limitation. To overcome this limitation, the researcher employed a tool that allows pre-service teachers to make comprehensive observations and conducted in-depth focus group interviews with them. In addition, based on pre-service teachers' grasp of the cognitive demand framework, this study attempted to explain the nature of mentor teachers' classroom atmosphere. As a consequence, through observations and interviews, this circumstance, which we characterize as a limitation, discloses the focus points and perspectives of PSTs.

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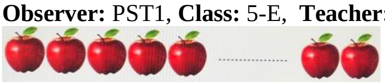
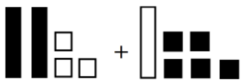
Appendix 1. The participants sample student observation and coding

Goal: Calculates the fractional part of a whole and the whole of a part by using unit fractions. **Observer:** PST2, **Grade:** 5-E, **Teacher:** Akin **Task:** When painters draw a human body, they divide the body into parts. This procedure helps painters to check whether the drawn parts are compatible. For example, they sketch the head as $\frac{1}{8}$ of the total length, arm length as $\frac{3}{8}$ of the total length, and the leg length as $\frac{4}{8}$ of the total length. If the length of a human body sketched in accordance with the above measurements is 40 centimeters, can you find how many centimeters the lengths of the head, arms, and legs are sketched? If these measurements were accurate for all people, how many centimeters would a person with a height of 176 centimeters have in head, arm, and leg length? **Source:** MNE (2019, pp. 107) **The summary of task implementation** After the teacher reminded prior knowledge about fractions, he asked them to sketch a human body by counting the squares in the notebook. T: Look at how long a square in your notebook is with a ruler. S1: 0.5 cm. T: So, 2 squares equal 1 cm. If the man's height is 24 cm, how many squares do we need? S2: I need 48 squares. The teacher provided approximately 10 minutes for the students' sketch, but most could not sketch it. So, the teacher started to sketch it on the board himself by questioning students. Because the students had given no response, the teacher compared the situation to a piece of baklava (a kind of sweet), divided 24 into 8 equal portions, and then found 3 pieces. Thus, he connected the task with a daily life situation and made the problem easier to understand. The students found the leg length as 9 cm by applying similar procedures. Then, he provided students time to explore the second part of the task, monitored their solutions, and provided feedback. As a result, the lesson was finished before the task could be completed**.**	**The CD levels and reasons determined by the PST** This task aims to find the fractional part of a whole. Before the solution, the teacher reminded **prior knowledge** on fraction and unit fraction concepts. He explained that to find the fractional part of a whole, it is necessary to find the unit fraction and multiply it by the number of parts. To be better understood, he let students make **connections** by **exploring daily life situations**. It is a **PWC** type of task because the students realized the **underlying concepts** of proportional reasoning by comparing quantities. While **monitoring** students' solutions, he **provided feedback on their mistakes**. Since he **provide a classroom setting to enable students to think and reason**, there was no change in the CD level during the implementation of tasks. **Researcher's comments** The task aims to enable students to use proportional reasoning skills connecting with fractional quantities in a real-life context. In the second part of the task, they have to rethink the proportional quantities they discovered for real human dimensions. Because the second part of the task is complicated and cannot be solved immediately, it causes anxiety in students, seeks to regulate cognitive processes and demands high-level cognitive functions. Hence, the task is at the **DM level**. The teacher allowed for a while for the task to be solved, then completed it on the board with help of the students. Even though he did not provide enough time for the task to be explored, he established an atmosphere based on the students' reasoning without routinizing the task. Therefore, there has been no change in the cognitive demand level of the task. The factors affecting cognitive demand, emphasized by the PST, as can be seen in the bold signs, were determined as **establishing a relationship with daily life, conceptual connections, building on preliminary knowledge, reasoning, and providing students with formative feedback.**
Goal: Converts compound fraction to proper fraction and proper fraction to compound fraction. **Observer:** PST1, **Class:** 5-E, **Teacher:** Akin  **Task:** Ayse will share 27 apples with 5 friends. Explain how many apples are given to each friend of Ayse. **The summary of task implementation** The teacher provided students time to explore the question, however, he didn't monitor their solutions. He then initiated a whole-class discussion, emphasized on equal partitioning and focused on two different solutions. In the first solution, after distributing 25 apples to 5 people, the remaining two apples were divided into $\frac{2}{5}$ for each friend. In the second solution, each apple was divided into 5 slices, so they discussed on 27 slices of $\frac{1}{5}$, or $\frac{27}{5}$. Then, by connecting these solutions, he made them realize that $5\frac{2}{5}$ is equal to $\frac{27}{5}$.	**The CD levels and reasons determined by the PST** This task includes **a daily life context,** aiming to **make sense** of a conversion of a compound fraction to a mixed fraction and to convert a mixed fraction to a compound fraction; hence it is a PWC task. The task was launched by the teacher in **two different ways**. He **provided adequate time to explore** and implement it without declining the cognitive demand of the task by constantly **questioning.** **Researcher's comments** The task aims to establish a conceptual relationship and connect with daily life context; hence it is a PWC task. Although the teacher didn't keep the monitoring time longer, he focused on different strategies, enabled students to establish conceptual relationships, and make judgments in a whole-class discussion. Therefore, the task was maintained at the PWC level in the implementation phase. The factors affecting cognitive demand, emphasized by the PST, as shown in the bold signs, were determined as **making conceptual connections, associating with daily life, building on preliminary knowledge, providing exploration time, emphasizing various strategies, and orchestrating whole-class discussions.**
Goal: Does addition and subtraction in algebraic expressions. **Observer:** PST11; **Class:** 7-E, **Teacher:** Duru	**The CD levels and reasons determined by the PST** This task involves the student making operations and modeling in algebraic expressions. It is a PWC task as it requires connecting algebraic expressions with **model representation**.



Task: Add the algebraic expressions given above.

The summary of task implementation

The teacher asked a student to say the algebraic expressions in the first and second models on the smartboard without giving the students any time to explore. The student said the expressions 2x-3 and -x + 5 and the teacher firstly wrote the addition operation (2x-3) + (- x + 5) = x + 2 on the board, then sketched the model for the x + 2 algebraic expression.

Because the teacher first did **routine** algebraic operations without **providing the students enough time to explore** the model, she removed the task from its purpose (**routinized** the task by not utilizing models as a conceptual tool). Consequently, she implemented the task at a PWoC level by declining its cognitive demand.

Researcher's comments

Since the goal of the task is using model representation to make sense of operations in algebraic expressions, it is a PWC task. However, because the teacher didn't provide exploration time, did not use models as a conceptual tool, and aimed to focus on the correct solution using the routine algorithms she taught, it caused a decline in the cognitive demand of the tasks during implementation. The factors affecting cognitive demand, emphasized by the PST, as shown in the bold signs, were determined as **not providing enough time to explore, focusing on the correct answer, and routinizing the task.**

Goal: Finds the desired proper fractional part of a quantity.

Observer: PST8; **Class:** 5-D; **Teacher:** Ali

Task: $\frac{3}{4}$ of the oranges in the basket is 6 kilograms. Since you have eaten 2 kg of oranges, how many kilos are left?

The summary of task implementation

The teacher provided clues that they should go from part to whole. He provided a student some time and directed him to the smartboard to complete the work. The student solved it by first calculating the weight of one piece, which was 2 kg, and then calculating the total weight, which was 4x2 = 8 kg. He then subtracted the eaten portion to get the solution.

The CD levels and reasons determined by the PST

During the lesson, the teacher solved similar problems, provided clues on the students' challenges, and focused on the correct answer rather than the meaning.

Researcher's comments

Because there are no connections to make sense of the part-whole relationship, it is a PWoC level task. The teacher did not give students any time to explore the task throughout the implementation but instead aimed to reinforce a routine procedure without reasoning, therefore it was maintained at the PWoC level. The factors affecting cognitive demand, emphasized by the PST, as shown in the bold signs, were determined as **routinizing, providing clues, focusing on the correct answer, and not making connections.**

Goal: Knows the concepts of variable, constant terms, and coefficients

Observer: PST10; **Class:** 7-E; **Teacher:** Duru

Task: Fill in the blanks in the table.

	Variables	Constant terms	Coefficients
a+3	a	3	
2x+3y			2, 3
5mn			
3x+5y-4	x, y		

The summary of task implementation

The teacher asked about the expressions that should be used to fill in the blanks. Students were having trouble finding variables, so she remarked to them that the unknown is always variable and then the students in one voice stated all expressions.

The CD levels and reasons determined by the PST

Recalling the rules or formulas of variables, constant terms, and coefficients in algebraic expressions is a memorization task that does not involve **any procedure and reasoning.** The teacher's statement that the unknown is a variable led to the misconception that each letter is a variable. During the task's implementation, there was no change in the level of cognitive demand.

Researcher's comments

The task requires students to recall definitions, facts, rules, or formulas in their minds without the need for thinking, reasoning or using any procedure. Therefore, it is a memorization task. The factors affecting cognitive demand, emphasized by the PST, as shown in the bold signs, were determined as **recalling the rules or formulas and not using any procedure or reasoning.**

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Abstract

This study eliminates students' misconceptions about decimal notation with the teaching method implemented according to the 5E model enriched with Digital Concept Cartoons (DCCs). The study was conducted with eight sixth grade students. In this study conducted using the action research method, lesson plans were designed based on the 5E model enriched with DCCs to eliminate misconceptions. The data were collected from Misconception Identification Forms 1 and 2, observation notes, and interviews conducted during the implementation process. Qualitative data analysis techniques were employed to analyze the data. Consequently, it was revealed that most students' misconceptions about decimal notation decreased with the application of the 5E model enriched with DCCs. After the implementation, it was observed that most of the students' misconceptions about sorting, place value, addition–subtraction, marking the numbers on the number line, and rounding in decimal notation were largely eliminated. In contrast, it was observed that students' misconceptions regarding the multiplication/division operations and problems in decimal notation did not decrease.

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Research Article

Can Students' Misconceptions regarding Decimal Notation be Eliminated with the 5E Model Enriched with Digital Concept Cartoons?[*]

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Abstract

This study eliminates students' misconceptions about decimal notation with the teaching method implemented according to the 5E model enriched with Digital Concept Cartoons (DCCs). The study was conducted with eight sixth grade students. In this study conducted using the action research method, lesson plans were designed based on the 5E model enriched with DCCs to eliminate misconceptions. The data were collected from Misconception Identification Forms 1 and 2, observation notes, and interviews conducted during the implementation process. Qualitative data analysis techniques were employed to analyze the data. Consequently, it was revealed that most students' misconceptions about decimal notation decreased with the application of the 5E model enriched with DCCs. After the implementation, it was observed that most of the students' misconceptions about sorting, place value, addition–subtraction, marking the numbers on the number line, and rounding in decimal notation were largely eliminated. In contrast, it was observed that students' misconceptions regarding the multiplication/division operations and problems in decimal notation did not decrease.

Keywords: Decimal notation, digital concept cartoons, mathematics education, misconception, 5e model

1. INTRODUCTION

With the rapid development of science and technology, technological developments have entered the 21st-century educational environment, and the use of technology in teaching has become a pedagogical tool (Naidoo, 2014). The need for people who can generate information and use it functionally in life, think critically, solve issues, and contribute to society and community has increased with the evolving needs of individuals and society (Ministry of National Education [MoNE], 2018). In this process, skills such as reasoning, critical thinking, creativity, and problem-solving are of great importance. Mathematics plays an important role in acquiring these skills (National Council of Teachers of Mathematics [NCTM], 1989). In recent years, the use of technology has increased rapidly in learning environments (Shallcross & Harrison, 2007), and the use of technology-based materials as a pedagogical tool has brought positive developments in teaching (Arvanitaki & Zaranis, 2020). However, these pedagogical tools were insufficient in teaching mathematics (Drijvers, Doorman, Boon, Reed, & Gravemeijer, 2010).

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Mathematics is perceived as abstract and difficult by many students (Mohd-Rustam & Azlina, 2016) because it comprises several abstract concepts and spiral structures. Mathematical concepts are essential components of the teaching and learning process (Zaslavsky & Shir, 2005). Therefore, concept teaching has an important role in understanding mathematics (Arnaodin & Mintzes, 1985). To ensure learning, concepts must be fully understood and associated with each other (Baki, 2008). In a math class, it can be difficult to define a concept. To describe a concept, it is sometimes necessary to explain the concepts associated with it. For example, defining a fraction is required to understand the decimal notation. Therefore, in mathematics lessons, students learn new information by building on previous knowledge. Incorrectly learned concepts create problems for students over time and cause misconceptions. The concept of misconception defined differently by many researchers in literature. For example, Hashweh (1988) defined misconception as an immature concept, Elby (2001) explained it as misapplication, Fisher (1983) called it as erroneous ideas, and Smith, Disessa, and Roschelle (1994) defined it as student understanding that systematically produces errors. It is important for teachers to be aware of misconceptions and to eliminate misconceptions that students have. If the teachers know the misconceptions and their reasons, they can prevent students' possible misconceptions (Köken, 2020). Elimination of misconceptions is vital for effective mathematics teaching. Hewson and Hewson (1984) stated that misconceptions negatively affect students' learning. Türkdoğan, Güler, Bülbül, and Danışman (2015) stated that because of the 45 articles that they examined, there were studies generally aimed at determining misconceptions and that there were a limited number of studies on eliminating them. When international literature is examined, it is observed that the studies conducted to detect misconceptions are more than the studies conducted to eliminate them (Ang & Shahrill, 2014).

Moreover, students have misconceptions in several mathematics-related aspects. Adıgüzel, Şimşir, Çubukluöz and Gökkurt-Özdemir (2018) in their study examining 138 theses, revealed that students at the secondary school level have misconceptions about each learning field (Adıgüzel et al., 2018). It is possible to come across studies in which teachers and teacher candidates have misconceptions as well as students (Bursalı & Gökkurt-Özdemir, 2019). One of the topics that students have misconceive options about is decimal notation. Some studies (Yılmaz, 2007) have revealed that the decimal notation issue is the most difficult and complex topic at the secondary school level, and students have misconceptions about it. Decimal notation features less in (MoNE, 2018) compared to other subjects, but it is important for percentages, length measurements, currencies, and other similar subjects. Russell (1945) emphasis on the use of decimal notation in many professions supports this explanation. For this reason, it is thought that giving the necessary importance to decimal notation from the initial years of secondary school and learning it in a way that minimizes misconceptions as much as possible will contribute to the learning of the other related topics. In this context, this study focused on eliminating misconceptions about decimal notation, in particular.

1.1. Objectives of the Study

The following is the Research Question (RQ) addressed in this study: Can Grade 6 students' misconceptions about decimal notation be eliminated with the teaching method implemented according to the 5E model enriched with Digital Concept Cartoons (DCCs). In line with this RQ, the misconceptions of the students in decimal notation were determined in Stage I. In Stage II, it was investigated whether these misconceptions were eliminated by the teaching method implemented according to the 5E model enriched with DCCs.

1.2. Theoretical Framework

The literature review for this study has been arranged under the titles "The use of concept cartoons as a pedagogical tool in mathematics classrooms" and "The use of the 5E model in mathematics classrooms.

1.2.1. The use of concept cartoons as a pedagogical tool in mathematics classrooms

Students who attend mathematics classes face many misconceptions about various subjects. Some techniques are used to reveal those misconceptions. While questionnaires and interviews are used mostly by researchers, teachers generally use practical methods such as written documents by students, their drawings, and discussions (Chin & Teou, 2009). One of the alternative techniques used by teachers is concept cartoons (Naylor & Keogh, 2000). Concept cartoons are the materials that consist of dialogues of cartoons. Only one of the ideas presented in those cartoons is accepted as scientifically right, and all the others represent scientifically wrong ideas (Keogh, Naylor & Wilson, 1998). When the literature is examined, it is possible to come across studies in which concept cartoons are used for different purposes. Among them, there are studies that aim to structure ideas (Keogh & Naylor, 1996), make clear the concepts (Taslidere & Yıldırım, 2023), and remediate the misconceptions (Chin Siong et. al., 2023; Erdoğan & Ozsevgec, 2012; Yong & Lee, 2017) and use them as an assessment tool (Chin & Teou, 2009; Çavaş et. al., 2023; Keogh, Naylor, de Boo & Rosemary, 2002). For example, Yürekli and Gökçek (2019) found that concept cartoons were effective in eliminating Grade 7 students' misconceptions about integers (Yürekli & Gökçek, 2019). Conversely, Genç (2020), as a result of a compilation of studies made with concept cartoons, found that they increase students' interests in the lesson, motivate and encourage them to think, and facilitate permanent learning (Genç, 2020). According to the Önal and Çilingir-Altiner (2022) results a significant difference was determined in terms of the academic achievement in the mathematics course between the experimental group in which concept cartoons were used and the control group in which the classic approach was used. Kaplan, Altaylı, and Öztürk (2014) in their study with grade 8 students, found that students' misconceptions about square-rooted expressions were eliminated with concept cartoons, and they were more effective than traditional teaching methods. Therefore, in this study, concept cartoons were used to overcome misconceptions about decimal notation. Concept cartoons have gained more popularity, and parallel to this, they have been transferred to the digital environment as a result of advancing technology. The concept cartoons used in this research were designed digitally for reasons such as the remarkable nature of DCCs, easier preparation in terms of visualization, and ease of making changes in the digital environment.

1.2.2. Use of the 5E model in mathematics classrooms

The education system is constantly evolving in developed countries. Because of this aspect, constructivism, which is the information theory, was implemented in Turkey in 2005 and emerged as a Constructivist Teaching Approach (CTA). At the same time, CTA has not only been a static approach, but many educational models also have been developed based on this approach. One of them is the 5E model. The origins of this model used at secondary education levels since the 1980s are based on the viewpoints of Johann Herbart, John Dewey, and Jean Piaget (Jobrack, 2013). It emerged as a 5E model with the revision of the curriculum and education model developed in the 1980s as a result of the Biological Sciences Curriculum Studies conducted by The American Institute of Biological Sciences (Bybee, 2009). This model includes five stages (Carin, Bass & Contant, 2005; Jobrack, 2013). These are given in Figure 1.

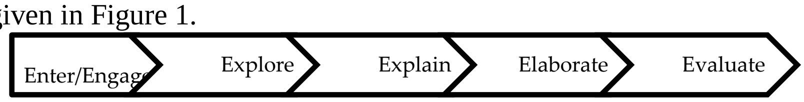

Figure 1. The 5E model

Each phase has specific functions. This model contributes to students learning scientific knowledge in the best way (Bybee, et al., 2006). The 5E model was created based on the conceptual change model and constructivist learning. In this model, it is suggested that the student should integrate a new subject with his previous learning (Tanner, 2010). Previous studies investigated the usability of the 5E model in teaching mathematics and obtaining positive results (Başer, 2008; Ertem-Akbaş & Kılıç, 2023; Tuna, 2011). This model, which is based on CTA, does not only emphasize learning but also highlights the importance of teaching in which information and communication technologies are integrated (Bülbül, 2010). In this study, the 5E model enriched with DCCs was applied to overcome the students' misconceptions. Birisci, Metin, and Karakas (2010) stated that teachers' use of concept cartoons in their lessons supports the constructivist learning approach, which reveals the reason for the integration of the 5E model and concept cartoons in this study (Birisci et al., 2010). Previous studies support the rationale for using this method. Many researchers used the 5E model enriched with DCCs (Şahin, 2018; Yılmaz, 2018) or concept cartoons (Jobrack, 2013; Yürekli & Gökçek, 2019), Previous studies that revealed that it has a positive effect on students' academic achievement, problem-solving skills, or attitudes (Uğurel & Moralı, 2006). Teaching conducted according to the 5E learning model helps increase academic achievement, eliminate misconceptions, and improve positive attitudes (Çepni & Şahin, 2012).

In the literature review, although there are many studies (Guven, Kozcu Cakir, Sulun, Cetin & Guven, 2020) in which science teaching and the 5E model are handled together, there are a limited number of studies using teaching activities based on the 5E model. For example, Teltik-Başer (2008) concluded that students who learn about circles and cylinders with activities in line with the 5E model are more successful than students who study using traditional methods. In this study, Tuna (2011) with Grade 10 students, found that the mathematical thinking and academic achievement post-test scores of the experimental group were significantly higher than the control group (Tuna, 2011). Hiçcan (2008) revealed that teaching based on the 5E model on equations with a first-order unknown has a positive effect on the academic success of Grade 7 students (Hiçcan, 2008). Although there are few implementations in mathematics teaching, it is concluded that this is an effective method when looking at the findings of the study. Therefore, it is thought that this research will fill the gap in this area to some extent. Furthermore, the design of lesson plans following the 5E model enriched with DCCs that can be used by teachers in decimal notation is another matter that reveals the importance of the research.

2. METHOD

2.1. Research Design

In this study based on a qualitative approach, the action research method was implemented. Action research is a method used to eliminate a problem faced by practitioners or improve the current situation (Mills, 2003). First, the researcher observed that the students who took his course during his teaching career often made mistakes in decimal notation. In this context, thinking about an action plan for eliminating students' misconceptions and an answer for the RQ was sought. For this reason, this method was preferred to eliminate the misconceptions of middle school Grade 6 students related to decimal notation with lesson plans designed with DCCs based on the 5E model. In this study, the researcher worked with Grade 6 students who had been taking his classes since Grade 5 and had misconceptions, a determinant deduced as a result of the observation notes. This study was classroom action research, because the researcher focused on the problem he experienced and set a goal for developing his teaching practices. Such action research studies are conducted by teachers to develop their teaching practices in classroom settings (Hendricks, 2009).

2.2. Participants

This study was conducted with eight students (five girls and three boys) studying in Grade 6 of a public secondary school for the 2018–2019 academic year. These students continued their education at a socioeconomically low state high school in the center of a province in the western region of Turkey. An easily accessible sampling method, one of the purposeful sampling methods, was used in the selection of participants. Misconception Identification Form (MIF) 1 and teacher observation notes were considered in the selection of the participants. Two of these students were integration students with mild mental and learning disabilities. The participants' real names were not used, and they were given codes, namely, P1… P8. Additionally, permission was obtained from the students and their parents to participate in the study based on ethical grounds.

2.3. Procedure

In this study, before working with the participants, a pilot study was conducted for the researcher to gain experience and for the validity and reliability of the study. The data collection process in the pilot study was conducted in four stages. In Stage I, a pool of questions was created by the researcher to detect students' misconceptions in decimal notation. In the preparation of the questions, the objectives about decimal notation in the MoNE (2018) and the observation notes about the misconceptions as a result of the researcher's previous experiences were considered. Additionally, in case of the possibility that misconceptions in the literature might exist in the students who participated in this study, the questions about those misconceptions were included in the data collection tool. MIF-1, which consists of 25 questions, was submitted to an academic member and a mathematics teacher, an expert in the field of mathematics education, for content validity. In line with the expert opinions, as the implementation period is limited and the question items were similar, four questions were removed from the abovementioned form, and it was finalized with 21 questions. To examine the explanations of the participants in detail, a directive was added to the end of some question items, such as "Explain why." For the question items, codes such as Q1… Q21 were used. Since there are sub-questions in the question items, these sub-question items are named a1, a2, b1, b2, a,b,c,d etc. In Stage II, MIF-1 was applied. Students were given sufficient time to solve MIF-1. The implementation process took approximately 3 lesson hours (120 minutes). For the MIF-1, semi-structured interviews of 25–35 minutes were conducted with each student in the environment they desired. Because the question set was large, interviews were conducted twice for each student.

2.3.1. Process of creating lesson plans

As a result of the pilot implementation, students' misconceptions were determined, and DCCs were designed with the web tool (https://www.storyboardthat.com/tr). The fact that both the researchers had publications in the field of misconceptions and one of the researchers had taught the course for 1.5 years helped them identify misconceptions. While preparing the lesson plans, DCCs were used at every stage of the 5E model. As for the stages, they were mostly used in the deepening stage to determine whether the students' misconceptions had been eliminated and understand how permanent the learned information was. An example of the lesson plans designed within the scope of this research is given in the appendices section (A1). In Stage III, the prepared lesson plans were applied for five weeks. In Stage IV, MIF-2 (which measures the same misconceptions), which was prepared to be like MIF-1 in Stage I, was used to find out whether the misconceptions had been eliminated. In addition, semi-structured interviews were conducted according to the answers given to these forms. In the pilot study, as a result of the observation that this teaching method was effective in eliminating the misconceptions students had about decimal notation, the researcher decided to use this teaching method for his students who had misconceptions in the actual implementation. Lesson plans designed for the reliability of the study were validated by two experts in the fields of mathematics education and computer technology and informatics. The lesson plans were corrected in line with the opinions of the experts (e.g., the discovery phase was not understandable, some materials were added to the lesson plans, and the cartoons were named). After the pilot study, the main implementation was initiated. The process of the research is included in Figure 2.

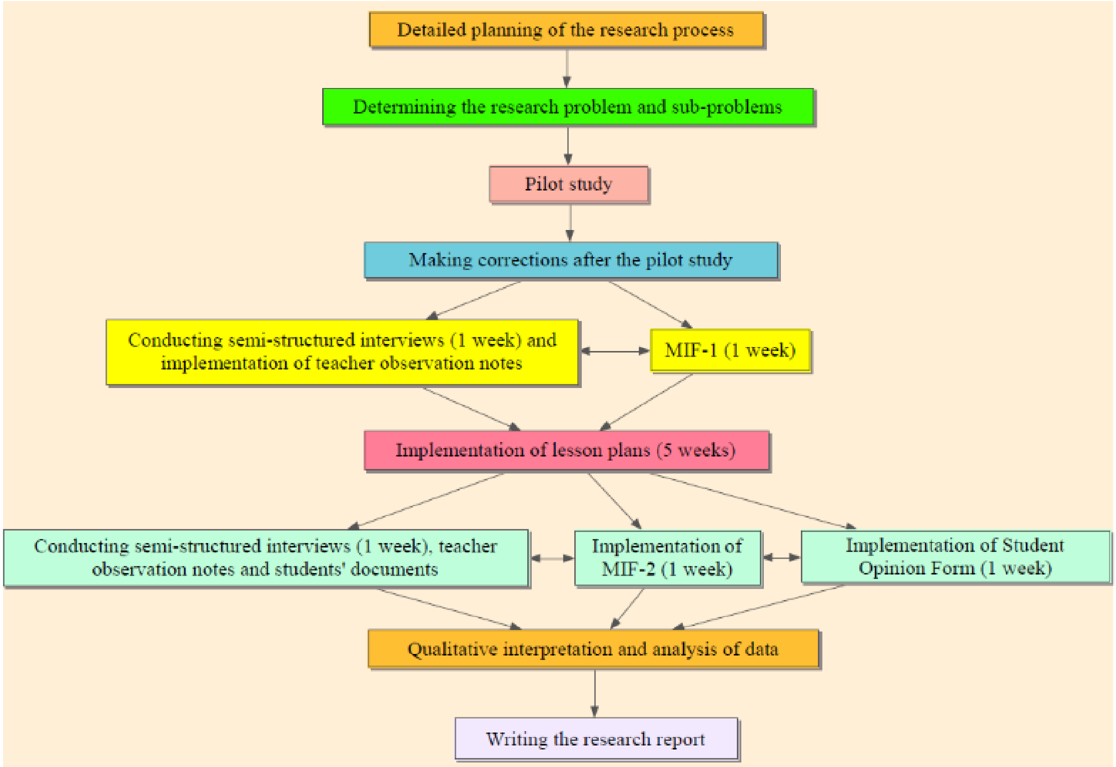

Figure 2. The process of the research

Similarly, steps in the pilot study were followed in the original implementation. The data diversity (triangulation) method was used for the reliability of the study, and interview, observation, and document analysis techniques were also conducted. The data of the interview process are given in Table 1.

Table 1. Interview process

	Interview date		Interview time		Location	
Ps	MIF-1	MIF-2	MIF-1	MIF-2	MIF-1	MIF-2
P1	05.02.2019	19.02.2019	30	35	Teachers' room	Classroom environment
	08.02.2019	21.02.2019	27	32	Teachers' room	Classroom environment
P2	05.02.2019	21.02.2019	29	38	Classroom environment	Classroom environment
	07.02.2019	20.02.2019	30	33	Classroom environment	Classroom environment
P3	06.02.2019	19.02.2019	25	30	Teachers' room	Classroom environment
	07.02.2019	20.02.2019	26	32	Classroom environment	Teachers' room
P4	06.02.2019	20.02.2019	29	35	Classroom environment	Teachers' room
	08.02.2019	22.02.2019	30	33	Classroom environment	Classroom environment
P5	05.02.2019	20.02.2019	35	35	Classroom environment	Teachers' room
	07.02.2019	21.02.2019	30	32	Classroom environment	Teachers' room
P6	06.02.2019	19.02.2019	28	30	Classroom environment	Classroom environment
	08.02.2019	23.02.2019	30	25	Classroom environment	Classroom environment
P7	07.02.2019	21.02.2019	32	35	Teachers' room	Classroom environment
	08.02.2019	24.02.2019	31	34	Teachers' room	Teachers' room
P8	07.02.2019	20.02.2019	25	30	Teachers' room	Classroom environment
	08.02.2019	24.02.2019	27	29	Teachers' room	Classroom environment

*Ps: Participants

In the analysis of the data obtained from MIF-1 and MIF-2, the framework of Karaoglan-Yılmaz et al. (2018) was used, and descriptive analysis was performed. The reason for the use of this framework may be to eliminate concept misconceptions, as in this study, and the emergence of data following the codes given in Table 2.

Table 2. Categories

Answer Categories (AC)	Explanations
Completely correct (Cc)	The question has been answered correctly and the description of the student is correct.
Correct (C)	The question has been answered correctly, but the student's description is superficial or there are minor deficiencies in the description.
Somewhat correct (Sc)	The question is answered close to the true answer, but there are false statements in the student's description.
Somewhat incorrect (Si)	The question has been answered close to be false, but there are also correct statements in the description of the student.
Incorrect (I)	The question is answered incorrectly, the student's description has irrelevant statements that are not related to the question, or the student has misconceptions.
Blank (B)	The question has been left blank.

After the coding process was completed by the researcher, the data were re-encoded by another researcher, and the percentage of agreement of Miles and Huberman (1994) was calculated. The consistency between coders was calculated as 0.95 at the end of the ×100 process. In all, 95% consistency of codes was obtained from the study, a discussion environment was established with an expert in 5% different coding, and a common decision was reached.

3. FINDINGS

The distribution of the findings regarding the answers given by the participants in the MIFs for the questions related to associating the concept of division and fraction in decimal notation before and after the implementation is presented in Table 3.

Table 3. Frequency and percentage table of the answers given by the students on associating the concept of division and fraction in decimal notation before and after the implementation

AC	**Pre-implementation**				**Post-implementation**			
	Q1				***Q1***			
	a1	***a2***	***b1***	***b2***	***a1***	***a2***	***b1***	***b2***
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	8(100)	8(100)	3(37.5)	2(25)	8(100)	7(87.5)	7(87.5)	3(37.5)
C	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-
Si	-	-	-	-	-	-	-	-
I	-	-	5(62.5)	6(75)	-	-	1(12.5)	3(37.5)
B	-	-	-	-	-	1(12.5)	-	2(25)
Total	8(100)							

Q1: First Question

By observing Table 3, it was perceived that the students gave the correct answer to the questions, i.e., they had no problem converting the figures they saw into fractions but had trouble associating fractions with the division. After the implementation, it was revealed that the students corrected these misconceptions. The answers of P2, who corrected the misconceptions, are given in Figure 3.

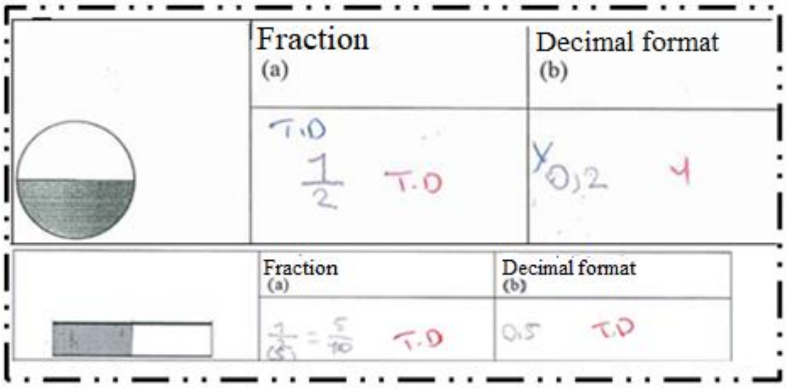

Figure 3. The answers of P2

When the solution of P2 is examined, it is seen that the problem provides the correct solution to Option A; for Option B, it was seen that the student thought of the denominator as the part after the comma and misinterpreted the problem. Interview data with the student also support this. To eliminate this misconception, an activity was conducted with the students in the discovery phase of the lesson plan prepared according to the 5E model. In this activity, a table of 100 was distributed to the students, and they were asked to paint 35 identical squares out of 100. They were asked to write down how many 1/100 pieces they got and were directed to answer the questions. As a result of this activity, it was observed that most of the students associated the concept of the fraction with the division process. To ensure full learning, an activity was conducted about concept cartoons and decimal notations that they may encounter in daily life. In Table 4, the frequency and percentage distribution of the codes for the answers given by the students to the questions about the reading subject in decimal notation before and after the implementation are given.

Table 4. Frequency and percentage table of the answers given by the students on reading decimal representations before and after the implementation

AC	**Pre-implementation**				**Post-implementation**			
		Q2				***Q2***		
	a	***b***	***c***	***d***	***a***	***b***	***c***	***d***
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	7(87.5)	7(87.5)	6(75)	4(50)	7(87.5)	7(87.5)	7(87.5)	7(87.5)
C	-	-	-		-	-	-	-
Sc	-	-	-	-	-	-	-	1(12.5)
Si	-	-	-	-	-	-	1(12.5)	-
I	1(12.5)	1(12.5)	2(25)	3(37.5)	1(12.5)	1(12.5)	-	-
B	-	-	-	1(12.5)	-	-	-	-
Total				8(100)				

Q2: Second Question

When Table 4 is examined, it is seen that almost all of the students read the decimal notation correctly. A small number of students who had misconceptions about this outcome corrected them after the lesson with concept cartoons was taught. It was observed that P2 had the misconception of incorrect cascading and did not know that 7 was the tenths digit. On the contrary, the answers of P2, who gave the correct answer after the implementation, are given in Figure 4.

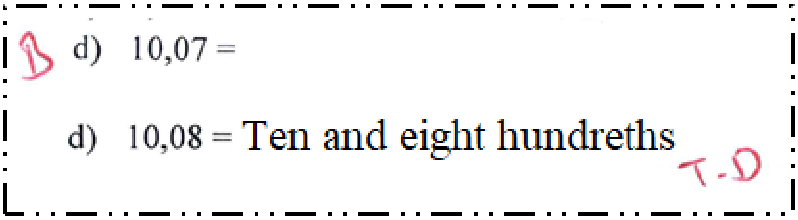

Figure 4. Answer to option d of question 2 before and after the implementation by P2

Figure 4 shows that the student had a lack of knowledge before the implementation, and this deficiency was eliminated as a result of the lessons taught according to the 5E model. When asked why he did not answer this question in MIF-1 during the interview with P2, it was revealed that he left the question blank because he did not want to give an incorrect answer. As a result of the lessons taught with the 5E model, it was observed that the students' misconceptions decreased. The frequency and percentage distribution of the codes related to the writing in decimal notation are given in Table 5.

Table 5. Frequency and percentage table of the answers given by students on writing decimal notations before and after the implementation

AC	**Pre-implementation**				**Post-implementation**			
			Q3				***Q3***	
	a	***b***	***c***	***d***	***a***	***b***	***c***	***d***
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	8(100)	6(75)	6(75)	8(100)	8(100)	7(87.5)	7(87.5)	7(87.5)
C	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	1(12.5)
Si	-	-	-	-	-	1(12.5)	1(12.5)	-
I	-	2 (25)	2 (25)	-	-	-	-	-
Blank	-	-	-	-	-	-	-	-
Total					8(100)			

Q3: Third Question

When Table 5 is examined, it is revealed that students generally do not have trouble writing simple decimal notations (e.g., two seven tenths = 2.7). The frequency and percentage distribution of the codes related to the issue of sorting decimal notations are given in Table 6.

Table 6. Frequency and percentage table of the answers given by the students to the subject of ranking in decimal notation before and after the implementation

AC	**Pre-implementation**					**Post-implementation**				
			Q4		***Q5***			***Q4***		***Q5***
	a	***b***	***c***	***d***		***a***	***b***	***c***	***d***	
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	1(12.5)	1(12.5)	1(12.5)	1(12.5)	-	6(75)	6(75)	7(87.5)	6(62.5)	5(62.5)
C	1(12.5)	1(12.5)	1(12.5)	1(12.5)	1(12.5)	-	-	-	-	-
Sc	-	-	2(25)	1(12.5)	4(50)	1(12.5)	1(12.5)	1(12.5)	-	2(25)
Si	-	1(12.5)	2(25)	1(12.5)	-	-	1(12.5)	-	1(12.5)	1(12.5)
I	4(12.5)	4 (12.5)	1(12.5)	3(37.5)	1(12.5)	1(12.5)	-	-	1(12.5)	-
B	2(25)	1(12.5)	1(12.5)	1(12.5)	2(12.5)	-	-	-	-	-
Total						8 (100)				

Q4: Fourth Question, Q5: Fifth Question

According to Table 6, the misconceptions regarding the issue of ranking in decimal notation were mostly eliminated by DCCs prepared according to the 5E model. Seven students could not give

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the correct answer to Option A of Question 4 before the implementation. After the implementation, two students could not give the correct answer. According to the answers given by the students to this question before the implementation, the misconception of the concept that the long number is greater when sorting came to the forefront. In the introduction of the lesson plan prepared to eliminate this misconception, the teacher enters the classroom with a meter to draw the attention of the students. He asks the students about the usage areas of the meter in daily life and poses a problem to them with the concept cartoon he prepared in a digital environment. The introduction of the course plan prepared according to the 5E model aimed to garner the attention of students with the problem, "Who is taller?" which is quite frequent in daily life (see Figure 5).

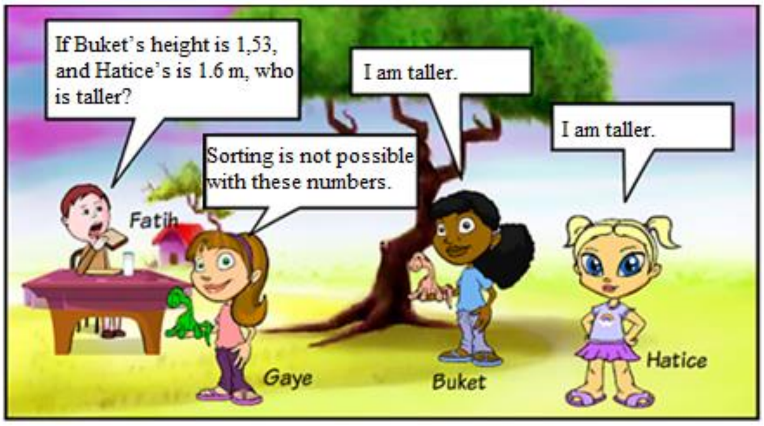


Figure 5. Concept cartoon in the lesson plan

This question is adapted to the concept cartoon and a discussion environment is created with the students. Students' existing misconceptions were revealed with DCCs. Students who chose Buket see the longer decimal notation as larger. During the discussion in the classroom, none of the students chose Gaye, and they were hesitant between Hatice and Buket. In collaboration with their peers, they moved away from comparing the height of Buket and Hatice and started to compare their height. As a result of a friend's height of 1.50 (measurements made in meters), P8 explained the incident in the following way: "If we express your height as 1.5, my height is 1.47, and I am shorter than you. Then, if we say the height of Hatice is 1.60, she is taller." As a result of this explanation, some students' misconceptions were cleared. For the remaining students, an activity was performed under the guidance of the researcher in the discovery part to observe and correct their mistakes themselves. Students understood that 0.6 is greater than 0.53 when modeling the decimal notations 0.6 and 0.53 for decimal and hundred cards. The instructor had the students conduct the activity as a guide in the discovery part. In the deepening part according to the 5E model, the students were guided by teachers, and most of the students eliminated their misconceptions. The answer of P8, who corrected his error, is given in Figure 6.

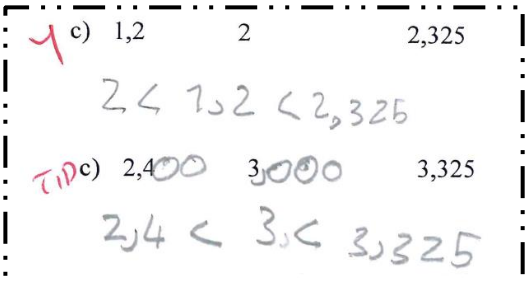


Figure 6. Answer to option c of question 4 before and after the implementation by P8

In Figure 6, it is seen that P8 responds by ignoring the comma in decimal notation and considering the number as an integer. This misconception was eliminated after the implementation, and he replied with the correct code. P8 wrote in his explanation to the question that he ordered the denominators from small to large by equalizing them. During the lesson, P8 solved the question in MIF-1 again. In Figure 7, the observational note showing P8's correction is given.

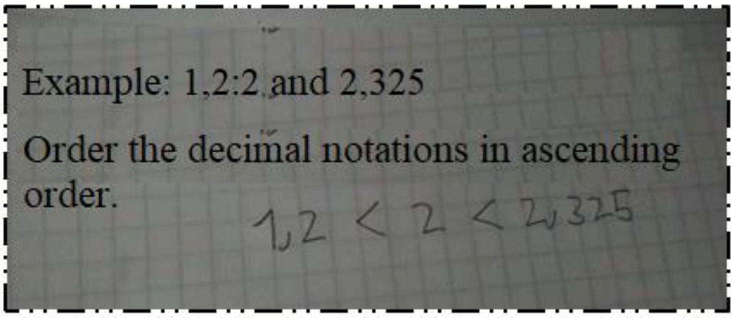


Figure 7. P8's notebook example related to the solution of the problem in MIF-1 during the implementation

While the lesson was being taught, the researcher redirected the question asked in MIF-1 to the class. Although P8 gave an incorrect answer to MIF-1, he resolved the misconception during the implementation. His response to MIF-2 also supports this aspect. In the interview, P8 explained, "When I was sorting in decimal notations, I practically sorted the parts after the comma by enlarging them." According to these findings, it is seen that the students generally understood the subject of ranking. In Table 7, the frequency and percentage distribution of the codes of the answers given by the students to the questions about the place value in decimal notation before and after the implementation are given.

Table 7. Frequency and percentage table of the answers given by the students on place value in decimal notation before and after the implementation

AC	Pre-implementation				Post-implementation			
	Q6	***Q7***		***Q8***	***Q6***	***Q7***		***Q8***
		a	***b***			***a***	***b***	
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	3(37.5)	1(12.5)	2(25)	-	7(87.5)	3(37.5)	3(37.5)	3(37.5)
C	-	-	-	-	-	-	-	-
Sc	-	-	-	2(25)	-	-	-	2(25)
Si	-	1(12.5)	4(50)	1(12.5)	-	-	4 (50)	-
I	4(50)	5(62.5)	1(12.5)	4(50)	1(12.5)	4(50)	-	2(25)
B	1(12.5)	1(12.5)	1(12.5)	1(12.5)	-	1(12.5)	1(12.5)	1(12.5)
Total	8(100)							

Q6: Sixth Question, Q7: Seventh Question, Q7: Eighth Question

When Table 7 is examined, it is seen that students' misconceptions are partially eliminated. Question 7, students were asked to continue the pattern. The answers given by P7 to Option A of Question 7 are given in Figure 8.

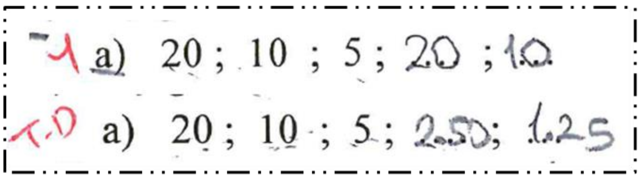


Figure 8. P7's answer to the question 7 before and after the implementation

In all, seven students could not reach the correct answer before the implementation. When the answer of P7 in Figure 8 was examined, the students thought of the numbers as symbols and came to the conclusion by returning to the beginning instead of continuing the current order. It was observed that the student who gave this answer could not think that he could use decimal notation while continuing the order in decimal notations. After the implementation, P7 was asked how he answered the question, and the answer was "I filled in the blanks by dividing the numbers into two...." It is seen that the student here associates the concept of the fraction line with division. The answers of P1, who corrected the error about the place value, are given in Figure 9.

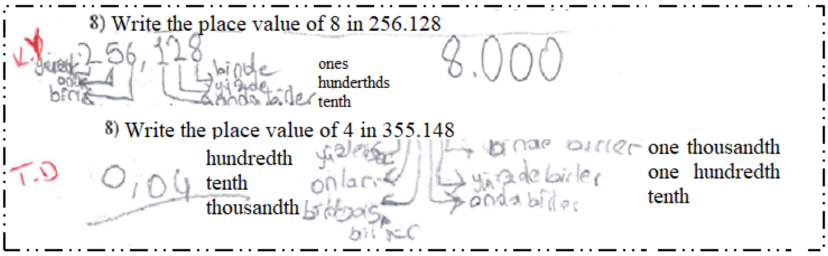


Figure 9. P1's answers to Question 8 before and after the implementation

It is seen that P1 recognized the digit names of natural numbers before the implementation. However, it was observed that the student did not recognize the names of the digits in the decimal notation after the comma. After the implementation, the student grasped the value of the digits after the comma and answered the question correctly. The frequency and percentage distribution of the codes of P1's answers to the questions about the relation of decimal notation with fractions before and after the implementation are given.

Table 8. Frequency and percentage table of the answers given by the students about the relationship between decimal notations and fractions before and after the implementation

AC	Pre-implementation			Post-implementation		
	Q9		***Q10***	***Q9***		***Q10***
	a	***b***		***a***	***b***	
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	7(87.5)	6(75)	4(50)	8(100)	7(87.5)	6(75)
C	-	-	1 (12.5)	-	-	-
Sc	-	-	-	-	-	-
Si	-	1(12.5)	-	-	-	-
I	1(12.5)	1(12.5)	1(12.5)	-	1(12.5)	1(12.5)
B	-	-	2(25)	-	-	1(12.5)
Total			8(100)			

Q9: Ninth Question, Q10: Tenth Question

In Table 8, it is seen that students' misconceptions about associating decimal representations with fractions before the implementation were low. Upon examining the MIF-1, it can be said that the reason students tend to be mistaken about this issue is that they do not conceptually learn the decimal notation, and do not understand the place values of the decimal part after the decimal point. The students who realized that decimal notation is a different representation of fractions resolved their mistakes after the implementation. When the findings of Question 10 are examined, while four students gave incorrect answers before the implementation, the number decreased to two after the implementation. In this regard, P4, who had made an error before the implementation, was able to resolve that error after the implementation. The answers of P4 are in Figure 10.

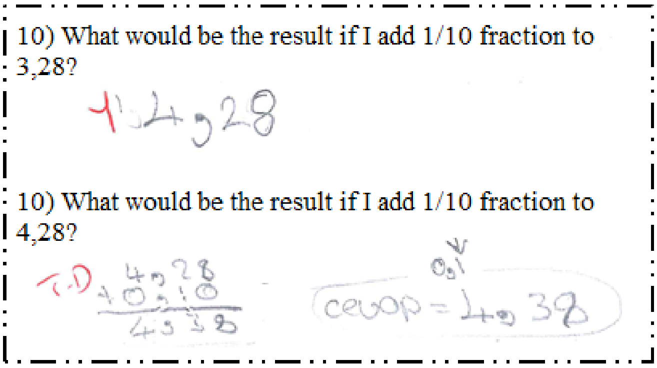


Figure 10. P4's answers to question 10 before and after the implementation

P4 found the result 4.28 by seeing the numerator of the fraction given in the question as a whole part before the implementation, adding 1 to the 3 in the full part of the decimal notation. As a result of the observations made by the researcher during the lesson, the student's repetition of this error in the questions he solved during the lesson shows that the student had a misconception about this outcome. After the implementation, P4 learned to convert fractions to decimal notation and answered Question 10 correctly. In Table 9, the frequency and percentage distribution of the codes of the answers given by the students to the questions about addition and subtraction in decimal notation before and after the implementation are given.

Table 9. Frequency and percentage table of the answers given by the students to addition and subtraction operations before and after the implementation

AC	Pre-implementation						Post-implementation					
	Q11			*Q12*			*Q11*			*Q12*		
	a	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	2(25)	2(25)	1(12.5)	1(12.5)	1(12.5)	1(12.5)	6(75)	7(87.5)	6(75)	5(62.5)	5(62.5)	5(62.5)
C	1(12.5)	-	-	1(12.5)	1(12.5)	2(25)	-	-	-	-	-	-
Sc	1 (12.5)	2 (25)	-	1 (12.5)	-	-	-	-	-	1(12.5)	1(12.5)	1(12.5)
Si	-	-	1(12.5)	-	-	-	-	-	-	1 (12.5)	1 (12.5)	-
I	4(50)	4(50)	6(75)	4(50)	6(75)	4(50)	2(25)	-	1(12.5)	-	1(12.5)	1(12.5)
B	-	-	-	1(12.5)	-	1(12.5)	-	1(12.5)	1(12.5)	1(12.5)	-	1(12.5)
Total	8(100)											

Q11: Eleventh Question, Q12: Twelfth Question

Upon examining Table 9, it is seen that the number of students who answered with the correct code before the implementation was low. It is noteworthy that there is an increase in the number of students who answered with the correct code after the implementation. The answers of P7 regarding this are given in Figure 11.

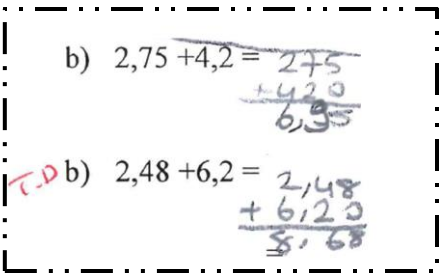


Figure 11. P7's answers to option b of question 7 before and after the implementation

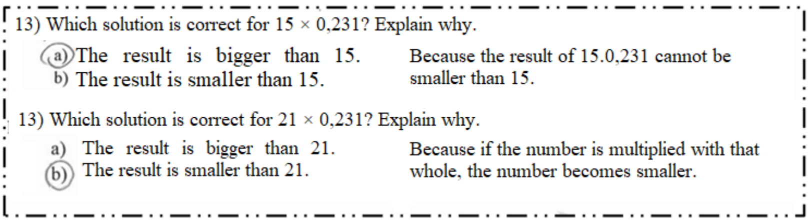
Before the implementation, P7 had partially achieved the correct response. Ignoring the comma and processing them as natural numbers, he added commas in the conclusion. In his explanation, he wrote, “I did normal addition and converted them into decimals.” In the interview, the student could not explain why he put a comma after 6 at the end of the procedure before the implementation and made a superficial, memorization-based explanation such as “We do it this way, I know that...” Therefore, his answer is evaluated as partially correct. After the implementation, although the student did not write in detail, he wrote, “I filled the blanks with 0 and performed the operation.” He explained how he performed the addition in decimal notation. When the student wrote the given decimal notation as a fraction, he stated that the denominators were not equal, and hence, he equalized the denominator to sum up 6.2 to 2.48 decimal notations, added 0 to 6.20, and made the denominator 100. Therefore, his answer is included among the correct ones. During the interview process, it was observed that some students did not have any misconceptions but gave wrong answers due to errors in operation. In Table 10, the frequency and percentage distribution of the codes of the students’ answers regarding the effect of multiplication and division on the size of decimal notation are given.

Table 10. Frequency and percentage table of the answers given by the students to the questions regarding the effects of decimal representations on multiplication and division on the size before and after the implementation

AC	Pre-implementation		Post-implementation	
	Q13	***Q14***	***Q13***	***Q14***
	f (%)	f (%)	f (%)	f (%)
Cc	-	-	2(25)	2(25)
C	-	-	-	-
Sc	1(12.5)	2(25)	-	-
Si	-	-	-	-
I	4(50)	3(37.5)	3(37.5)	1(12.5)
B	3(37.5)	3(37.5)	3(37.5)	5(62.5)
Total	8(100)			

Q13: Thirteenth Question, Q14: Fourteenth Question

Before implementation, students were found to have the misconception that multiplication always makes numbers bigger, and division always makes numbers smaller. As seen in Table 10, all of the students did not think that multiplication could make numbers smaller, and division could make numbers larger before the implementation. During the implementation, the students were taught one of the methods of multiplication and division in decimal notation: “We can write the number given as a decimal notation as a fraction and multiply or divide it.” In addition, multiplication and division were done in the classroom environment, and the students were asked to discover them. However, when the answers after the implementation were examined, it was seen that only two students’ misconceptions were eliminated. Related to this, the answers of P5 are given in Figure 12.


13) Which solution is correct for 15 × 0,231? Explain why.

a) The result is bigger than 15. Because the result of 15.0,231 cannot be smaller than 15.

b) The result is smaller than 15.

13) Which solution is correct for 21 × 0,231? Explain why.

a) The result is bigger than 21. Because if the number is multiplied with that whole, the number becomes smaller.

b) The result is smaller than 21.

Figure 12. P5’s answers to question 13 before and after the implementation

When Figure 12 is examined, it is seen from the statement of P5 that the student thinks the result cannot be small because it is multiplied. It is seen that the student always falls into the misconception that multiplication always results in something larger. After the implementation, the student realized that the decimal notation subject can shrink a whole by dividing it into equal parts. When asked why he gave this answer in the interview, P5 said, “I multiplied by 0, so I have to divide 21 into 1000 equal parts and write 231 as an answer. For this reason, I thought the number would be small if 0 is multiplied by a full…” In Table 11, the frequency and percentage distribution of the codes of the answers given by the students to the multiplication and division operations on decimal notation are given.

Table 11. Frequency and percentage table of the answers given by the students to multiplication and division in decimal notation before and after the implementation

AC	Pre-implementation						ʼPost-implementation					
	Q15			*Q16*			*Q15*			*Q16*		
	a	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***
	f (%)	f (%)	f (%)	f(%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
CC	-	3(37.5)	-	2(25)	1(12.5)	1(12.5)	4(50)	1(12.5)	2(25)	4(50)	2(25)	2(25)
C	1(12.5)	-	-	-	-	-	-	-	-	-	-	-
SC	1(12.5)	-	2(25)	-	-	-	-	1 (12.5)	-	-	-	-
Si	1(12.5)	-	1(12.5)	-	-	1(12.5)	2(25)	1(12.5)	3(37.5)	2(25)	3(37.5)	3(37.5)
I	4 (50)	3(37.5)	2 (25)	2(25)	2 (25)	1(12.5)	-	3(37.5)	1(12.5)	-	1(12.5)	-
B	1(12.5)	2(25)	3(37.5)	4(50)	5(62.5)	5(62.5)	2(25)	2(25)	2(25)	2(25)	2 (25)	3(37.5)
Total							8(100)					

Q15: Fifteenth Question, Q16: Sixteenth Question

When Table 11 is examined, it is seen that students had misconceptions in multiplication and division operations before the implementation. During the implementation, activities were performed to eliminate the misconceptions of the students in the multiplication process. In the lesson plan prepared according to the 5E model, the teacher asked the students who came to the classroom with an apple, banana, and orange in their hands whether there was someone in their families who goes to the grocery store. He posed a problem to them at the beginning. In the exploration section, the activity was started under the guidance of the teacher, and this problem was asked to be solved by the students. To understand whether the students’ misconceptions were eliminated, another problem was posed by the teacher in the deepening part with concept cartoons. Incorrect answers in concept cartoons enabled the researcher to identify students who had misconceptions. DCCs, a part of the deepening phase of the lesson plan prepared according to the 5E model, provided opportunities for students to correct their mistakes. As in the multiplication process, it is seen that the concept of misconceptions cannot be eliminated in the division process by the students. In Table 12, the frequency and percentage distribution of the codes of the answers given by the students to the questions about showing the decimal notation on the number line before and after the implementation are given.

Table 12. Frequency and percentage table of the answers given by the students regarding the display of decimal notations before and after the implementation on the number line

AC	Pre-implementation						Post-implementation					
	Q17			*Q18*			*Q17*			*Q18*		
	a	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
CC	2(25)	3(37.5)	2(25)	3(37.5)	-	-	5(62.5)	5(62.5)	5(62.5)	6(75)	2(25)	4(50)
C	-	-	-	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	1(12.5)	1(12.5)	1(12.5)	1(12.5)	2(25)	2(25)
Si	1(12.5)	2(25)	1(12.5)	-	2(25)	2(25)	-	1 (12.5)	1 (12.5)	1 (12.5)	2 (25)	1 (12.5)
I	5(62.5)	3(37.5)	5(62.5)	5(62.5)	6(75)	6(75)	2(25)	1(12.5)	1(12.5)	-	2(25)	1(12.5)
B	-	-	-	-	-	-	-	-	-	-	-	-
Total	8(100)											

Q17: Seventeenth Question, Q18: Eighteenth Question

When Table 12 is examined, it is seen that the number of students who gave the correct answer before the implementation is small. After the implementation, the number of students who gave the correct answer increased. During the discovery phase of the lesson plan, two students were asked to show the distance they traveled on the number line. The observation note about the activity is given in Figure 13.

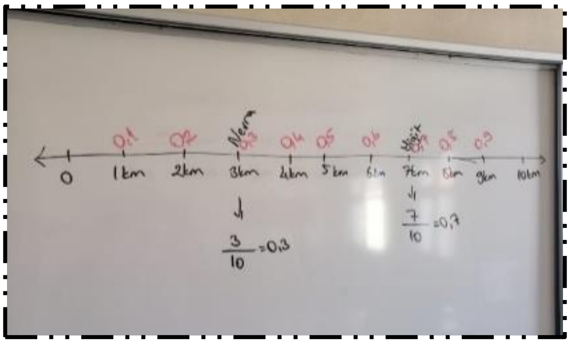


Figure 13. Observation notes for the activity in lesson plan 3

When the answers given by the students after the implementation were examined, it was revealed that most of the students' misconceptions were eliminated. The answers of P2, who corrected the error after the implementation, are given in Figure 14.

Figure 14. P2's answer to option b of question 17 before and after the implementation

As seen in Figure 14, the student had the misconception of dividing the 0.7 decimal notation into 11 equal parts between 0 and 1. Instead of separating 0 to 1 into 10 matching parts, the student focused on the number of lines and drew 10 lines between 0 and 1. During the interview process, the student emphasized that he had to draw 10 lines because the denominator was 10. The student realized that he should correct this mistake after the implementation and focus on the number of identical parts and not the number of lines. When evaluated in general, it is seen that the misconceptions about showing decimal notations on the number line have been largely eliminated. Based on the statements

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made by some students during the interviews, it was found that the errors they made in showing the number line were due to carelessness. In Table 13, the frequency and percentage distribution of the codes for the answers given by the students to the problems in decimal notation are given.

Table 13. Frequency and percentage table of the answers given to the questions related to the problem subject in decimal notations before and after the implementation

AC	Pre-implementation		Post-implementation	
	Q19	***Q20***	***Q19***	***Q20***
	f (%)	f (%)	f (%)	f (%)
Cc	-	1(12.5)	-	2(25)
C	-	-	-	-
Sc	-	-	-	-
Si	-	2(25)	1(12.5)	2(25)
I	6(75)	3(37.5)	2 (25)	4(50)
B	2(25)	2(25)	5(62.5)	-
Total		8(100)		

Q19: Nineteenth Question, Q20: Twentieth Question

In Table 13, it was seen that almost all of the students' misconceptions and mistakes could not be eliminated compared to other subjects. During the lectures, the researcher noticed that the students had difficulty understanding what they read in line with the observation notes. Some expressions of students, such as "I could not fully understand the problem" and "I could not understand what you mean," supported this explanation. It was also observed that some students left the questions blank. Although some students could not correct their mistakes after the implementation, it was determined that they understood the problem and correctly determined the procedures to be conducted to solve the problem. In Table 14, the frequency and percentage distribution of the codes of the answers given by the students to the questions about rounding in decimal notation before and after the implementation are given.

Table 14. Frequency and percentage table of the answers given by the students to the questions related to rounding in decimal notations before and after the implementation

AC	Pre-implementation					Post-implementation				
			Q21					***Q21***		
	a	b	c	d	***e***	***a***	***b***	***c***	***d***	***e***
	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
Cc	2(25)	1(12.5)	1(12.5)	2(25)	1(12.5)	7(87.5)	3(37.5)	3(37.5)	4(50)	5(67.5)
C	-	-	-	-	-	-	-	-	-	-
Sc	1 (12.5)	-	-	-	-	-	-	-	-	-
Si	-	1 (12.5)	1(12.5)	-	1(12.5)	-	2(25)	1(12.5)	-	1(12.5)
I	3(37.5)	3 (37.5)	4(50)	4(50)	3(37.5)	1(12.5)	3(37.5)	4(50)	4(50)	2(25)
B	2(25)	3 (37.5)	2(25)	2(25)	3(37.5)	-	-	-	-	-
Total						8(100)				

Q21: Twenty-First Question

Upon examining Table 14, most of the students had reached the correct answer post the implementation. The answers of P8, who gave the correct answer after the implementation, are given in Figure 15.

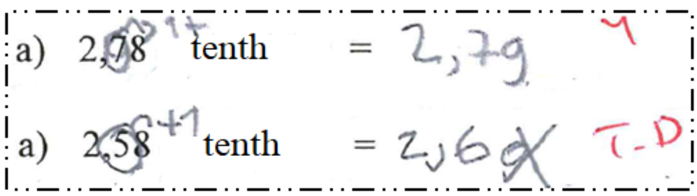

Figure 15. P8's answers to option a of question 21 before and after the implementation

As seen in Figure 15, before the implementation, the student knew the tenth digit to be rounded. However, the student reached the wrong answer by adding 1 to 8 in one digit. After the implementation, he reached the right answer.

In summary, when the results are evaluated, it is seen that the misconceptions were largely eliminated after the teaching based on concept cartoons based on the 5E model.

4. DISCUSSION and CONCLUSION

In this study, it was observed that with the 5E learning model enriched with DCCs, students' misconceptions regarding decimal notation, especially ranking, place value, addition–subtraction operation, marking numbers on the number line, and rounding on the number line, were largely eliminated. In this study, most of the students made mistakes or had misconceptions, especially in ordering. When the literature was examined, it was found that many researchers had found similar results. That is, they stated that students had errors or misconceptions in decimal notation (Kaya, 2015; Yılmaz, 2007). The most obvious misconception detected among the students is the misconception of "assuming that the longer number is bigger." After the implementation, most students were able to identify their mistakes. The following is the reason the teaching method using the 5E model is effective: While the use of concept cartoons helps identify students who have misconceptions, the 5E learning model enables them to realize their misconceptions based on their own experiences. Gökkurt-Özdemir (2019) stated that by using concept cartoons, teachers will not only get feedback about students' thoughts but also reveal any misunderstandings that they have (Gökkurt-Özdemir, 2019). They argued that students participated more actively in the lesson because the discussions created by concept cartoons provided an environment for students to express themselves. In addition, the 5E learning model has been effective in eliminating errors related to decimal notation, because in the 5E learning model, the learning individual compares the information received with their previous learning and examines and interprets the same to develop their own knowledge and information (Hanley, 1994). Considering the developmental characteristics of young children, it can be said that the 5E learning model enriched with concept cartoons is effective in teaching decimal notation, which is an abstract and difficult topic for students. The fact that Grade 6 students are in a transition period, i.e., from the concrete to abstract, two students are inclusive and the low socioeconomic level of the school where the students were studying reveals the importance of the selection of appropriate teaching methods for teaching mathematics. Considering some difficulties in the acquisition of mathematical concepts, it is an issue that should be emphasized in lesson plans suitable for inclusive students or students with low mathematics achievements. Understanding the importance of gaining mathematical knowledge and skills for daily life, mathematics teaching should be organized according to these students and presented in accordance with their requirements. The DCCs used in this study contained visual elements and were remarkable, and the 5E learning model gave students effective participation and problem-solving opportunities, thus helping in eliminating students' misconceptions. The 5E learning model entails remarkable activities and enables students to develop and learn concepts easily through implementations. Therefore, the fact that there are activities in addition to DCCs in the lesson plans prepared with the 5E learning model and the enrichment of these activities with materials has positively affected the learning of the students. Many researchers in the literature using the 5E model enriched with DCCs (Şahin, 2018; Yılmaz, 2018) or concept cartoons (Kaplan et al., 2014; Yürekli & Gökçek, 2019), Balım et al. (2008) and Korucu (2009) revealed that it has a positive effect on students' academic achievement, problem-solving skills, or attitudes.

One of the topics where misconceptions were eliminated was the addition–subtraction operations in decimal notation. The most common mistake committed by students is "putting the comma in the wrong place." This mistake has been largely corrected. While performing the addition–

subtraction operations, it was observed that some students reached the wrong results due to the operation error. Yorulmaz (2018) highlighted that students often make a mistake in subtraction (Yorulmaz, 2018). When the results regarding the multiplication–division operations were examined, it was found that compared to other topics, the 5E learning model is not effective in eliminating misconceptions on the abovementioned topic. In this study, it was found that students experienced more difficulties performing the multiplication process compared to the addition and subtraction process. The fact that the students expressed their negative attitudes or difficulties in the interviews supports this explanation. Because of the difficulties that students faced with multiplication (Üçüncü, 2010), course plans prepared to address their misconceptions in the multiplication process are not considered effective. Similarly, the complex nature of the division process did not allow misconceptions to be eliminated. Usta's (2018) statement that students who cannot multiply also have difficulty in division supports this result. Hence, the multiplication operation is a prerequisite for the division operation. The misconception evident in the multiplication–division process is the error that "multiplication always increases the result; division always makes it smaller." Yavuz-Mumcu (2015) found that students make the same mistake. After the implementation, very few students realized this error. Another result of the study is that students have misconceptions before the implementation while showing the decimal notations on the number line. In the beginning, it was observed that the students had problems in converting decimals to fractions and could not establish a relationship between the numerator and denominator. After the implementation, it was noticed that while students showed the fraction on the number line, they drew a line between 0 and 1 as much as the denominator in the given fraction. It is possible to find studies that report the same mistake in the literature (Karaoglan-Yılmaz, Gökkurt-Özdemir, & Yasar, 2018). It was observed that the 5E learning model was effective in eliminating this error after the implementation. Another consequence of the study is that in decimal notation, students struggle to solve problems. The reason for their failure was revealed through interviews with students. Most students stated that they did not try to solve the problems asked for in the interviews as they did not understand them. It was understood that students who solved the problem incorrectly did not understand the question and therefore did so incorrectly. Upon examining the literature, many studies revealed that students have difficulty in understanding the content of mathematical problems (Gökkurt, Örnek, Hayat & Soylu, 2015; Sezgin-Memnun, 2015). The reason the 5E learning model is not effective in this regard, at the expected level, could be insufficient activities focusing on problem-solving steps in lesson plans. In this study, with the 5E learning model enriched with DCCs, students' misconceptions about most issues related to decimal notation were eliminated. Researchers are recommended to use this model in eliminating students' misconceptions in other mathematics-related topics. This study is action research, and it is limited to eight students. Thus, it is recommended that future studies examine the effect of this method on student achievement using quantitative methods on larger samples.

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Ethics Committee Decision

This research was carried out with the permission of Bartın University Publication Ethics Board with the decision numbered 2019/013 dated 28.01.2019.

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APPENDIX

A1. *Lesson plan example*

Subject: Math
Class: Grade 6
Learning area: Numbers and Operations
Time: 2 lesson hours
Achievements regarding the misconceptions that students have about decimal notation
M.5.1.5.3. Understands the relationship between the whole part and the value of the decimal place in decimal notation.
M.5.1.5.4. Writes and reads the decimal notation of fractions that can be expanded or simplified to a denominator of 10, 100, or 1000.
M.6.1.6.2. Decimal notation decodes the given numbers.
Examples of the misconception's students have
Thinking of the part after the comma as an integer, wrong cascading, consider the decimal part as a numerator, the full part as a denominator, ignoring the zero after the comma, incorrect cascading after the comma, incorrect naming the decimal notation, thinking the comma as a separator, thinking the part after the comma as a whole number, incorrect naming, inability to name the digits in the decimal notation part correctly, and using the concept of digits instead of the concept of place value.
Enter
First, students are asked who has the task of going from home to the grocery store. A scenario is presented to one of the students who have undertaken this task: They are asked if they go to the market and buy chocolate for 1.5 TL, how many 25 kurus they should give. When this student answers, their friends are also asked to calculate, and the results are compared. When comparing these results, attention is drawn to how many 25 kurus they used to get 1 TL.
Exploration
Students generally ignore zero after the comma. Students are presented with an activity to explore the values of the digits after the comma. Students are expected to create their information by giving two different decimal notations like each other at the same time.

Activity
Let's analyze the decimal notation 0.50 with events.
a) Students are asked to convert the given decimal notation to a fraction.
$0.50 = \frac{50}{100}$
A table of 100 and a table of 1000 are distributed to students who have converted both. They are asked to paint both fractions.
The students who finish the painting are asked the difference between these two cards and whether they are equal.
Students are expected to discover that two fraction numbers are different from each other. Students are asked to simplify these two fractions so that they can be written with a different decimal notation.
b) $\frac{50}{100}$ simplifying the fraction number.
$\frac{50:10}{100:10} = \frac{5}{10}$
You are asked how many unit fractions this simplified fraction number is equal to.
c) writing $\frac{5}{10}$ fraction as $\frac{1}{10}$ or 0.1
written as $\frac{5}{10}$ = 5 units $\frac{1}{10}$ or 0.1
From here;
As a result of simplification;
$\frac{5}{10}$ = 0.5 = 5 deciles are obtained.
The students are asked whether 5 deciles are equal to the initial decimal notation. At this stage, students are expected to realize that the value of the fraction does not change as a result of simplification and that the decimal notation given at the beginning is equal to 5 deciles.
e) They are asked to write how the fraction is read in the last state.
$\frac{5}{10}$ = five-tenths or five divided by ten
f) They are asked to write the reading of the decimal notation in the last state.
0.5 = zero whole five-tenths

Let's analyze the decimal notation 0.050 with events.
a) Students are asked to convert the given decimal notation to a fraction.
$0.050 = \frac{50}{1000}$
A table of 100 and a table of 1000 are distributed to students who have converted both. They are asked to paint both fractions.
The students who finish the painting are asked the difference between these two cards and whether they are equal.
Students are expected to discover that two fraction numbers are different from each other. Students are asked to simplify these two fractions so that they can be written with a different decimal notation.
b) $\frac{50}{1000}$ simplifying the fraction number.
$\frac{50:10}{1000:10} = \frac{5}{100}$
You are asked how many unit fractions this simplified fraction number is equal to.
c) writing $\frac{5}{10}$ fraction as $\frac{1}{10}$ or 0.1
written as $\frac{5}{100}$ = 5 units $\frac{1}{100}$ or 0.01
From here;
As a result of simplification;
$\frac{5}{100}$ = 0.05 = 5 centesimals are obtained.
The students are asked whether 5 centesimal are equal to the initial decimal notation. At this stage, students are expected to realize that the value of the fraction does not change as a result of simplification and that the decimal notation given at the beginning is equal to 5 centesimal.
e) They are asked to write how the fraction is read in the last state.
$\frac{5}{100}$ = five percent or five divided by one hundred
f) They are asked to write the reading of the decimal notation in the last state.
0.05 = zero whole five percent

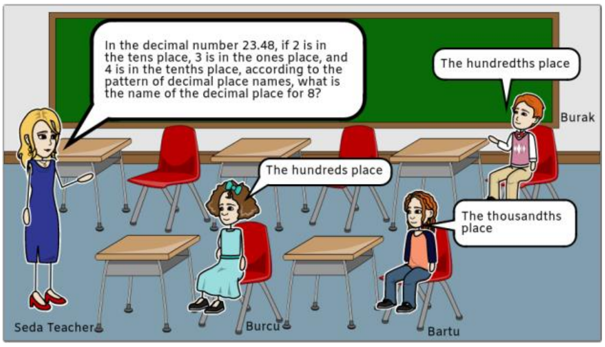
With this activity, students discovered the value of zero after the comma. At the same time, they are expected to consolidate the information they already know (when the fraction number is simplified and expanded, its value does not change). The reading of decimal notation is discovered with students who know how to read the fraction number.

Explanation
The teacher asks the students to express the information they have learned as a result of the activity in one sentence. The teacher expresses the information in a scientific language.

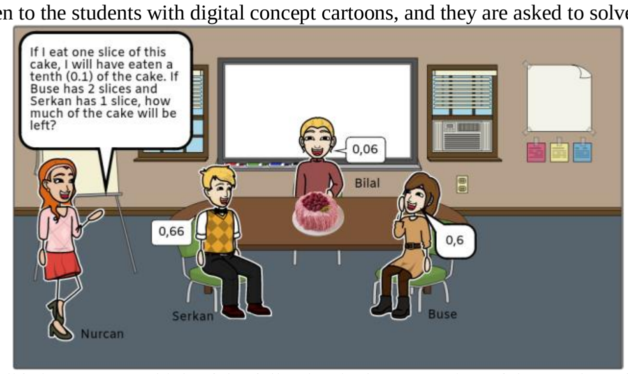
Information box
Decimal notations are a different notation where fractions are expressed using commas.
Fractions with denominators 10, 100, 1000 can be expressed as decimal notation.
The comma separates the decimal notation from the whole and into smaller parts (the decimal).
Sample:
While a fraction is written as decimal notation, if the denominator of the fraction is 10, the decimal part is one digit, if 100, the decimal part is two digits, and if the decimal part is 1000, the decimal part is written with three digits.
While reading decimal notation
First, the number in the whole part is read, and then the "full" expression is used. The number in the fraction is read after using the expression "tenths" if the decimal part is one digit, "percent" if it has two digits, and "per thousand" if it has three digits.

87,236					
Full part			**Decimal Part/Fraction Part**		
Number value	8	7	2nd	3	6
Place value	80	7	0.2	0.03	0.006
Digit names	Ten's digit	One's digit	Tenths digit	One-hundredths digit	The ones in a thousand digit

Considering this information, the decimal representation of 87,236 is analyzed with students.
Decimal Notation Analysis
Eloboration
The teacher asks a question prepared with a digital concept cartoon to the students to use the solutions they have discovered and learned in different problem situations.



Students are given time to solve the question individually. The students are asked who gave the correct answer. They are expected to reach the correct result by creating a discussion environment in the classroom.
Evaluation
At this stage, a problem is given to the students with digital concept cartoons, and they are asked to solve the questions.



1) Let's expand it and simplify it to make the denominator 10, 100, or 1000 into decimal notation.

a) $\frac{3}{5}$

b) $\frac{7}{20}$

c) $\frac{48}{100}$

d) $1\frac{113}{250}$

e) $5\frac{135}{500}$

2) Which of the following is the expression of the number "five hundred thousand 32 whole one percent" in numbers?
a) 532,01
b) 50032,01
c) 500032,01
d) 5000032,01

3) In decimal notation 36,145 what digit is the number 4?
a) In the hundreds
b) In tenths digit
c) In hundredths
d) thousandths digit

4) Which of the following analyzes is correct?
a) $0{,}205 = \frac{2}{10} + \frac{5}{100}$
b) $5.14 = (5 \text{ x } 1) + (4 \text{ x } 0.1) + (1 \text{ x } 0.001)$
c) $20.67 = (2 \text{ x } 10) + (6 \text{ x} \frac{1}{10}) + (7 \text{ x} \frac{1}{100})$
d) $3{,}089 = (3 \text{ x } 1) + (8 \text{ x} \frac{1}{10}) + (9 \text{ x} \frac{1}{100})$

883

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Conceptualization, literature review, methodology, implementation, data analysis, translation, and writing.

Abstract

Changes in the world climate and population growth have brought along many problems. It is expected that resources such as water and energy will be used consciously, and individuals will be conscious about this issue. In this respect, the concept of sustainability, which means the careful use of existing resources and the protection of resources for the future, comes to the fore. Sustainability and sustainable development, while meeting the needs of today, necessitate taking into account the living conditions and environmental values of future generations, and creating healthy living environments for people in the environment-economy-technology relationship to be established to ensure this. Sustainability is one of the main policy issues at both national and international level today. Many international organizations invite states to take responsibility and cooperate for the development of sustainable development. Within the framework of these developments, the development of the way of thinking and behavior related to sustainable life in students has become one of the current aims of education. Taking these into consideration, this section provides information on both sustainability and sustainable education and practices.

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Review Article

Sustainability and its Reflection on Education [*]

Gamze YAYLA ESKİCİ [1]

Abstract

Changes in the world climate and population growth have brought along many problems. It is expected that resources such as water and energy will be used consciously, and individuals will be conscious about this issue. In this respect, the concept of sustainability, which means the careful use of existing resources and the protection of resources for the future, comes to the fore. Sustainability and sustainable development, while meeting the needs of today, necessitate taking into account the living conditions and environmental values of future generations, and creating healthy living environments for people in the environment-economy-technology relationship to be established to ensure this. Sustainability is one of the main policy issues at both national and international level today. Many international organizations invite states to take responsibility and cooperate for the development of sustainable development. Within the framework of these developments, the development of the way of thinking and behavior related to sustainable life in students has become one of the current aims of education. Taking these into consideration, this section provides information on both sustainability and sustainable education and practices.

Keywords: Sustainability, education, sustain in curriculum

1. INTRODUCTION

"…. From time to time, the darkness of a strange disaster surrounds the region and everything starts to change. An ominous spell descends upon society. Mysterious diseases ravage chicken flocks, cattle and sheep get sick and die. There is the shadow of death everywhere... Where might the birds have gone, for example? The bird feeders in the garden have been abandoned. This is a quiet spring (1962, Rachel Carson, Silent Spring)"

The fact that the world's resources are finite requires the conscious use of resources (Özerdinç, Kızılay & Hamalosmanoğlu, 2022). The food shortage, which increased with the rapid increase in the population in the 1940s, was the beginning of the path to the emergence of the concept of sustainable development (Yalçın, 2022; Yazıcı-Demir & Hayta, 2023). The "Green Revolution", which is seen as an important invention to meet the food shortage, has been one of the reasons why human beings encounter environmental problems. When the evaluations about the book "Silent Spring" written by Carson in 1962 are examined, the view that it was the most effective publication in the beginning of the environmental movement still maintains its validity (Teksöz, 2014). Combining his deep knowledge of biology, field experience and his ability to tell with his observations, Carson has succeeded in bringing events to the attention of people in a very effective way.

Sustainability comes from the Latin word "sustinere" and means to keep in balance (Palmer, et. al., 2004). Sustainability: It is the protection of the resources necessary for the future while meeting the needs necessary for the present (Somuncu, 2018). Development is defined as "growth in an economy that leads to transformation in the social and institutional structure, including changes in

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people's value judgments, worldview, consumption and behavior patterns" (Kılıç, 2012). Sustainable development is "meeting the needs of the present without compromising the ability of future generations to meet their needs" (Karahan-Aydın, 2019). According to the Environmental Law, sustainable development refers to "development based on the principle of establishing a balance between environmental, economic and social objectives that ensure that present and future generations live in a healthy environment" (Karahan-Aydın, 2019).

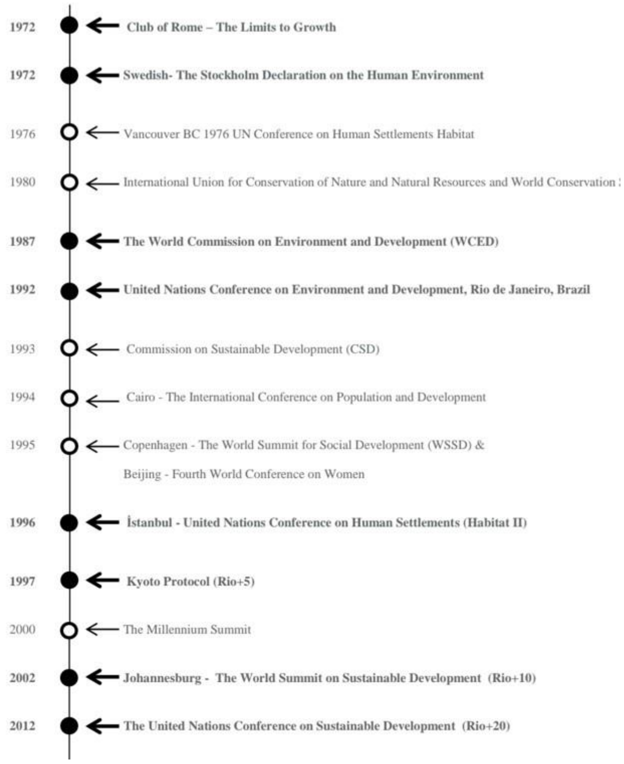

Figure 1. Sustainable development historical development (Golemen, 2014)

Sustainability and sustainable development, while meeting the needs of today, necessitate taking into account the living conditions and environmental values of future generations, and creating healthy living environments for people in the environment-economy-technology relationship to be established to ensure this (McDonough, 1992). UNDP (United Nations Development Programme), the leading development agency of the United Nations, is working in more than 170 countries and regions to ensure that the goals targeted in line with the Sustainable Development Goals are achieved by 2030 (Özerdinç et. al., 2022). The Sustainable Development Goals, which entered into force in January 2016, consist of 17 interrelated main objectives (Figure 2):

Figure 2. Sustainable development goals (United Nations, 2016)

Sustainable development is addressed in three pillars. These are economic, social and environmental dimensions. In order for sustainable development to be effective, these three dimensions must be taken into account in the process (Ergün & Çobanoğlu, 2012).

Environmental Dimension: It means that the environmentally harmful activities are taken under control and natural resources are not consumed in a way that cannot meet the future needs (Engin, 2010). Controlling resource consumption is an indispensable condition, and the environmental dimension includes the protection of the cultural environment as well as atmospheric balance, biodiversity and other ecosystem elements (Ergün & Çobanoğlu, 2012).

Economic Dimension: In the understanding of sustainable development, the first economically expected need is to meet individual and social needs effectively. Economic conditions should be determined in a way that takes into account the benefit of present and future generations (Ergün & Çobanoğlu, 2012).

Social Dimension: The social dimension in the understanding of sustainable development: providing social services such as education and health equally and adequately to everyone and ensuring gender equality with political responsibility and participation (Engin, 2010)

When these three basic elements are considered independently from each other in the development process, environmental problems are experienced and continue to increase, especially since the environment is ignored (Yıldız, 2011).

1.1. Sustainability and Education

"If you think education is expensive, consider the price of ignorance (Socrates)."

Sustainable development was first defined in the report of the World Commission on Environment and Development in 1987, as people being intertwined with nature but not consuming the natural resources necessary for future generations before their time (Kaypak, 2011). For the solution of global environmental problems that concern the world, the successful search for a solution by all circles depends on educated individuals. In other words, education for today's children and future adults is an investment in the future (Atasoy & Ertürk, 2008).

The UN emphasized that the concept of sustainable development should be taught together with education and determined the period between 2005 and 2014 as the "Decade of Education for Sustainable Development" so that the vision of "Education for Sustainable Development (ESD)" should be included in all education programs (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2005). The contribution of the education system, which enables the individual to take responsibility for his/her environment and is the process of realizing behavioral change, is great in understanding the sustainable development goals fully and accurately (Özerdinç et. al., 2022).

Sustainability is one of the main policy issues at both national and international level today. Many international organizations invite states to take responsibility and cooperate for the development of sustainable development. Within the framework of these developments, the development of the way of thinking and behavior related to sustainable life in students has become one of the current aims of education.

Sustainability is not just about conserving physical resources of water and nutrients (Yalçın, 2022). At the same time, the technology of the future aims to find a way to meet these needs and to ensure that future generations have the necessary knowledge base to solve the problems we cannot predict, that is, to educate them (Çayak, 2021). Sustainable education, "What kind of education?" Instead of defining it superficially like the answer to the question; We need to focus on education itself, its aims, educational practices, education models, principles, and the level of competence for the time we live in, and to focus on the actual questions needed in accordance with the needs of the current century (Marim, 2021).

Considering the importance of sustainable development, educators should make more efforts to create sustainable development awareness in individuals (Erdoğan & Tuncer, 2009). It is possible to raise generations with high environmental awareness and sustainable consumption behaviors through teachers (Arslan & Yağmur, 2022). As in every field, the subject knowledge of teachers who will guide students in this process is important. However, many teacher education programs still do not address ESD education (Karrow & DiGiuseppe, 2019). The point that needs to be considered in education is only "What kind of education?" It is not only the answer to the question but also the necessity of following a program and method that will allow this awareness to be formed in new generations (Yazıcı-Demir & Hayta, 2023). In this sense, sustainable education; It refers to the guiding paradigms that enable understanding the existing order of the world in its various dimensions such as social, economic and ecological, and in acquiring the equipment that will help transfer all these aspects to life (Belen, 2020).

1.2. Sustainable Environmental Education

Sustainable development education has a very broad meaning in which environmental education is at its center (Kaya & Tomal, 2011). In the related literature (Davis, 1998) stated that one of the most important duties of societies for a sustainable life is to equip children with knowledge, skills, attitudes and values related to environmental protection. Sustainable development is to improve the quality of life in such a way that it remains within the carrying capacity of the natural systems that support life in the environment. Sustainability of the environment means that natural resources should not be consumed faster than their capacity to renew themselves and that activities harmful to the environment should be controlled (Engin, 2010). Environmental education aims to raise sensitive people who are interested in people's natural problems, offer alternatives to solve these problems, and do their best to solve them (Akçay, 2006). The understanding of environmental education, which primarily focuses on the solution of environmental problems, has over time transformed into the concept of "Education for Sustainable Development" (ESD) with the idea of sustainable development (Arslan & Yağmur, 2022).

According to Demirkaya (2006), three approaches to environmental education are mentioned. These;

1. Education for environmental management and control: In this approach, environmental education promotes the understanding and learning of physical and human systems and their interactions.

2. Environmental awareness and interpretation education: In this approach, environmental education enables students to acquire various skills and supports interests and pursuits that consider education as a resource for learning through field trips.

3. Education for sustainability: According to this approach, environmental education builds on two other approaches that include an environmental ethic that encourages students to take responsibility for their own behavior, and knowledge-based issues that foster courage. The main factor that distinguishes this approach from others is the adoption of sustainable development by the new generation (Özdemir, 2007).

One of the most important responsibilities of societies for sustainability is to provide children with attitudes, values, knowledge and necessary skills for the protection of their environment (Güler, 2009). In the Gothenburg report prepared by the Council of Europe, the environmental factor was added as a third dimension to the Lisbon process, which considers sustainable development as social and economic development (Somuncu-Demir, 2012). Climate change, public health, sustainable transportation and natural resources management are the four key priorities in this report. The common point in both the UNESCO program and the Gothenburg report is that sustainable development can be achieved with a sustainable environment. According to the Sustainable Development Goals, cheaper, affordable and clean energy is needed (Zakari, Khan, Tan, Alvarado & Dagar, 2022). In other words, ensuring energy efficiency and reducing carbon dioxide emissions will become mandatory by 2030 (Haroszowski, 2015).

The aim of environmental education is to raise students who question, research, transfer what they have learned to daily life and look at events from a different perspective. In this way, students will be individuals who can discuss, think, and actively participate in the learning environment, and who can learn meaningfully and permanently. It is not to memorize scientific findings, but to raise people with attitudes and skills who can question environmental problems (Çakıcı, 2010). There is no special course on environmental education and sustainable education in our country. Environmental issues are included in different units in the compulsory Life Science, Social Studies and Science and Technology courses (Tanrıverdi, 2009). Sustainable environmental education has taken its place in the programs of the Ministry of National Education, including primary and secondary school programs. The main purpose is to give individuals the necessary value to themselves and the environment they live in, to use the natural resources in the world correctly and equally and to know how to protect these resources. Sustainable environmental education has an important place for the protection and continuation of the world we live in.

Developing science and technology in our country has affected the education system as well as the living conditions of people. The education system has been re-adapted to reflect contemporary learning approaches to all education levels by the Ministry of National Education. In this context, it is seen that many curricula that were last renewed in 2017, especially science education curriculum, take the concept of sustainable environment into their goals (Tanrıverdi, 2009; MoNE, 2018).

1.3. What is Sustainable Education?

Maintaining a healthy environmental climate is very important for the future of humanity. Tomorrow's leaders will be tasked with tackling social, economic and environmental sustainability in creative ways. Science, technology, engineering, and mathematics (STEM) education is key to making today's students the solution-focused workforce of tomorrow (Southern Oregon University, 2023). The number of "green" jobs or jobs in sustainability-oriented sectors is expected to increase significantly in the coming years. In this regard, STEM education (K-16) will play a vital role in developing this growing workforce.

"Sustainability Education" or education for sustainable development is an exciting new field that blends a range of pedagogical techniques to promote understanding of the links between the environment, economy and society. Still an emerging field, the primary goal of sustainability education is to harness the power of education to develop environmental literacy and civic engagement that prepares students for jobs that contribute to a more equitable and sustainable future.

According to the U.S. Education Partnership for Sustainable Development, education for sustainability is defined as "a combination of content, learning methods, and outcomes that assist students as well as help students develop a knowledge base about the environment, economy, and society." They learn the skills, perspectives and values that guide and motivate them to seek sustainable livelihoods, participate in a democratic society, and live sustainably." The report summarizes three key standards that shape sustainability education:

1. Students understand and can apply the key concepts and principles of sustainability (ie: meeting current needs without compromising the ability of future generations to meet their needs). For sustainability education to be effective, educators must provide students with a basic understanding of

sustainability. In 1998, the Brundtland Commission published the World Commission on Environment and Development Report, which defines sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Although environmental science has evolved greatly since 1998, this definition is still used by national and international commissions to understand the driving idea behind sustainability. Humanity needs clean air, clean water, efficient farming systems and other life-sustaining resources to survive, but humans must ensure that the same resources are available to future generations. Sustainability education aims to help students understand the importance and ultimate purpose of sustainability.

2. Students recognize the concept of sustainability as a dynamic situation characterized by the interdependence between ecological, economic, and social systems and how these interconnected systems affect individual and societal well-being. They develop an understanding of human connection and interdependence with the natural world. Students must understand the relationship between economic, environmental, and social factors in order to be able to make informed decisions later in life. Multidisciplinary STEM education is uniquely positioned to support these relationships and improve student engagement and understanding. Educators can use STEM education techniques to help students understand systems interconnectedness. Students can discuss energy conservation and the science behind it while learning how light bulbs work in the classroom. Outside of the classroom, students discuss the importance of plants to humans and animals while simultaneously learning about how plants grow. Or students can learn through digital spaces such as naturalist, which encourages students to become “citizen scientists” by documenting their experiences with wildlife, learning about these species, and connecting with other “citizen scientists”.

3. Students develop a multidisciplinary approach to learning the knowledge, skills and attitudes necessary to continually improve the health and well-being of present and future generations through both personal and collective decisions and actions. To achieve this, they can envision a sustainable world with primary changes that need to be made by individuals, local communities, and countries. Education for Sustainability or Sustainability Education is an emerging field. Education for Sustainability is the combination that helps students learn skills, perspectives, as well as develop a knowledge base about the environment, economy, and society, enabling them to seek sustainable livelihoods and participate in a democratic society (McMillan & Higgs, 2003). Sustainable education refers to a paradigm that provides an understanding of the social, economic, and ecological system of the world order and reveals behaviors that will help transfer these systems to life (Köybaşı-Şemin, 2022). In the book “Education for Sustainable Development” prepared by UNESCO (2012) for teachers, it is stated that “Sustainability can be handled by every discipline and can be positioned in education as interdisciplinary”.

In order to integrate the concept of sustainability into preschool, primary and secondary education, some themes have been determined based on the USP (U.S. Partnership for Education for Sustainable Development) standards. The USP consists of individuals, organizations, and institutions dedicated to education for sustainable development in the USA. The U.S. Education Partnership for Sustainable Development [USPESD] designed an “Open Space” meeting in Washington, DC, in November 2003, attended by nearly 100 participants from a variety of industries, including K-12 and higher education, science, and research organizations. In this regard, the USP act as a regulator, catalyst and communicator working in all sectors of society (USPESD, 2009).

Education for Sustainability is interdisciplinary in nature and therefore can be easily integrated into core content teaching and learning. Education for Sustainability uses a variety of pedagogical techniques that promote participatory learning and higher-order thinking skills. Sustainability education focuses not only on imparting knowledge, but also on empowering students to become real-world problem solvers. Fortunately, educators can use a variety of STEM (Science, Technology, Engineering and Mathematics) techniques to connect sustainability knowledge to inquiry and action.

For example, project-based education encourages students to participate in long-term, real-life projects that challenge complex questions using knowledge from a variety of disciplines. Place-based learning is another promising example of an educational technique that can help students develop knowledge, attitudes and skills to address sustainability issues. Place-based learning leverages local assets such as parks, public spaces, museums and businesses to immerse students in the world and understand how places shape environmental, social and economic systems (and vice versa).

1.4. Themes and Contents for Sustainable Education

In connection with the above-mentioned three basic standards for sustainable education, basic concepts for sustainable education have been determined. An evaluation has also been made on what the concepts can be at which teaching level. Related to this, summary tables were created at primary, secondary and high school levels. Thanks to Figure 3, an idea can be obtained about the themes that should be given for a sustainable education in international standards.

Component	K-4	5-8 (Building on topics and areas of study in K-4)	9-12 (Building on topics and areas of study in 5-8)
1.1 Intergenerational Responsibility	• Family • Generations (grandparents, parents, children)	• Responsibility to Future Generations	• Intergenerational Equity
2.1 Interconnectedness	• Relationships • Historical Connections • Sense of Place	• Systems • Interdependency	• Systems Thinking • Cradle-to-Cradle Design
2.2 Ecological Systems	• Connection to Nature • Plants, Animals, Habitats	• Natural Resources (renewable & non-renewable) • Biodiversity • Ecosystems • Ecological Footprint (including Carbon Footprint) • Carrying Capacity • Environmental Stewardship • Nature as Model and Teacher	• Respect for Limits • Respect for Nature • Tragedy of the Commons • Environmental Justice • Biomimicry • Urban Design/Land Management • Natural Capital
2.3 Economic Systems	• Human Needs and Wants (food, water, energy, shelter)	• Equity • Resource Scarcity • Energy Economics • Ecological Economics • Food Systems	• Poverty • Ecosystem Services • Alternative Indicators and Indexes of Progress • Globalization • True (or Full) Cost Accounting • Triple Bottom Line • Micro Credit
2.4 Social and Cultural Systems	• Family and Friends • Personal Identity • Happiness • Fairness • Collaborative Learning	• Cultural Diversity • Multiple Perspectives • Citizenship • Resource Distribution • Population Growth • Quality of Life Indicators • Education	• Human Rights • Social Justice • Peace and Conflict • Multilateral Organizations • International Summits, Conferences, Conventions, and Treaties • Global Health • Appropriate Technology • Governance
3.1 Personal Action	• Setting Goals • Communicating Ideas • Making a Difference	• Personal Responsibility • Personal Footprint Calculation • Critical Thinking • Problem Solving • Project Planning and Action	• Accountability • Lifelong Learning and Action • Personal Change Skills and Strategies
3.2 Collective Action	• Setting Goals • Working Together	• Designing a Sustainable System • Structural vs. Personal Solutions • Democracy • Societal Footprint Calculation • Local, State, and National Sustainability Plans	• Local to Global Responsibility • Community-Based and Societal Level Decision-Making • Public Discourse and Policy • Organizational and Societal Change Skills and Strategies

Figure 3. Expression of concepts in sustainable education according to teaching levels (USPESD, 2009)

Sustainability concepts determined according to each education level in Figure 2 are primary school 1-4. Grade, middle school 5-8. Grade and Secondary Education 9-12. It is summarized as a class. It is seen that the concepts in the summary are also grouped depending on the 3 basic standards of sustainability. For example, “Students develop a multidisciplinary approach to learning the knowledge, skills and attitudes necessary to continually improve the health and well-being of present and future generations through both personal and collective decisions and actions.” Themes in the form of personal action and collective action were created for the third standard. Under each theme, concepts were created according to grade levels. As the grade level increases, there are differences according to the themes in the increase in the number of concepts.

The contents of the concepts in Figure 3 and the information they cover are also a matter of curiosity in this respect. In this regard, the "USPESD National Sustainability Education Standards" determined the contents of the concepts. While determining these contents, content limitations were made according to grade levels. The contents of the concepts according to grade levels are defined below (USPESD, 2009).

1.5. Primary School 1-4 Grade Sustainability Concepts and Contents

1.5.1. Intergenerational responsibility

Family - Students analyze their roles and responsibilities in their family.

Generations (grandparents, parents, and children) - Students draw and label their family tree indentifying different generations. Students understand how their actions today may affect other generations; they take action to minimize negative impacts on future generations (service-learning projects)

*1.5.2. Interconnected*ness

Relationships - Students interact respectfully with others, including those with whom they have differences.

Historical Connections - Students demonstrate understanding of the concepts of “past”, “present”, and “future.”

Sense of Place – Students demonstrate an understanding of place – the natural systems and cycles, the human/cultural context, and the connections between both. At this grade level they focus on developing their sense of place in their immediate community. Example: Students create a story or drawing that demonstrates their understanding and connection to a special place of significant meaning to themselves, their family, and their community.

1.5.3. Ecological systems

Connection to Nature – Students, in both urban/sub-urban and rural environments spend time outdoors experiencing and interacting with nature by walking, observing, gardening, etc. They feel comfortable being in the outdoors (e.g.: getting dirty, seeing insects and animals), they see the patterns and connections in nature, and they begin to develop a naturalist intelligence.

Plants, Animals, Habitats - Students can distinguish between plants and animals and can explain how living organisms interact with the environment in which they live. Students identify food /energy, water, shelter as basic needs of animals and plants. Examples: Students sort local common organisms into animal and plant groups. They design and build a schoolyard habitat for native species, taking into consideration the basic needs of the plants or animals.

1.5.4. Economic systems

Human Needs and Wants (food, water, energy, shelter) - Students distinguish between personal wants and needs and identify how culture, marketing, and advertising inform their consumption patterns. Students identify food, water, energy and shelter as basic human needs.

1.5.5. Social and cultural systems

Family and Friends - Students define and develop productive and satisfying relationships with others. They value and know how to help create an atmosphere of mutual respect and kindness.

Personal Identity - Students develop a sense of unique worth and personal competence.

Happiness - Students have a sense of well-being and understand which factors contribute to their own and other’s happiness.

Fairness – Students treat others fairly. They develop an understanding that resources need to be shared to meet the needs of living things – across places and generations.

Collaborative Learning - Students perform effectively on teams that set and achieve goals, conduct investigations, solve problems, and create solutions (e.g., by using consensus-building and cooperation to work toward group decisions).

1.5.6. Personal action

Setting Goals - Students assess their own learning by developing criteria for themselves, and use these to set goals and produce high-quality work.

Communicating Ideas - Students use different media to share ideas with diverse audiences.

Making a Difference - Students take an active role in their community and feel a locus of control or self-efficacy. Students understand that everyone has the ability to affect change or impact a system, community, and self

1.5.7. Collective action

Setting Goals - Students work cooperatively and respectfully with people of various groups to set community goals and solve common problems.

Working Together - Students perform effectively on teams that set and achieve goals, conduct investigations, solve problems, and create solutions (e.g., by using consensus-building, conflict resolution, and cooperation to work toward group decisions). Students use systematic and collaborative problem-solving processes, including mediation, to negotiate and resolve conflicts. Students respect and value human diversity as part of a multi-cultural society and world.

2. IMPLICATIONS

Sustainable education contents explained above and presented as examples for primary school level are also defined separately for secondary and secondary education levels. As in every field, it is essential to receive education on this subject from childhood in order to achieve sustainable development goals in terms of raising awareness of individuals. There are many application examples in the relevant literature for this situation, which is reflected in both scientific course contents and environmental education courses. In addition, applications for sustainable education can be designed by accessing other parts of the US Partnership for Education for Sustainable Development USPESD K-12 Standards content.

According to the U.S. Education Partnership for Sustainable Development, educating for sustainability is defined as "a combination of content, learning methods, and outcomes that help students develop a knowledge base about the environment, economy, and society." The three basic standards that shape sustainability education are briefly as follows:

1- Students understand and can apply the basic concepts and principles of sustainability (i.e.: meeting current needs without compromising the ability of future generations to meet their needs).

2- Students recognize the concept of sustainability as a dynamic state characterized by the interdependence between ecological, economic and social systems and how these interconnected systems affect individual and societal well-being. They develop an understanding of human connection and interdependence with the natural world.

3- Students develop a multidisciplinary approach to learning the knowledge, skills and attitudes necessary to continually improve the health and well-being of current and future generations through both personal and collective decisions and actions. They can envision a sustainable world with fundamental changes that need to be made by individuals, local communities and countries to achieve this.

Sustainability Education is interdisciplinary in nature and therefore core content can be easily integrated into teaching and learning (Sandri, 2022). Educators can use a variety of STEM (Science, Technology, Engineering, and Mathematics) techniques to connect sustainability knowledge to inquiry and action. As in the study of Sousa, Maroco, Gonçalves and Machado (2022), determining factors can be taken into account by considering it from a digital learning perspective. According to the results of the relevant study, if we want a digital sustainability education, the following are important: 1- Characteristics of online classes 2- Support from the School and Professors factor 3- Online classes vs. face-to-face classes and gender.

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