OSMANGAZİ JOURNAL OF EDUCATIONAL RESEARCH

OJER

OJER: http://ojer.ogu.edu.tr

Osmangazi Journal of Educational Research is published by Institute of Education in Eskisehir Osmangazi University, Türkiye

OSMANGAZİ JOURNAL OF EDUCATIONAL RESEARCH

(OJER)

Volume 10, Number 1, Spring 2023

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Osmangazi Journal of Educational Research (OJER) is published by the Institute of Education of Eskisehir Osmangazi University, Türkiye.

OJER is an online, open-access, international, scholarly, peer-reviewed journal offering scholarly research articles on various topics in all areas of educational sciences.

All submitted manuscripts must be original, previously unpublished and not under consideration for publication in any type of publication outlet.

OJER is being published twice a year.

"It is best learned from people who are themselves in the learning process."

(Jackson Brown)

Dear Readers,

The Great Leader Mustafa Kemal Atatürk said, "It is our motto to act with reason, logic and intelligence. The cases that fill our entire lives are the proofs of this truth." With this aphorism, he draws attention to the importance of reason, logic and intelligence and reveals the importance of science as guide. R. Descartes states that it is not enough to have a good mind, the important thing is to use the mind well. If the mind is a tree, it is depicted as the fruit of honesty, and as a matter of fact, reason and conscience are two concepts that are mentioned together. Useful discoveries and scientific researches, in which reason and conscience are put to work together, have an important effect on the development of humanity.

Problems and solutions change in society and in the world, and development is thus possible. The change of individuals, who are the building blocks of society, is possible with planned or unplanned education and training for all ages and levels. Educational researches are carried out with various scientific methods in many areas such as increasing the knowledge and experience of individuals, ensuring that they reach the right information in an appropriate way, improving education and solving problems related to theory and practice. A. S. Györgyi describes the researcher as someone who sees what everyone has seen before, but finds meanings that no one else has thought of. Research is an action that requires curiosity, interest, attention and patience; and although it is tiring, it gives pleasure and excitement when the research goal is achieved. In a scientific process, as if supporting the maxim that individuals who set out without knowing what to research, they will only travel, the researcher should well define the problematic of the research, the problem situation, and be aware of its purpose. A research is the output of a science-to-science process that is built on a conceptual or theoretical framework with its assumptions and limitations. In the process of producing knowledge from knowledge, the relevant literature is an important guide in determining the problematic and original value of the research. If a scientific study, from the planning till the reporting, it is based on reason, ethical rules and conscience. A new research finding, which is added to the national and international researches on the subject, is the spark of knowledge that contributes to the knowledge ball.

With this motivation, **OJER (Osmangazi Journal of Educational Research)** is published twice a year in English by Eskişehir Osmangazi University Institute of Educational Sciences. It is an online, open accessed, international, peer-reviewed journal that offers scientific research articles in all fields of educational sciences. Qualitative and quantitative mixed method researches and compilation studies in many fields whose subject is education and training; research results from theory to practice are included. Our goal is to promote researches that are original, creative, enlightened and that shape the future with ethical values.

In this issue of **OJER**, there are important studies that will contribute to the field. We would like to express our gratitude to the researchers, the reviewer referees, the editorial board, the journal secretariat and our readers who examined our journal and reached us via e-mail. In this issue of **OJER** of Spring 2023, 7 studies are presented, as introduced below:

The 1st article of this issue is entitled "The Impact of Augmented Reality Applications on the Primary School 2nd Grade Students' Idioms Learning Levels" written by Seda ŞAHİN, and Ali ERSOY. The participants of the study were 29 students in the experimental and control groups attending the 2nd grade of a primary school in Eskişehir province. In the experimental group, the idioms were taught with augmented reality applications which lasted for two weeks, and ten idioms were examined respectively. Static group pre-test-post-test design was employed in the study. Data were collected with the forms developed by the researchers. As a result, it was found that there was a statistically significant difference of learning success between the groups in favor of the experimental group. Based on the findings, it is concluded that augmented reality applications are effective in improving the idioms learning levels of primary school 2nd grade students.

The 2nd article of this issue is entitled "Investigation of Life Studies and Social Studies Curriculum in the Context of Sustainable Development Goals" written by Derya BEKiROĞLU, and Nur ÜTKÜR-GÜLLÜHAN. In this qualitative research, life studies and social studies course curricula were analyzed according to the sustainability goals of the United Nations Development Program (2016). The research group is the 2018 life studies curriculum and primary school social studies curriculum. The data were accessed using the "document review" technique. According to the findings, it is the principle of "gapped health and well-being, responsible production and consumption" of the sustainability goals

that the outcomes of the life studies and social studies course curriculum are the most included. It was determined that the number of outcomes related to goals such as "quality education, gender inequality" in both curriculums is low. In this context, the results of the research showed that both courses were partially compatible and indirectly related to the UNSO (2016) objectives.

The 3rd article of this issue is entitled “Predictors of Smartphone Addiction in Teacher Candidates: Self-Control and Communication Skills” written by Mehmet Enes SAĞAR, and Süleyman SAĞAR. In this research which was conducted based on the relational survey model, the predictive role of self-control and communication skills on smartphone addiction levels of teacher candidates was examined. The research group consisted of 378 teacher candidates, 181 males and 197 females. “Smartphone Addiction Scale-Short Version”, “Brief Self-Control Scale”, “Communication Skills Scale” and “Personal Information Form” were data collection tools. As a result, it was determined that the variables of self-control and communication skills significantly predicted smartphone addiction.

The 4th article of this issue is entitled “Examination of Eighth Grade Students’ Statistical Reasoning Skills Regarding Pie Chart” written by Leyla ÖZTÜRK ZORA, and Pınar ANAPA SABAN. The aim of this qualitative, case study design research is to examine in depth the eighth-grade students’ levels of statistical reasoning by pie chart by using “The Middle School Student Statistical Thinking Model”. The study group consists of three eight-grade students attending a public school in İstanbul, Turkey. The activities developed by the researchers, the clinical interviews based on activities and the researcher notes were used as the data collection tools. The results indicated that in the process of describing data, the students' statistical reasoning levels decrease from high academic achievement to low academic achievement. In addition, the sub-process with the lowest reasoning levels of the students is to determine the effectiveness of data display types that representing data. It was determined that the most significant differentiation between the reasoning levels of the students is in the process of analyzing and interpreting data. Students mostly had difficulties in the sub-process of making inferences about a data display.

The 5th article of this issue is entitled "Investigation of Secondary School Students' Processes of Constructing Area and Volume Relations of Rectangular Prisms" written by Kürşat YENİLMEZ, and İlhan OKUYUCU. The purpose of this qualitative, case study design research is to examine the knowledge construction processes of 5th grade students, who do not have any knowledge about the surface area and volume of the rectangular prism, within the framework of the observable epistemic actions of the RBC (Recognizing, Building-with, and Constructing) abstraction model. Three homogeneous groups were formed and semi-structured interviews were conducted with six students. An activity paper consisting of eight problems was used to obtain data. As a result, only a student with a low level of mathematics achievement couldn't construct knowledge of the surface area of the prism. It was seen that recognition and building-with actions are easier to perform than construction action. As the level of mathematics achievement decreased, the speed and success of abstraction decreased.

The 6th article of this issue is entitled "Ethnomathematics Approaches at Middle School Textbooks" written by Gülsüm DEMİR, and Munise SEÇKİN KAPUCU. In this qualitative research, Middle School Mathematics Curriculum and Middle School Mathematics Textbooks were examined in terms of ethnomathematics approach. Answers were sought to the questions of 'how is it related to culture?' within the subject of acquisitions, content (lecture), learning-teaching process (activities) and evaluation (questions) in the books prepared within the scope of the Middle School Mathematics Curriculum implemented in Türkiye. Examples of mathematical tasks suitable for these achievements were examined in the textbooks of 5-8th grades, published by the Ministry of National Education in 2018. The examinations were made in the context of the relationship between acquisitions, content, learning-teaching process and evaluation with culture. Of these four titles, only two acquisitions were associated with culture in the Curriculum, which includes a total of 52 acquisitions in the sources examined. In terms of content, activity and evaluation, it was seen that culture was emphasized in subjects such as Numbers and Operations, Geometry and Measurement, Algebra, Data Processing as a field of learning. The emphasis on culture in terms of content and learning-teaching process was equal when examined of these two titles.

The 7th article of this issue is entitled “The Relationship between Teachers' Attitudes Regarding the Use of Technology in Lessons and Lifelong Learning” written by Cavide DEMİRCİ, and Ahmet GÜVEN. This research aimed to determine the relationship between teachers’ attitudes toward lifelong learning and technology usage. Correlational research design was employed. The sample of this study consists of 145 teachers working in Odunpazarı and Tepebaşı districts in Eskişehir city center. The data analysis showed that there is no significant relationship between teachers' attitudes about the use of technology and lifelong learning tendencies. As a result of the data analysis, it was concluded that the attitudes toward the use of technology did not show significant differences according to gender, age, and seniority.

See you in the next issue, next year….

“Stay with Science, Stay with Us”

M. Zafer BALBAĞ, Ph.D.
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Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Şahin, S., & Ersoy, A. (2023). The impact of augmented reality applications on the primary school 2nd grade students' idioms learning levels. *Osmangazi Journal of Educational Research, 10*(1), 1-26.

Submitted: 12/09/2022 **Revised:** 16/02/2023 **Accepted:** 16/02/2023 **DOI:** 10.59409/ojer.1168012

The Impact of Augmented Reality Applications on the Primary School 2nd Grade Students' Idioms Learning Levels

***Seda Şahin, **Ali Ersoy**

Abstract. This study investigated the impact of augmented reality applications on improving the idioms learning levels of primary school 2nd grade students. The participants of the study were 29 students in the experimental and control groups studying in the second grade of a primary school in Eskişehir. In the experimental group, the idioms were taught with augmented reality applications. The experimental group implementation lasted for two weeks, and ten idioms that were mentioned in the 2nd grade Turkish course book under the theme of "Health, Sports and Play" were examined respectively. Data collection tools such as; "Idioms-Matching Form", "Idioms-Filling the Blank Form", "Idioms-Sentence Forming Form" developed by the researchers were used in the study. In the study, static group pre-test-post-test design, which is one of the pre-experimental designs, was used. The data obtained were analyzed with the statistical package program and it was found that there was a statistically significant difference between the groups in favor of the experimental group. In addition, the responses given to the Idioms-Sentence Forming Form were evaluated by content analysis method in order to demonstrate the change in the students' learning levels of idioms and support the research result. Based on these findings, it can be said that augmented reality applications are effective in improving the idioms learning levels of primary school 2nd grade students. The impact of augmented reality applications on other components of the vocabulary can also be determined.

Keywords. Primary school, teaching Turkish, vocabulary, idioms, augmented reality.

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Note: This article is derived from the first author's master thesis with the same title.

It is important to develop vocabulary for effective communication and to provide opportunities for children. One of the critical periods in which these opportunities will be presented is the primary school period. Vocabulary is all of the words in a language, but it can also be named as lexicon, word-stock, word-hoard, storehouse of words, and treasury of words (Türk Dil Kurumu [TDK], 2016). Vocabulary, which is a requirement for speaking and writing a language (Calp, 2010), is also related to understanding what one reads and listens. Aksan (2002, 13) defines the vocabulary as "a concept composed of words, reduplications, proverbs, related words, idioms and formulaic words". Children start using the language proficiently between the ages of 5-10 and can learn the subtleties of the language (Yapıcı, 2004). It is important for primary school students to enrich their vocabulary in the development of their language skills. The acquisition of the four basic language skills of reading, writing, speaking and listening and the ability of the individual to effectively use these skills are closely related to the acquired rich vocabulary (Karatay, 2007). Students' thorough and accurate understanding of what they read or listen to and expressing what he/she understands, thinks and designs effectively in words and writing depends on the richness of the vocabulary (Sever, 2000). Ministry of National Education [MoNE] (2017) Turkish Language Curriculum aims to help students reach language pleasure and consciousness by enriching their vocabulary based on what they read, listen to/watch. In addition to this, it is also aimed at developing their feelings, thoughts and imaginations.

It can be said that there is a close relationship between the development of four basic language skills and vocabulary. It allows students to interpret words accurately and to understand what they read and listen to. Individuals with rich vocabulary use their speaking and writing skills more effectively (Pehlivan, 2003). At this point, it is necessary to focus on the ways in which students' vocabulary will be enriched. There are many different approaches and techniques used in vocabulary teaching. One of the reasons for this is that teachers' experience and knowledge are very different from each other (Karadüz & Yıldırım, 2011). According to the Primary and Secondary School Turkish Lesson Curriculum, in the development of vocabulary, dictionary, picture dictionary, word cards and word maps can be used. Acquisitions about idioms, which are an element of vocabulary, start in the 3rd grade (MoNE, 2017). In this respect, one of the subjects that should be highlighted in order to enrich the vocabulary is the teaching of idioms. Because primary school children are exposed to idioms in some way in their daily lives.

Idiom is defined in the dictionary as "a formulaic phrase, or word with a specific meaning, more or less different from its real meaning" (TDK, 2017). Idioms are used to communicate a situation or concept as interesting in a special pattern. Idioms do not declare rules or judgments (Çakıcıoğlu, 2014). Using an idiom makes expression more effective by strengthening its meaning as well as its appeal. Given the relationship between idioms and vocabulary, it can be said that idioms are a sub-dimension of vocabulary. Idioms in a language are also included in the vocabulary; they are important elements that reveal the power and success of the language-speaking society, its tendency towards analogy and wit (Aksan, 2004). Idioms, like proverbs, are formulaic words. The syntax of an idiom cannot be spoiled, and the words of an idiom cannot be changed and replaced with other words, even if the meaning remains the same (Aksoy, 1993). In Turkish, situations and events that are difficult to explain and that can be considered as detail are explained with very subtle analogies through idioms. This is called "concretization" of the meaning (Aksan, 2004). As the child begins to interact with language, the child encounters idioms. Although MoNE (2017) does not include the achievements of idioms and proverbs at the 2nd grade level in the Turkish Lesson Curriculum it has published, idioms are used in order to strengthen the meaning in the texts in the 2nd Grade Turkish Textbook (2016). In transferring the values of the society, the child lives in, proverbs and idioms are crucial for individuals to express themselves effectively in the socialization process. These are the most important indicators of the depiction of an identity, a photograph, a lifestyle, a society. Proverbs and idioms that emerge as a result of a certain life experience in societies takes an important place in education with their didactic features (Aksoy, 1981). Therefore, teaching idioms emerges as an issue that should not be neglected in the acquisition of vocabulary.

The idioms dealt with in the study are in the theme of Health, Sports and Play in the primary school 2nd grade Turkish Textbook (2016); "to be sick of something", "not to care", "to be an heirloom", "to bend one's neck", "to give shape to something", "to barge in", "to tidy up", "to go silent", "to go out of sight" and "be like a pearl" (MoNE, 2016, 74-84). These idioms strengthen the expression in the texts. The use of idioms in the texts enabled the students to have preliminary knowledge about idioms. Idioms, both analogically and metaphorically, were introduced to students through texts. Idioms are one of the important elements of culture that deepens the meaning of writing and makes it more sincere. Since idioms are used many times in daily life, children encounter idioms from the moment they are born. Children are taught in primary school the meaning of the idioms they are exposed to in both listening and reading activities. Many methods, techniques and tools can be used in teaching idioms. One of them is the augmented reality [AR] application.

AR applications can be effective and functional in making learning permanent. AR makes learning more permanent by combining real and virtual environments simultaneously (Azuma, 1997) and integrates the materials prepared with the applications in the virtual and real-world context. AR are environments where real and virtual worlds come together in the same sensory area in real time and reach the user (Özarslan, 2011). From this point of view, it can be said that AR creates real-time learning environments by employing more than one sense and makes learning permanent. AR is the reflection of any object, shape or picture displayed on mobile devices or computers, as if they were real, on the screen by converting them to specific images. In short, thanks to this system, an object or an event that is not there in real life seems to occur through the screen of the computer or mobile device in the palm of the hand (Çakır, Solak, & Tan, 2015). Azuma (1997) divided AR into two as optical and video-based, considering the technological possibilities. The main difference that separates optical and video-based reality technologies from each other is the place where the image is seen as a result of the integration of the real and virtual world. The integrated scene in optical systems is seen in the real world through glasses, while the integrated scene in video-based systems is seen on the PC/tablet/mobile device (Somyürek, 2014). Video-based augmented reality application was used in this research.

In the experimental group of the study conducted, the videos prepared about the idioms were reflected on the screen through the visuals in which the idioms were written and the AR application. Virtual learning objects and textbooks can be used together, thanks to its feature of providing multimedia content by adding a digital layer to real world images simultaneously with AR (İbili & Şahin, 2015). Sensory, interactive, and well-designed multimedia with network-developed multimedia materials enable students to participate in the learning process actively and to learn permanently (Küçük, Yılmaz, & Göktaş, 2014). The MoNE has made textbooks interactive and included the 2-d codes that enable the textbooks to be able to access content that reinforces the subject as of 2017-2018 academic year. From this point of view, it can be predicted that the rate of use of AR technology in educational environments will increase in order to ensure permanent and effective learning. Some of the studies in the literature state that the similarity of the material used in the learning process with real life creates effective and productive learning situations (Klopfer & Squire, 2008). Using augmented reality applications can ensure the effectiveness and permanence of education in situations where living, experiencing and learning is difficult. It can also make learning more enjoyable by providing motivation for learning.

There are application examples of AR applications that include pre-school (Çevik et al., 2017), primary school (Onbaşılı, 2018), secondary education and undergraduate education levels (Di Serio, Ibáñez, & Kloos, 2013; Akkuş, 2016). It has been demonstrated by scientific research that AR applications have a positive impact on cognitive, social and affective development and make the learning environment realistic (Yılmaz & Batdı, 2016); makes learning interesting (Hwang et al., 2016); concretizes the learning of concepts, events and objects (Wu et al., 2013); makes the lesson enjoyable and ensures active participation (Yılmaz & Batdı, 2016; Bacca et al., 2014); positively affects students' motivation and attitudes towards the course (Singhal et al., 2012); it is effective in teaching dangerous situations that are difficult to observe (Abdüsselam, 2014); provides learning by doing (Dunleavy & Dede, 2014); supports informal learning (Huang, Chan, & Chou, 2016). Since idioms are elements of vocabulary that are more or less far removed from the real meaning, they need to be concretized in order for students to learn idioms. For this purpose, AR technology is thought to be one of the best ways to concretize the teaching of idioms. The purpose of the study is to examine the impact of augmented reality applications on improving the idioms learning levels of primary school 2nd grade students.

Limitations

This research has the following limitations:

1. Research findings are limited to the data obtained from the 2nd grade students of a private primary school in Eskişehir in the 2017-2018 academic year,

2. The idioms found in the theme of "Health, Sports and Play" in the 2nd Grade Turkish Textbook of the Ministry of National Education (2016).

Assumptions

The following assumptions are made in this research:

1. It is assumed that uncontrollable variables in the experimental and control groups affected both groups similarly,

2. The level of readiness for the "Health, Sports and Play" theme of the students in the experimental and control groups is equal.

Methodology

Research Model

In this study, pre-experimental static group pre-test post-test design was used. In this design, also known as the pre-test post-test non-equivalent group design, ready groups are used. There is no random assignment or matching of subjects to groups. One of the groups is determined as the experimental (E) group and the other as the control (C) group. The usability of the design increases as it allows knowing the starting points of the groups regarding the measured quality, the measurement and testing of the change (Büyüköztürk et al, 2016). The symbolic view of this pattern is given in Table 1.

Table 1.

Static Group Pretest-Posttest Design

Group	Pre-test	Process	Post-test
E	O1	X	S1
C	O2		S2

The starting point of this research is the researchers' observations and inferences during his teaching experience and the opinions of his colleagues. In addition to the activities of the Primary and Secondary School 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th Grade Turkish Language Curriculum (2017), it was aimed to determine whether a technology-based activity is effective or not. In addition, the fact that the researcher (first author) was the classroom teacher of the experimental group provided a suitable environment for the implementation. For this purpose, the research design was chosen as a static group pretest-posttest design.

Study Group

The study group of the research consists of 29 students studying in the second grade of a private primary school in Eskişehir. There are 15 students in the experimental group and 14 students in the control group. Convenient sampling method was used because the researcher is a teacher, every student in the school has a tablet and support staff available for downloading the AR application to be used on student tablets. Necessary permissions were obtained to carry out the study and to implement the data collection tools at the designated school. Convenient sampling aims to prevent time, money and labor loss (Büyüköztürk et al., 2016). Table 2 shows the information about the parents' education and family income and the number of computers/tablets at home for 9 girls, 6 boys in the experimental group, and 7 girls and 8 boys in the control group.

Table 2.

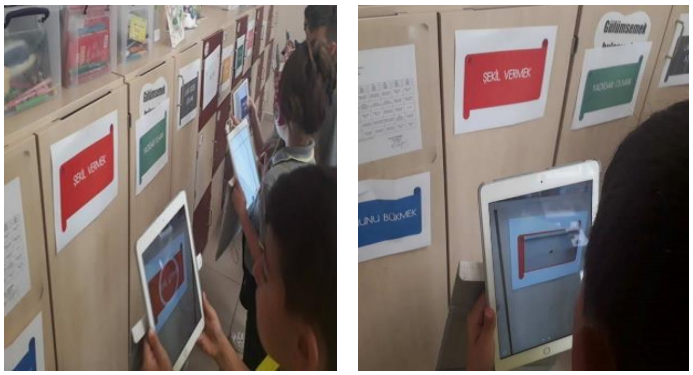
Information on the Parents' Education, Income and Number of Computers/Tablets at Home of the Study Group

		Experimental Group		**Control Group**	
		f	**%**	**f**	**%**
Mother's Education	High school	5	33.3	1	7.1
	Undergraduate education	7	46.7	9	64.3
	Postgraduate education	3	20.0	4	28.6
	Total	**15**	**100.0**	**14**	**100.0**
Father's Education	High school	1	6.7	-	-
	Undergraduate education	14	93.3	5	35.7
	Postgraduate education	-	-	9	64.3
	Total	**15**	**100.0**	**14**	**100.0**
Family Income (1 dollar 6000 TL)	Between 5001-10.000 TL	7	46.7	3	21.4
	More than 10.001	8	53.3	11	78.6
	Total	**15**	**100.0**	**14**	**100.0**
Number of Computers/Tablets at Home	1	4	26.7	4	28.6
	2	7	46.7	8	57.1
	3	3	20.0	1	7.1
	4	1	6.7	1	7.1
	Total	**15**	**100.0**	**14**	**100.0**

Table 2 shows that while 33.3% of mothers of experimental group students had high school diplomas, 46.7% had undergraduate degrees, and 20% had postgraduate degrees, only 7.1% of mothers of control group students had high school diplomas, 64.3% had undergraduate degrees, and 28.6% had postgraduate degrees. While 6.7% of the fathers of the students in the experimental group were high school graduates, 93.3% had undergraduate degree; 35.7% of the fathers of the control group students had undergraduate degree and 64.3% had graduate degree. According to this, it is seen that the educational status of the parents of the control group is higher than that of the experimental group. While the income of 46.7% of the families of the experimental group students was between 5,000-10,000, 53.3% of them were higher than 10,001; the income of 21.4% of the families of the control group students is between 5.000-10.000, the income of 78.6% of them is higher than 10,001. It can be said that the economic status of the families of the control group students is higher than that of the experimental group. When the number of computers/tablets at home was considered, 26.4% of the students in the experimental group have 1 computer/tablet, 46.7% have 2, 20% have 3 and 6.7% have 4 computers/tablets; 28.6% of those in the control group have 1 computer/tablet, 57.1% have 2 computers, 7.1% have 3 computers and 7.1% have 4 computers/tablets. With this regard, it can be said that there are more computers/tablets in the house of the experiment group students than the control group.

Experimental Process

The pre-test was administered on 14 May 2018. The first author is the practitioner of the experimental group. Permission to practice was also obtained from the classroom teacher of the control group. According to the idioms determined, the students prepared dialogues in accordance with the idiom they were assigned. The students then recreated these dialogues with finger puppets and recorded the video of these animations. The animations are planned in order to present the meaning of the idiom correctly and to use it in AR application. The animations were performed with groups of only 2 or 3 people and were recorded. Animation and video recordings were made in order for the students to access the appropriate use of the idioms by using the AR application. The image recordings were embedded in the images prepared by the first author with the AR application, in which the idioms were written. After each animation, images were posted in the classroom and the students used these images to access the embedded video with in the image in all their free time through the AR application. In this process, they both used technology and had the opportunity to see the use of idioms in an interesting way over and over again. The application ended with the application of the post-test on June 2, 2018. Visuals related to the implementation process are given in Picture 1.



Picture 1. Examples from the Experimental Group Implementation Process.

In Picture 1, students first access the video recordings containing the determined idioms through the AR application on their tablets. Then, the AR application displays the image on which the idiom is written on the tablet screen. Finally, it provides access to the recording of the relevant image. The students used finger puppets while shooting the animations embedded in the posted image through AR application. The embedding of the image records into the image with the AR application was carried out by the first author.

Data Collection Tools

For the idioms in the theme of "Health, Sports and Play" in the primary school 2nd grade Turkish lesson, 4 forms were developed in order to determine the level at which the students can achieve the goals identified. Expert opinion was sought for the content validity of the Idioms-Matching, Idioms-Filling the Gap and Idioms-Sentence Forming forms developed by the researchers. The forms were used as a pre-test before the implementation and as a post-test at the end of the implementation. Students answered the forms in an integrated manner, one after the other. In each form, there is a question related to each idiom determined. In addition, the Parent Information Form was also used. Explanations on these forms are given below.

Idioms-Matching Form. In this form, the specified idioms and the meanings of these idioms are given in a mixed form. The student was expected to find and match the meaning of each idiom. The form was scored as 1 for each correct match and 0 for blank or incorrect matching. Students can get a minimum of 0 and a maximum of 10 points from the form.

Idioms-fill-in-the-blank form. In the paragraphs created in this form, spaces are given where the idioms can be placed in accordance with their meaning. It is expected that the appropriate one of the given idioms should be placed in the blank space in each of the paragraphs. The form was scored as 1 for each correct match and 0 for blank or incorrect matching. Students can get a minimum of 0 and a maximum of 10 points from the form.

Idioms-sentence forming form. In this form, students were expected to construct a meaningful sentence for each of the given idioms. Students got 1 point if sentences suitable for the meaning of the idiom were formed, and 0 points if sentences were not made in accordance with the meaning of the idiom or left blank. Students can get a minimum of 0 and a maximum of 10 points from the form. In addition, the data obtained from this form were evaluated through content analysis.

Parent information form. With this form, information about the purpose of introducing the study group was collected from the parents. Information on the education of the students' parents, the economic status of the family, and the number of computers/tablets at home were collected.

Data Analysis

The data obtained from the forms applied as pre-test and post-test were transferred to the computer. There are 10 questions in the forms. Each correct question is given 1 point. Evaluations were made out of 10 points. In the forms, there are questions about both the semantics of idioms and their proper use in sentences. It was aimed to reveal the development in the students' learning levels

of idioms by conducting content analysis on the answers given to the open-ended questions in the Idioms-Sentence Forming Form of the experimental group. After obtaining the pre-test and post-test scores of the experimental and control groups, the average scores of the groups and other descriptive statistics were calculated. Normality analysis was performed to determine if the obtained data were normally distributed. Since the group size was less than 50, normality analysis was performed with the Shapiro-Wilk Normality Test. Büyüköztürk (2017) stated that if the calculated p-value is less than $p<.05$, the scores will be interpreted as showing a significant (extreme) deviation from the normal distribution, and in this case, statistics that require the "normality" assumption should not be used. The Normality analysis tables and results are given in Table 3.

Table 3.

Shapiro-Wilk Normality Test Analysis Results of the Experimental Group Data

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Pre-test	.891	15	.070
Post-test	.906	15	.117

According to the Shapiro-Wilk Normality Test analysis results of the data obtained from the experimental group in Table 3, statistics that require the assumption of normality should be used in the statistics to be used regarding the pre-test and post-test scores ($p>.05$). In Table 4, the Shapiro-Wilk Normality Test analysis results of the data obtained from the control group are given.

Table 4.

Shapiro-Wilk Normality Test Analysis Results of Control Group Data

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Pre-test	.971	14	.894
Post-test	.878	14	.055

According to Table 4, statistics that require the assumption of normality should be used in the statistics to be used regarding the pre-test and post-test scores ($p>.05$). For this reason, the Two-Factor ANOVA Test for Mixed Measures, one of the parametric tests, was used. The coding and statistical analyzes of the collected data were made with the statistical package program.

Findings

Findings and Comments on Pre-test and Post-test Results of Experimental and Control Groups

In the study, the answer to the question: "Do the pre-test and post-test results of the experimental and control groups differ?" has been sought. The pre-test scores of the students in the experimental group from the Idioms-Matching Form, Idioms-Filling the Blank Form and Idioms-Sentence Forming

Form are shown in Table 5. The names in the tables are not the real names of the students. Students were given code names.

Table 5.

Number of True, False and Blank Answers Given by Experimental Group Students in the Pre-test

	Idioms-Matching Form			**Idioms-Filling the Blank Form**			**Idioms-Sentence Forming Form**		
Students	True	False	Blank	True	False	Blank	True	False	Blank
Ayşe	5	1	4	7	3	0	3	5	2
Sevgi	10	0	0	6	3	1	6	4	0
Fatma	5	4	1	1	8	1	3	7	0
Melek	9	1	0	9	0	1	8	2	0
Ayten	2	0	8	3	2	5	2	1	7
Gül	2	0	8	3	7	0	3	1	6
Ahmet	3	0	7	3	1	6	5	0	0
Mehmet	5	0	5	4	0	6	3	1	6
Aysun	1	1	8	1	1	8	3	0	7
Veli	1	1	8	2	8	0	3	7	0
Cihan	5	2	3	6	3	1	3	1	6
Selim	3	2	5	5	5	0	3	6	1
Nuray	7	3	0	7	2	1	0	1	9
Emre	5	1	4	2	0	8	4	4	2
Merve	5	3	2	4	6	0	3	1	6

As can be seen in Table 5, Sevgi got full points and Melek got 9 points in the pre-test Idioms-Matching Form, respectively, received the highest scores. Aysun and Veli got the lowest scores with 1 point. In the Idioms-Filling the Gap Form, the highest scores were achieved by Melek with 9 points, Ayşe and Nuray with 7 points. The lowest scores belong to Fatma and Aysun with 1 point. In the Idioms-Sentence Forming Form, the highest scores were received by Melek with 8 points and Sevgi with 6 points. The lowest scores belong to Nuray, who did not get points, and Ayten, who got 2 points.

The post-test scores of the experimental group students from the Idioms-Matching Form, Idioms-Filling the Gap Form and Idioms-Sentence Forming Form are given in Table 6.

Table *6.*

Number of True, False and Blank Answers Given by Experimental Group Students in the Post-Test

	Idioms-Matching Form			**Idioms-Filling the Blank Form**			**Idioms-Sentence Forming Form**		
Students	True	False	Blank	True	False	Blank	True	False	Blank
Ayşe	10	0	0	10	0	0	7	3	0
Sevgi	8	1	1	10	0	0	10	0	0
Fatma	10	0	0	5	0	5	6	4	0
Melek	10	0	0	10	0	0	10	0	0
Ayten	8	1	1	9	1	0	10	0	0
Gül	8	2	0	10	0	0	6	1	3
Ahmet	10	0	0	10	0	0	9	1	0
Mehmet	8	1	1	10	0	0	8	2	0
Aysun	10	0	0	10	0	0	9	1	0

Veli	10	0	0	10	0	0	9	1	0
Cihan	8	2	0	10	0	0	9	1	0
Selim	8	1	1	3	7	0	10	0	0
Nuray	10	0	0	10	0	0	10	0	0
Emre	7	0	3	9	1	0	9	1	0
Merve	8	2	0	10	0	0	7	3	0

According to Table 6, Ayşe, Fatma, Melek, Ahmet, Aysun, Veli and Nuray got the highest scores in the post-test Idioms-Matching Form. Emre got the lowest score with 7 points. Ayşe, Sevgi, Melek, Gül, Ahmet, Mehmet, Aysun, Veli, Cihan, Nuray and Merve got the highest scores in the Idioms-Filling the Gap Form. The lowest scores were received by Selim with 3 points and Fatma with 5 points. In the Idioms-Sentence Forming Form, the highest scores were obtained by Sevgi, Melek, Ayten, Selim and Nuray by getting full points. The lowest scores were received by Gül with 6 points and Ayşe with 7 points.

The pre-test scores obtained by the control group students from the Idioms-Matching Form, Idioms-Filling-the-Blank Form and the Idioms-Sentence Forming Form are given in Table 7.

Table 7.

Number of True, False and Blank Answers Given by the Control Group Students in the Pre-test

	Idioms-Matching Form			**Idioms-Filling the Blank Form**			**Idioms-Sentence Forming Form**		
Students	True	False	Blank	True	False	Blank	True	False	Blank
Sema	5	5	0	9	1	0	6	4	0
Yusuf	5	5	0	5	0	5	4	6	0
Serap	4	6	0	4	2	4	3	5	2
Veli	5	4	1	3	7	0	3	3	4
Ceren	1	6	3	3	7	0	4	5	1
Damla	5	5	0	5	0	5	6	3	1
Selin	7	3	0	5	0	5	5	4	1
Hacer	10	0	0	6	0	4	6	2	2
Ali	7	0	3	7	0	3	4	2	4
Hasan	7	1	2	7	1	2	2	4	4
Alper	5	0	5	4	2	4	6	0	4
Esra	8	2	0	7	1	2	10	0	0
Yiğit	6	1	3	3	0	7	2	0	0
Cemil	4	4	2	6	1	3	4	3	3

According to Table 7, Hacer achieved the highest scores in the pre-test Idioms-Matching Form with full points and Esra with 8 points. Ceren got the lowest score with 1 point. Sema with 9 points and Ali and Hasan with 7 points got the highest scores in the Idioms-Filling the Gap Form. Veli, Ceren and Yiğit got the lowest scores with 3 points. Esra achieved the highest score in the Idioms-Sentence Formation Form with a full score. Hasan and Yiğit got the lowest scores with 2 points.

The post-test scores of the students in the control group from the Idioms-Matching Form, Idioms-Filling-the-Blank Form and Idioms-Sentence Forming Form are given in Table 8.

Table 8.

Number of True, False and Blank Answers Given by Control Group Students in the Post-test

	Idioms-Matching Form			**Idioms-Filling the Blank Form**			**Idioms-Sentence Forming Form**		
Students	True	False	Blank	True	False	Blank	True	False	Blank
Sema	8	2	0	8	2	0	7	2	1
Yusuf	5	2	3	5	0	5	5	0	5
Serap	4	6	0	4	0	6	4	3	3
Veli	5	3	2	4	6	0	4	5	1
Ceren	5	4	1	3	4	3	4	4	2
Damla	3	7	0	10	0	0	3	0	7
Selin	5	5	0	6	0	4	6	3	1
Hacer	10	0	0	10	0	0	8	2	0
Ali	7	0	3	8	0	2	3	5	2
Hasan	7	0	3	9	1	0	7	1	2
Alper	6	0	4	4	2	4	3	2	5
Esra	7	2	1	10	0	0	10	0	0
Yiğit	4	4	2	4	4	2	3	3	4
Cemil	6	3	1	5	1	4	3	3	4

According to Table 8, Hacer with full points and Sema got 8 points got the highest scores in the post-test Idioms-Matching Form. The lowest score belongs to Damla with 3 points and Yiğit with 4 points. Damla, Hacer and Esra achieved the highest scores in the Idioms-Filling the Gap Form with full points. The lowest scores were received by Ceren with 3 points and Serap, Veli, Alper and Yiğit with 4 points. Esra with a full score and Hacer with 8 points got the highest scores in the Idioms-Sentence Forming Form. The lowest scores belong to Damla, Ali, Alper, Yiğit and Cemil with 3 points.

The mean and standard deviation values of the pre-test and post-test scores of the experimental and control groups are given in Table 9.

Table 9.

Mean and Standard Deviation Values of Experimental and Control Groups' Pre-test and Post-test Scores

	Group	**$\bar{X}$**	**S**	**N**
Pre-test	Experimental Group	12,2000	5,67199	15
	Control Group	15,5714	4,66928	14
	Total	13,8276	5,39887	29
Post-test	Experimental Group	26,5333	2,89992	15
	Control Group	17,0714	5,92860	14
	Total	21,9655	6,60888	29

According to Table 9, the pre-experimental Idioms-Matching Form, Idioms-Filling-Blank Form and Idioms-Sentence Forming Form mean score of the experimental group in which idiom teaching was carried out with AR application was 12.20, while this value became 26.53 after the experiment. While the pre-experiment average score of the control group, which was taught idioms without using AR, was 15.57, this value was 17.07 in the post-test. Accordingly, it can be said that an increase was observed in the post-test scores of both groups. The change in the mean scores of the experimental and control groups from the pre-test to the post-test is given in Figure 1.

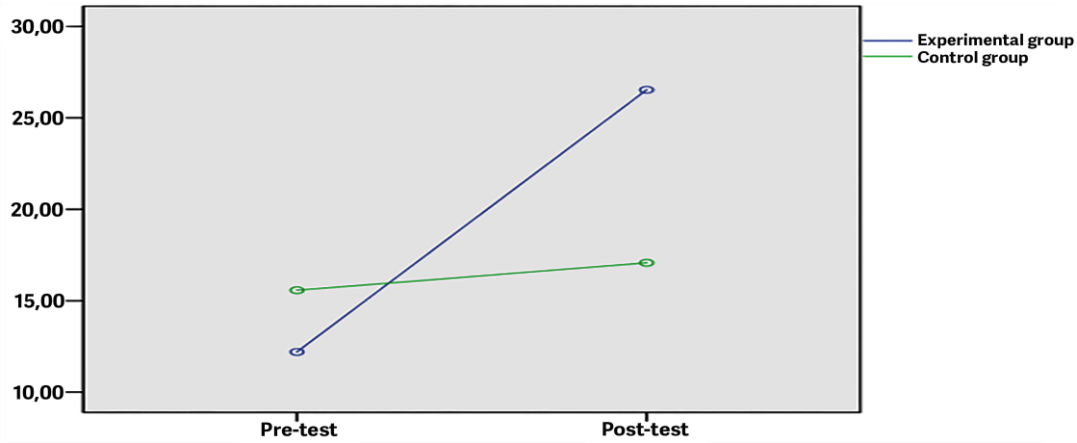


Figure 1. Pre-test and Post-test Average Scores of the Experimental and Control Groups.

According to Figure 1, the post-test scores of the experimental and control groups are higher than the pre-test scores. The two-factor ANOVA results of the experimental group students who were exposed to the experimental procedure and the control group students who were not subjected to the experimental procedure, regarding whether the changes observed after the experiment showed a significant difference compared to the pre-experimental process are given in Table 10.

Table 10.

ANOVA Results of Pretest-Posttest Scores of Experimental and Control Groups

Source of Variance	**KT**	**sd**	**KO**	**F**	**p**
Between subjects	1176.380	28			
Group (Individual/Group)	134.306	1	134.306	3.480	.073
Error	1042.074	27	38.595		
Within-subjects	1770.411	29			
Measure (Pre-test - Post-test)	907.687	1	907.687	91.990	.000
Group Measure	**596.307**	**1**	**596.307**	**60.433**	**.000**
Error	266.417	27	9.867		
Total	2946.791	57			

According to Table 10, it was found that the test scores of the experimental group in which idiom teaching was performed with AG applications showed a significant difference between before and after the experiment [$F_{(1,27)} = 60.433$, $p<.001$]. This significant difference is due to being in different implementation groups.

This finding shows that idiom teaching with AR applications has different impacts on increasing students' learning levels. In the scores obtained from Idioms-Matching Form, Idioms-Gap Filling Form and Idioms-Sentence Forming Form, it is understood that idiom teaching with AR applications, which reached a higher learning level than before the experiment, is more effective in increasing the learning levels of students compared to the teaching without AR applications. In this study, the results of the group and measurement main effect tests were not interpreted, since the focus of the research was only to test the effectiveness of two different groups in increasing the learning levels of different applications.

Findings and Comments Obtained from the Evaluation of the Idioms-Sentence Forming Form

Sentence building activities were created by researchers to determine whether the idiom being taught was fully learned by the students and used correctly. The evaluation of the Idioms-Sentence Forming Form is important in terms of demonstrating the change in the idioms learning levels of the experimental group students and supporting the research result. In this form, appropriate spaces were given under the determined 10 idiom and idioms, and students were expected to use the idioms in a sentence in accordance with their meaning.

As a result of the evaluation of the form, the scores of the students in the experimental group regarding 10 questions in the form were analyzed and evaluated. The frequency and percentage values of the answers given by the experimental group students to the first question in the Idioms-Sentence Forming Form in the pre-test and post-test are given in Table 11.

In the first question in the Idioms-Sentence Forming Form, the students were asked to use the idiom "to be sick of something" in a sentence, considering its meaning. When the answers given are examined, it is seen that the students generally gave correct answers as can be seen in Table 11. The frequent use of this idiom in daily life may have led to this result. In the pre-test, 13.3% of the students answer the question incorrectly. The incorrect answers were caused by the fact that the idiom was not used in the sentence, and students who answered incorrectly said, "Elif has a bad smell." They made explanations that reminded the meaning of the idiom.

When the answers from the pre-test to the post-test were compared, answers given in the pre-test such as, "I was very sick today." were prominent, while the majority of the answers in the post-test were in the form of using the garbage example "I was sick of the smell of the garbage ". Aysun's response to this question in the post-test, "I get very sick when you were eating with your mouth open." was the most striking and diversifying answer. The garbage sample was also used in the video recording that the students accessed through the AR application. From this point of view, it is seen that the AR application has a positive impact on the students' understanding of the meaning of the idiom, making sentences suitable for the meaning of the idiom, and therefore on the level of learning the idiom.

In the second question of the Idioms-Sentence Forming Form, students were asked to use the idiom "not to care" in a sentence, considering its meaning." As shown in Table 11, when the answers given are examined, the ratio of the correct answers has increased from 26.7% to 93.3%. The number of blank and false answers has noticeably reduced. This situation can be interpreted as the students' ideas about the meaning and usage of the idiom formed from the pre-test to the post-test. In addition to not using the idiom in a sentence, the incorrect answers were given as the removal of the negative suffix in the structure of the idiom as in the following sentence: "My friend has taken care of it today", "Ayşe, I will take care of you now." When the answers given in the pre-test test and post-test were compared, correct answers were given as in the example of:" I didn't care about my friend," he didn't care." Although these sentences are correct in terms of meaning and structure, they are the answers that the student knowledge of the idiom cannot be fully interpreted.

In the post-test, they used the phrase "don't care" together with a person or a behavior in a sentence. More qualified answers were given such as: "They made fun of me today, but I didn't care for them.", "I didn't care what he said." In the video recording that students accessed through the AR application, the example of not caring the word that contains sarcasm was used.

From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

Table 11.

Frequency and Percentage Values of the Experimental Group Students' Answers to the Questions in the Idioms-Sentence Forming Form in the Pre-test and Post-test

Idioms		**Answers**	**Pre-test**		**Post-test**	
			f	**%**	**f**	**%**
1.	Being sick of something	False	2	13.3	-	-
		True	13	86.7	15	100.0
		Total	15	100.0	15	100.0
2.	Not to care	False	4	26.7	14	93.3
		True	4	26.7	-	-
		Blank	7	46.7	1	6.7
		Total	15	100.0	15	100.0
3.	To be an heirloom	False	4	26.7	1	6.7
		True	2	13.3	14	93.3
		Blank	9	60.0	-	-
		Total	15	100.0	15	100.0
4.	Bend your neck	False	5	33.3	6	40.0
		True	3	20.0	9	60.0
		Blank	7	46.7	-	-
		Total	15	100.0	15	100.0
5.	Give shape to something	False	4	26.7	1	6.7
		True	4	26.7	14	93.3
		Blank	7	46.7	-	-
		Total	15	100.0	15	100.0
6.	Barge in	False	4	26.7	-	-
		True	7	46.7	15	100.0
		Blank	4	26.7	-	-
		Total	15	100.0	15	100.0
7.	Tidy up	False	4	26.7	2	13.3
		True	6	40.0	12	80.0
		Blank	5	33.3	1	6.7
		Total	15	100.0	15	100.0
8.	Go silent	False	7	46.7	4	26.7
		True	1	6.7	10	66.7
		Blank	7	46.7	1	6.7
		Total	15	100.0	15	100.0
9.	Go out of sight	False	4	26.7	3	20.0
		True	8	53.3	12	80.0
		Blank	3	20.0	-	-
		Total	15	100.0	15	100.0
10.	Like a pearl	False	3	20.0	1	6.7
		True	4	26.7	14	93.3
		Blank	8	53.3	-	-
		Total	15	100.0	15	100.0

In the third question in the Idioms-Sentence Forming Form, the students were asked to use the idiom "to be an heirloom" in a sentence, considering its meaning. As can be seen in Table 11, when the answers given are examined, the rate of the correct answers increased from 13.3% to 93.3%. The number of blank and false answers decreased significantly. This situation can be interpreted as the students' ideas about the meaning and usage of the idiom formed from the pre-test to the post-test. In

the pre-test, Sevgi and Selim said, "My grandmother said, 'This cardigan is an heirloom from me to you.'" and "I went to Portugal. The football player gave me his jersey and said, 'Let it be an heirloom to you.'" they gave the correct answers. The incorrect answers given in the pre-test include sentences that do not use the idiom and are not related to the idiom, as well as "Daddy, you are a very heirloom person." is given in the form of incorrect use. In the post-test, "This is a very nice memory, it was an heirloom from you to me.", "Let this buckle be your heirloom.", "Cem will move from here. I gave my ball to him as an heirloom." correct answers were given in accordance with the meaning and structure of the idiom. There was a significant increase in the number of correct answers in the post-test. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the fourth question in the Idioms-Sentence Forming Form, the students were asked to use the idiom "bend one's neck" in a sentence, considering the meaning of it. When the answers given were examined, the rate of correct answers increased from 20% to 60%, as shown in Table 11. The number of blank and false answers decreased significantly. The fact that this idiom reminds a real bowing gesture to students may have made it difficult for them to understand its meaning compared to other idioms. In the pre-test, the answer Melek gave is noticeable in terms of the correct use of the meaning of the idiom: "No one played with her, her neck was bent." In the pre-test, wrong answers were given literally conjured up the bowing gesture, "I bent my neck a lot yesterday.", "Girl, don't bend your neck while looking at the tablet!". In the post-test, "I was in a very helpless situation, my neck was bent.", "This cat bent its neck because it was hungry.", "I couldn't solve the question at the end of the lesson, my neck was bent." answers were given showing painful, helpless situations. The incorrect answers, on the other hand, were given in the form of writing the meaning of the idiom, not using it in a sentence, as well as using it in a real sense, as in the pre-test. Students who did not use it in a sentence wrote the meaning of the idiom correctly, but did not get points because they did not form a sentence. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the fifth question in the Idioms-Sentence Forming Form, students were asked to use the idiom "give shape to something" in a sentence, considering the meaning of it. When the answers given are examined, the rate of correct answers increased from 26.7% to 93.3%, as shown in Table 11. The number of blank and incorrect answers decreased significantly. In the pre-test correct answers are

given such as, “I gave shape to the kinetic sand.”, “Let's give shape to the play dough.”, “I gave shape to the cookies.”. The incorrect answers in the pre-test and post-test as in the example “I gave shape to my car.”, given as the use of the idiom inconsistent with its meaning. In the post-test, the correct answers were generally given in the form of styling the hair, which is also included in the video recording accessed by the students through the AR application. The correct answers in the examples “I gave shape to my hair before I came to school.”, “Can I give shape to your hair?”, “I gave shape to the dough with my friend.” are noticeable in terms of using the idiom in the correct sense. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the sixth question of the Idioms-Sentence Forming Form, the students were asked to use the idiom "barge in" in a sentence, considering its meaning. When the answers given are examined, the rate of correct answers increased from 46.7% to 100% as can be seen in Table 11. In the pre-test, "My friend was saying something, so I barged in.", "While my mother was talking, I barged in.", "Elif, please don't barge in." correct answers stand out. On the other hand, the wrong responses, in addition to using the idiom "barge in" also conjugate the idiom in the form of "I've barged in.", which give no indication that the participant understands the idiom. In the post-test, all students used the idiom in accordance with its meaning and structure. Following sentences are the examples of the use of the idiom in accordance with its meaning and structure: Aysun, "We're talking here, don't barge in.", Veli, "Gülçin was suddenly barged in while Erdem was talking.", Nuray, "Ayse barged in while I was talking to my teacher.". From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the seventh question in the Idioms-Sentence Forming Form, students were asked to use the idiom "to tidy up" in a sentence, considering its meaning. When the answers given were examined, the rate of correct answers increased from 40% to 80%, as seen in Table 11. The number of blank and incorrect answers decreased significantly. In the pre-test, the answers “Girl, tidy up your room.”, “I fell, but I got up and tidied myself up.” are noteworthy. The incorrect answers given in the pre-test were given not only by not using the idiom in the sentence, but also by using it in the meaning of "arranging something". In the post-test, "Ali, tidy up under the desk.", "Sevgi has tidied up her clothes.", "You have to tidy yourself up for your grades to be good." correct answers are noteworthy. The incorrect answers given in the post-test were as in the example of “I tidied up the lesson.” It is

done by someone who does not fit the meaning, does not have the authority to make it right, or as in the example of "Ali was very naughty, the teacher tidied him up." In addition to being left unfinished, it is given as situations where multiple factors play a role, and the correction is not made by a single person. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the eighth question in the Idioms-Sentence Forming Form, students were asked to use the idiom "to go silent" in a sentence, considering its meaning. When the answers given are examined, the rate of correct answers increased from 6.7% to 66.7%, as can be seen in Table 11. The number of blank and false answers decreased significantly. It may have made it difficult for students to understand the meaning of this idiom compared to other idioms, as it reminds them that the voice is literally muted and that there is sound no sound at all. In the pre-test, the correct answer that the student with the nickname Melek gave "I went silent with fear." answer stands out. The incorrect answers, on the other hand, are given by literally interpreting the idiom which does not give an idea about the idiom as in the example of "Mom, my voice has gone silent." or by simply conjugating the idiom "My voice has gone silent". In the post-test, the sentence of the student named Mehmet, "When my mother heard the news, her voice went silent." and Sevgi's sentence "While I was at the party, a famous person suddenly appeared before me, my voice went silent." and Ayten's sentence, "When the teacher started writing the assignments, everyone went silent." are examples. There is an increase in the quality of the sentences formed by the students from the pre-test to the post-test. Incorrect answers given in the post-test were misinterpreted by literally interpreting and using it in the wrong sense as not making any sound, being silent, or lowering the sound. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the ninth question in the Idioms-Sentence Forming Form, students were asked to use the phrase "go out of sight" in a sentence, considering its meaning. When the answers given are examined, the rate of correct answers increased from 53.3% to 80% as can be seen in Table 11. The number of blank and incorrect answers decreased significantly. In the pre-test, correct answers are usually given as the disappearance or disappearance of different people by different students as in the example "My brother suddenly went out of sight." The dialogue: Aysun, "Elif said, 'I'm go look for my friend.'" "Okay," said Selin. When Elif came, she said to Selin, "Elif has gone out of sight." is a striking example. In the post-test, as in the example "The black cat suddenly went out of sight.", making

sentences such as the disappearance and disappearance of different people by different students, as well as Sevgi's sentence "Aaa! Where is Sevilay? She suddenly went out of sight." and Cihan's sentence "My friend was telling me something, then he went out of sight." stand out. In the pre-test and post-test, the incorrect answers were given as not using the idiom in a sentence or writing its meaning. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

In the tenth question in the Idioms-Sentence Forming Form, students were asked to use the phrase "like a pearl" in a sentence, considering its meaning. When the answers given are examined, the rate of correct answers increased from 26.7% to 93.3%, as can be seen in Table 11. The number of blank and incorrect answers decreased significantly. In the pre-test, the correct answers are given in the following form: "The child writes like pearls.", "Your teeth are like pearls, always brush like this. OK?". The incorrect answers were given in the form of meaning the ornamental grain formed in the sea animals by interpreting it with real meaning, "Her diamond shone like pearls." In the post-test, the correct answers are "The doctor said my teeth are like pearls," as in the video recording that students access through the AR application. The students used the word tooth to use the idiom "like a pearl". Emre's sentence "What a beautiful, pearl like handwriting you have!" differed from other student answers in the posttest. The incorrect answer in the post-test was given as not using the idiom in a sentence. From this point of view, it can be interpreted that AR application has a positive impact on students' understanding of the meaning of the idiom, making more qualified sentences, and therefore on the level of learning the idiom.

Discussion and Conclusion

Within the scope of the study, the answer to the question: "Do the pre-test and post-test results of the experimental and control groups differ?" has been sought. As a result of the analysis, a significant difference was observed between the pre-test and post-test results of the experimental group students, while there was no significant difference between the pre-test and post-test results of the control group. AG applications have shown a positive impact on the development of idioms learning levels of primary school 2nd grade students. This result show similarities with Chiang, Yang and Hwang (2014), Çakır, Solak and Tan (2015), Estapa and Nadolny (2015), Ersoy, Duman and Öncü (2016), Küçük (2015), Özarslan (2013), Sırakaya (2015), Solak and Çakır (2015), Şahin (2017), Hsu (2017), Tosik Gün and Atasoy (2017), Korucu, Gençtürk and Sezer (2016), Çevik et al. (2017). These studies show that AR applications have a meaningful impact on facilitating learning and

success. However, there are also studies in the literature that conclude that AR applications do not have a significant impact on learning or achievement (İbili, 2013; Yılmaz 2016). The reason for this difference in the literature may be due to the application of researches in different disciplines. It can also be attributed to the fact that it was implemented in different age ranges. As a result, it can be said that the majority of studies stating that the use of AR applications in education creates significant differences on learning and success. In addition, the answers given by the students in the Idioms-Sentence Forming Form were evaluated in order to determine whether the idiom that was taught was fully learned and put into practice by the students and to support the research result. After the application, the number of correct answers increased, and the number of blank and incorrect answers decreased significantly. Students who answered correctly in the pre-test, on the other hand, formed more qualified sentences regarding the meaning of the idiom in the post-test. AR applications had a positive impact on students' learning levels of idioms.

Recommendations

Based on the main findings of the study, the following recommendations were made:

- In the research, it was concluded that augmented reality applications were effective in improving the vocabulary of primary school 2nd grade students in terms of idioms. AR applications can be used to concretize words, reduplications, proverbs, stereotypes, etc., which are the other components of vocabulary in teaching Turkish and make learning permanent.
- The study was conducted with primary school 2nd grade students. It can be carried out at different grade levels and with more participants.
- A qualitative dimension can be added to the research by taking the opinions of teachers and students about the application.
- Researches can be done on the usability of AR applications in other disciplines.
- The impact of different technologies can be researched to improve vocabulary.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

Ethical and legal principles were followed in this research.

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Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Bekiroğlu, D., & Ütkür-Güllühan, N. (2023). Investigation of Life Studies and Social Studies Curriculum in the Context of Sustainable Development Goals. *Osmangazi Journal of Educational Research*, *10*(1), 27-46.

Submitted: 22/01/2023 **Revised:** 04/08/2023 **Accepted:** 07/04/2023 **DOI:** 10.59409/ojer.1240497

Investigation of Life Studies and Social Studies Curriculum in the Context of Sustainable Development Goals

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Abstract. In this research, life studies and social studies course curricula were analyzed according to the sustainability goals of the United Nations Development Program (2016). The research was carried out with the qualitative research method. The research group is the 2018 life studies curriculum and primary school social studies curriculum. The data were accessed using the "document review" technique. Descriptive analysis was used in the analysis of the data. According to the findings, it is the principle of “gapped health and wellbeing, responsible production and consumption” of the sustainability goals that the outcomes of the life studies and social studies course curriculum are the most. It has been determined that the number of outcomes related to goals such as "quality education, gender inequality" in both curriculums is low. The life studies and social studies course aims “to develop the individual’s life skills and to support him/her to be a good and responsible citizen. In this context, the results of the research showed that both courses were partially compatible and indirectly related to the UNSO (2016) objectives.

Keywords. Life studies, social studies, curriculum, sustanability, outcomes.

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"Sustainability" is a concept that comes from the Latin word "sustinere" and "to continue, to continue, to exist" in English (Redclift, 2005). The concept of sustainability "has very wide-ranging content. It is seen that sustainability was first mentioned in the "World Nature Charter" document approved by the World Nature Conservation Union in 1982, following its current meaning and purpose (Ruiz-Mallén & Heras, 2020).

While the concept was initially used in life practice to guarantee the supply of natural life and vital resources, to draw attention to nature and environmental problems, and to raise awareness of these problems and their solutions, while sustainability today, along with rapid changes and developments in the rapidly developing science and technology and dynamic world, "economic, social, natural (environmental) dimension." It was stated in the Rio Summit report (UNESCO, 2012) that sustainable education should be included at all levels of education, and that people's attitudes, beliefs, and behaviors should be shaped to promote a sustainable lifestyle and thinking (Kahriman Pamuk & Olgan, 2020). Various disciplines such as sociology, economics, and geography can be used to study the economic, social, and environmental objectives of sustainable development. Due to the inclusion of subjects such as geography, history, economy, sociology, anthropology, psychology, philosophy, politics, and citizenship in the social studies course, it is considered an important subject (Kaya & Tomal, 2011).

Gadotti (2010) described that sustainability represents a better idea and that it is a concept that includes the individual's living dynamically and in harmony with the environment and differences in the environment. The expansion of the scope of sustainability over time has also been instrumental in taking concrete steps for the idea of "sustainable development". In 2015, the "sustainable development goals called our transforming world" were determined by the "United Nations". These principles, which included a total of 17 goals, are shown in Figure 1.

Figure 1. United Nations 2030 Sustainable Development Goals (UNDP, 2016).

As seen in Figure 1, priority will be given to efforts to end hunger across the world with the goals of "end poverty and hunger"; Raising awareness, and protecting every individual outcomes disease used by harmful chemicals and air, water, and soil pollution until 2030 with the aim of "healthy and quality life"; With the goal of "quality education", the knowledge needed by all students to advance sustainable development through education for sustainable development and sustainable lifestyles, human rights, gender equality, promoting a culture of peace and non-violence, world citizenship and recognition of the contribution of cultural diversity and culture to sustainable development, and the outcomes of skills, creating and developing educational opportunities sensitive to children, the disabled, and gender equality, and creating safe, non-violent, inclusive, and effective learning environments for all; Defending women and girls everywhere from discrimination, aiming to eliminate gender inequality; To reduce inequalities, it is adopted as a principle that respects differences, eliminates languages, religions, races, genders, and ethnicities, and builds a livable world (UNDP, 2016).

Education plays a key role in achieving the purpose of sustainability principles or goals. In addition, while sustainable development focuses on the sustainable welfare of societies, it does this in the widest, fastest, and most formal way with educational cooperation. According to UNECE (2005), the development of knowledge, skills, values, and attitudes of individuals with an innovative perspective on life through education will pave the way for the formation of sustainable societies.

In this context, it is necessary for all stakeholders who live in an integrated system for sustainable development to create awareness toward a common goal. Furthermore, sustainability was

traditionally viewed as an intensification of studies focusing on "environment and economy", while "social-human" structures were lagging (Gökmen, Solak & Ekici, 2019). The holistic and interdisciplinary feature of sustainable development education reveals the importance of social science-based courses. The objectives of the courses based on sites are to provide children with the knowledge, skills, values, and attitudes that are compatible with their own and social lives and can improve their quality of life. In this context, the "life studies" lesson, which is a social studies lesson in which the child receives holistic and interdisciplinary knowledge at the primary school level, and the "social studies" lesson guides the socialization of children from the 4th grade of primary school, the concepts of "sustainable" are introduced to individuals in their own lives and social life for sustainable development. These are the courses that directly or indirectly contain the necessary qualified information and activities. In this direction, the fact that life studies and social studies courses are "holistic and interdisciplinary", and has a broad perspective on "individual, nature, society, values, skills and competencies" necessitated examining their relationship with sustainable development goals. When the literature (Arslan & Yağmur, 2022; Demir, 2023; İşler, 2023) is examined, the studies in which the outcomes of the "social studies, geography, science, visual arts" courses at primary and secondary school levels are examined in terms of sustainable development (Bulut Çakmak, 2015; Demirbaş, 2011; Kayan & Tomal, 2011; Köksal, 2016; Mamur & Köksal, 2016; Özcan & Koştur, 2019; Teksöz, 2014; Yalçın, 2022). According to this study, the outcomes of "life studies and social studies" courses are focused on within the framework of sustainable development. In contrast to previous studies, the study analyzed social studies and life studies teaching programs, examining what is included in sustainability concepts and their development in social studies lessons. In a social studies lesson, children are taught basic information before proceeding to a social studies lesson. In this respect, we hoped that the results will contribute to the disciplines of life studies and social studies since the study is an original evaluation that will be made through life studies and social studies courses. Based on these considerations, the purpose of this research is to examine the outcomes of 2018 life studies and primary school 4th-grade social studies curricula in the context of "Sustainable Development Goals" determined by UNDP (2016). The sub-objectives of the research are listed as follows:

1. What are the outcomes related to the sustainable development goals in the 2018 Life studies curriculum?

2. What are the outcomes related to the sustainable development goals in the 2018 Social Studies (4th grade) curriculum?

Method

The research was conducted using the basic qualitative research method. Qualitative research is obliged to present events and facts without distorting reality; events and phenomena are not detached from their reality or context, and they are tried to be preserved as they were formed (Miles & Huberman, 1994).

Data Sources

The data sources of the research are primary school (1, 2, 3rd grade) Life Studies and Primary School 4th grade Social Studies program (MEB, 2018). In the selection of the data sources of the research, the "social-human" field of the concept of sustainable development was focused on, and for this purpose, the "purposive sampling" method was preferred in the selection of the data sources.

The units and themes of the data sources are as follows:

Life Studies curriculum (1,2 and 3rd grade)

- Life in Our School
- Life in Our House
- Safe Life
- Life in Our Country
- Life in Nature

Social Studies curriculum for 4th Grade

- Individual and Society
- Culture and Heritage
- People, Places and Environments
- Science, Technology and Society
- Production, Distribution and Consumption
- Active Citizenship
- Global Connections

Data Collection Tools

The data of the research were collected by document analysis technique. Document review is a systematic process used to examine or evaluate documents prepared in printed or electronic media (Bowen, 2009).

The data collection stages are as follows;

1. First, the life studies and social studies curriculums were accessed from the official website of the Ministry of National Education of the Republic of Turkey, which is presented in print and electronically.

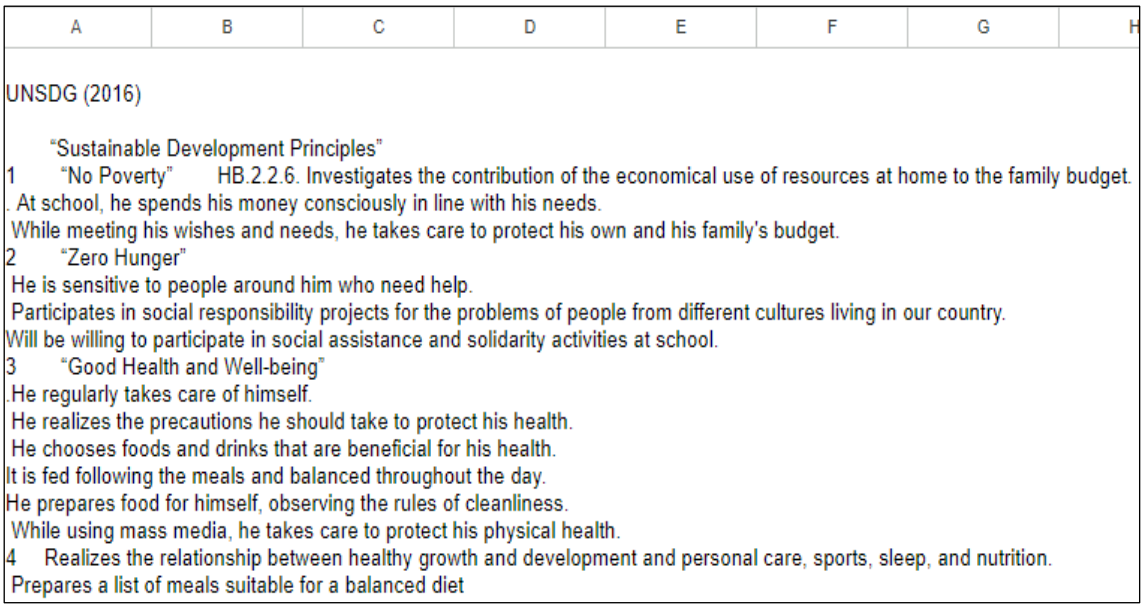
2. Secondly, the 17 sustainable development goals determined by the United Nations Development Program (2016) were accessed from the official website https://turkiye.un.org/tr/sdgs.

3. The outcomes were examined according to the UNDP goals (2016).

Data Analysis

The data of the research were analyzed by descriptive and content analysis methods. In the content analysis, the 'coding according to predetermined concepts' suggested by Strauss and Corbin (1990) was preferred, and the relevant outcomes were divided into codes and themes in line with the determined criteria. While performing data analysis, UNDP (2016) sustainable development goals were taken as criteria.

1. Firstly, the analysis started with the life studies curriculum. UNDP (2016) sustainable development goals content has been transferred to an excel file as in Figure 1.



A	B	C	D	E	F	G	H

UNSDG (2016)

"Sustainable Development Principles"
1 "No Poverty" HB.2.2.6. Investigates the contribution of the economical use of resources at home to the family budget.
. At school, he spends his money consciously in line with his needs.
While meeting his wishes and needs, he takes care to protect his own and his family's budget.
2 "Zero Hunger"
He is sensitive to people around him who need help.
Participates in social responsibility projects for the problems of people from different cultures living in our country.
Will be willing to participate in social assistance and solidarity activities at school.
3 "Good Health and Well-being"
.He regularly takes care of himself.
He realizes the precautions he should take to protect his health.
He chooses foods and drinks that are beneficial for his health.
It is fed following the meals and balanced throughout the day.
He prepares food for himself, observing the rules of cleanliness.
While using mass media, he takes care to protect his physical health.
4 Realizes the relationship between healthy growth and development and personal care, sports, sleep, and nutrition.
Prepares a list of meals suitable for a balanced diet

Figure 2. Data Analysis Contents.

2. Then, the outcomes of the life studies curriculum were listed in order of the unit, and the "goals and outcomes" that could be related and serve the same purpose were matched. For example, according to the UNDP (2016) principles, the "responsible production and consumption" target content is "LS.2.1.6. The outcomes of "Takes care in using school resources and belongings" is matched. The same analysis was made in the social studies curriculum and the results of the analyses were presented as a frequency table.

Validity and Reliability

Regarding the reliability of this study, Miles and Huberman's (1994) "encoder reliability formula (Reliability = Consensus / (Agreement + Disagreement)) was used. The research was conducted with the help of a social studies teacher who completed his PhD in a public school. The reliability between the encoder and researchers for the first sub-goal of the study was (Reliability= 47/(47+5)= 0.90).The encoder for the second sub-goal of the study" was used, and the reliability among researchers was. According to Miles and Huberman (1994), the research is considered reliable when the reliability agreement is 70% or higher.

Results

Sustainable Development in Life Studies Curriculum Outcomes

The outcomes related to the sustainable development goals in the life studies course curriculum are shown in Table 1.

Table 1.

Life Studies Course Curriculum

	"Sustainable Development Principles"	***Outcomes No***	***f***
1	"No Poverty"	LS.2.2.6. Investigates the contribution of the economical use of resources at home to the family budget. LS.2.1.11. At school, he spends his money consciously in line with his needs. LS.3.2.8. While meeting his wishes and needs, he takes care to protect his own and his family's budget.	3
2	"Zero Hunger"	LS.2.2.7. He is sensitive to people around him who need help. LS.3.5.7. Participates in social responsibility projects for the problems of people from different cultures living in our country. LS.3.1.7. Will be willing to participate in social assistance and solidarity activities at school.	3
3	"Good Health and Well-being"	LS.1.3.1. He regularly takes care of himself. LS.1.3.2. He realizes the precautions he should take to protect his health. LS.1.3.3. He chooses foods and drinks that are beneficial for his health. LS.1.3.4. It is fed following the meals and balanced throughout the day. LS.1.3.5. He prepares food for himself, observing the rules of cleanliness. LS.1.3.7. While using mass media, he takes care to protect his physical health. Realizes the relationship between healthy growth and development and personal care, sports, sleep, and nutrition.	15

		LS.2.3.2. Prepares a list of meals suitable for a balanced diet LS.2.3.6. Realizes the effects of seasonal fruit and vegetable consumption on human health. LS.3.6.2. Researches the growing conditions of fruits and vegetables. LS.2.3.7. Chooses clothes suitable for seasonal conditions. LS.1.1.8. Develops the habit of using the toilet and cleaning. LS.2.3.4. Explain the necessity of cleaning for a healthy life. LS.3.3.5. To protect the health of himself and the community, he obeys the rules of cleanliness and hygiene in common areas. LS.3.3.3. It is fed seasonal foods to maintain its health. LS.3.3.4. Adequate and balanced nutrition is required to maintain health.	
4	"Quality Education"	LS.3.1.6. Recognizes the individual and social contributions of the school.	1
5	"Gender Equality"		-
6	" Clean Water and Sanitation"		-
7	"Affordable and Clean Energy"		-
8	"Decent Work and Economic Growth"		-
9	" Industry, Innovation, and Infrastructure"		-
10	"Reduced Inequality"	LS.1.5.4. In our country, he realizes that he lives together with people from different cultures. LS.1.1.2. Distinguish the similarities and differences between himself and his peers. LS.2.1.2. Respects individual differences. LS.2.5.7. It respects the lifestyles and habits of people from different cultures living in our country. LS.3.1.8. Expresses their wishes and needs regarding the school in a democratic way in the school environment.	5

*f: Frequency

As seen in Table 1, the order of the outcomes related to the "sustainable development goals" in the 1st, 2nd, and 3rd-grade outcomes of the life studies curriculum is as follows: It is seen that the outcomes are mostly related to the goal of “health and quality life” (f=15). It is followed, in descending order, by “responsible production and consumption” (f=12); “climate action” (f=7) goals; “life on land, reducing inequalities (f=5); “no poverty, end hunger” (f=3); “quality education” (f=1).

In Figure 3, 4, and 5; sample activities that include the outcomes of the Sustainability Development Goals from the Life studies textbooks are given.

Personel Care

I use water sparingly while taking a bath.

I don't waste water on the toilet.

When brushing my teeth, I use enough toothpaste.

When I wash my hands, I don't waste water

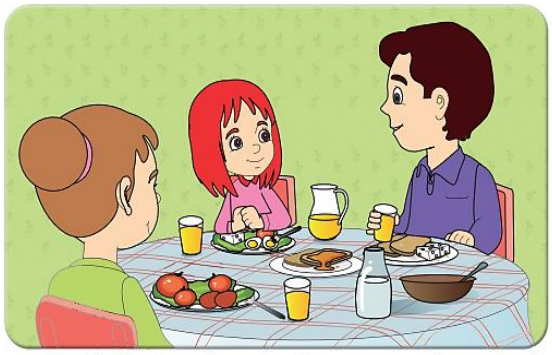
Figure 3. Primary School 3rd-Grade Life Studies Textbook (Çelikbaş, Gürel, & Özcan, 2018, p. 78).

As seen in Figure 3, there is content related to more than one topic at the event "sustainable development" principle. It is clear that this event, regarding the conscious use of resources and the importance of cleanliness, is related to the goals under the headings of "Good Health and well-being, sustainable societies" according to the UNDP (2016) goals.

Compare the correct and incorrect behaviors by examining the images below. What are our responsibilities to keep our classroom clean?

Figure 4. Primary School 3rd-Grade Life Studies Textbook (Çelikbaş et al., 2018, p. 87).

As seen in Figure 4, the activity is related to the goal of "Good health and well-being" based on environmental awareness and responsibility values.



– Evet, evimizdeki ekmek israfını önlemek için annemin bayat ekmeklerle yapabileceği yemek tarifleri bulabiliriz.

Annesi:

– Defne önerin çok güzel. Böylece evimizde ekmek israfını önlemiş oluruz. Bununla beraber diğer kaynakları da tasarruflu kullanmalıyız. Çamaşır ve bulaşık makinelerini tam dolu olarak çalıştırırsam elektrik ve sudan tasarruf etmiş oluruz.

Babası:

– Ben de lambaları tasarruflu ampullerle değiştirmeli ve damlatan muslukları en kısa sürede tamir etmeliyim.

We can find meals that our mother can make with stale bread to avoid wasting bread at home…

Figure 5. Primary School 3rd-Grade Life Studies Textbook (Çelikbaş et al., 2018, p. 59).

In Figure 5, the activity includes information about "saving" and efficient and conscious use of resources. It can be stated that the event is related to the principle of "responsible production, consumption and no poverty", one of the UNDP (2016) goals.

Research the production activities located near you. Plan a trip with your teacher.

What production activities are there in your neighborhood? Please mark it.

Figure 6. Primary School 2nd-Grade Life Studies Textbook (Dokumacı, Özdemir-Gök, and Dokumacı, 2018, p. 201).

In Figure 6, there is a trip event in which the production activities in our country are reflected on-site. It can be stated that the event is related to the principle of "responsible production, consumption and no poverty" from the UNDP (2016) goals.

Sustainable Development in Social Studies Curriculum Outcomes

The outcomes related to the sustainable development goals in the social studies course curriculum are shown in Table 2.

Table 2.

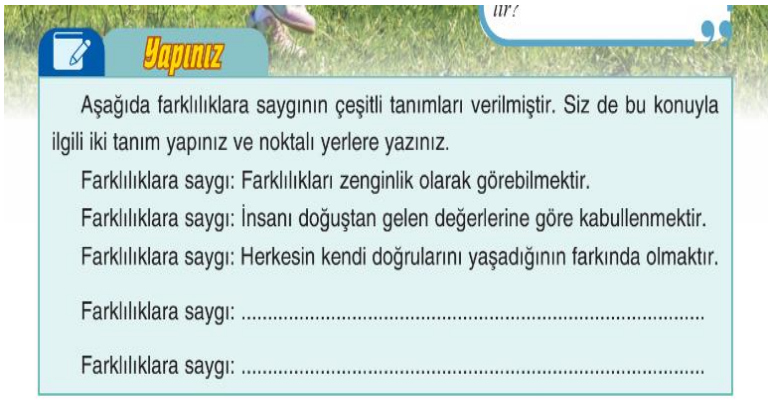
Social Studies Course Curriculum

	"Sustainable Development Principles"	*Outcomes No*	*f*
1	"No Poverty"	SS.4.5.4. Creates a sample budget of its own. SS.4.5.5. It uses the resources around it without wasting them.	2
2	"Zero Hunger"	-	-
3	"Gender Equality"	-	-
4	"Clean Water and Sanitation"	-	-
5	"Affordable and Clean Energy"	-	-
6	"Decent Work and Economic Growth"	-	-
7	"Industry, Innovation and Infrastructure"	-	-
8	"Gender Equality"	-	-

9	"Clean Water and Sanitation"	-	-
10	"Reduced Inequality"	SS.4.1.4. He puts himself in the shoes of other individuals with different characteristics. SS.4.1.5. Respect the different characteristics of other individuals. SS.4.7.3. Compares the cultural elements of different countries with the cultural elements of our country. SS.4.7.4. Respect different cultures.	4
11	"Responsible Consumption and Production"	SS.4.3.6. Makes necessary preparations for natural disasters. SS.4.6.1. He gives examples of the rights he has as a child. SS.4.6.4. Explain the relationship between the independence of his country and individual freedom	3
12	"Climate Action"	SS.4.4.5. Uses technological products without harming himself, others, and nature. SS.4.5.2. Recognizes the main economic activities in his family and close environment. SS.4.5.1. Makes conscious choices between the two by distinguishing between wants and needs. SS.4.5.3. Exhibits conscious consumer behavior as a responsible individual.	4
13	"Life Below Water"	SS.4.3.4. Observing the weather events occurring around him, he transfers his findings to illustrated graphics. SS.4.3.6. Makes necessary preparations for natural disasters.	2
14	"Life on Land"	-	-
15	"Peace and Justice Strong Institutions"	SS.4.3.3. Distinguish the natural and human elements in the living environment.	1
16	"Partnerships to achieve the Goal"	-	-
17	" Responsible Consumption and Production"	-	-

*f: Frequency

As seen in Table 2, in the case of primary school 4th grade Social Studies curriculum outcomes being related to sustainable development goals, the outcomes related to the goals of "responsible production and consumption and reducing inequalities" (f=4) come first. It was followed by the outcomes of “sustainable cities and societies” (f=3), respectively. It was ranked last concerning the goals of “end poverty and climate action (f=2) and “life on land” (f=1). In Figure 7, 8, and 9; sample activities that include outcomes related to sustainable development goals from social studies textbooks are given.



Different definitions of respect for differences are given below. Make two definitions about respect for differences and write them in the blanks.

Figure 7. Primary School 4th-Grade Social Studies Textbook (Tüysüz, 2018, p. 30).

In the activity shown in Figure 7, various definitions of the value of "respect for differences" were made and the students were asked to continue. This event coincides with the UNDP (2016) “reducing inequalities” goals.

What else do you think could be in the earthquake kit?

Figure 8. Primary School 4th-Grade Social Studies Textbook (Tüysüz, 2018, p. 86).

As seen in Figure 8, the activity is aimed at preparing earthquake bags. The students are asked what should be in the earthquake kit and what could be things that are not needed. It can be stated that the event is related to the UNDP (2016) “sustainable cities and societies” goal.

ZARAR VERMEDEN KULLANALIM.

“Teknolojik ürünleri kullanırken kendimize, başkalarına ve doğaya zarar verebiliriz.” diyen bir kişi bu sözüne kanıt olarak hangi durumları örnek gösterebilir?

Teknolojik ürünlerin neredeyse tamamı elektrikle çalıştığı için etrafa insan sağlığına zararlı elektromanyetik dalgalar yayıyor. Özellikle cep telefonları, bilgisayarlar, kablosuz modem, kulaklık, fare ve klavyeler ile uzaktan kumandaların yaydıkları elektronik dalgalar bizleri olumsuz etkiliyor. Örneğin cep telefonları beyin ısısını arttırarak beyin hücrelerimizin ölmesine ve kulağımızın zarar görmesine yol açabiliyor. Bu da duyma kayıpları ve denge bozuklukları gibi ciddi sağlık sorunlarını ortaya çıkarabiliyor.

Teknoloji firmaları ürettikleri ürünlerin yanlış kullanımını önlemek amacıyla çeşitli önlemler alır. Bu önlemlerin başında kullanım kılavuzları gelir. Bunun içindir ki kullanıcılar yeni bir teknolojik ürün aldıklarında ilk iş olarak o ürünün kullanım kılavuzunu incelemelidir. Aşağıda bir cep telefonunun kullanım kılavuzundan alınmış bazı bölümler görüyorsunuz.

Let's use it without harm

A person who says that we can harm ourselves, our environment and nature while using technology products can give an example of this statement as evidence?

Figure 9. Primary School 4th-Grade Social Studies Textbook (Tüysüz, 2018, p. 114).

As seen in Figure 9, the negative situations that may arise from the use of efficiency technology outside its purpose are explained. Particular attention was paid to the harm it can cause to humans and nature. In this respect, it is clear that the event is in line with the UNDP (2016) “responsible production and consumption” goals.

Discussion and Conclusion

In this research, the relationship with the UN sustainability goals was analyzed based on the outcomes of life studies and social studies courses. The first findings of the study indicate that the outcomes of the life studies course are quantitatively higher with the sustainable development goals than the outcomes of the 4th-grade social studies course. This finding reached in the study may be because the study is parallel with the quantity of the sample group. Because life studies course is given in the 1st, 2nd and 3rd class; in the social studies course, only the outcomes of the 4th grade were analyzed. In addition to this, it was observed that there are outcomes that are indirectly related to sustainable development goals in life studies course outcomes. In addition, it was observed that the outcomes compatible with the sustainability "responsible production and consumption" goals in the life studies course curriculum were the most. However, it has been observed that there is no direct or indirect gain related to goals such as “gender inequality, decent work, and economic growth”. This

finding of the research supports the results obtained from the study of Dinçol-Özgür (2020), which evaluated primary education programs according to the UN 2030 goals.

Findings related to the second sub-purpose of the study, it has been determined that the outcomes related to the objectives of "responsible production and consumption and reducing inequalities", such as the results achieved in the life studies lesson, are in the first place in the primary school 4th-grade social studies lesson outcomes. This finding of the study coincides with the findings of Kaya and Tomal (2011) in their study. However, while there are outcomes related to the goal of "reducing inequalities", no outcomes have been found regarding the principle of "gender inequality". In addition, the social studies course is goal-based by its nature. When evaluated in this context, the results of the research show that primary school 4th-grade social studies outcomes are partially indirectly related to the UN sustainability goals, but directly or indirectly supporting objectives such as "quality education, decent work, and economic growth, peace, justice, and strong institutions"can be stated as necessary. When evaluated in this context, life studies and social studies courses can be considered as courses that should address sustainability goals in a “social dimension”.

It is essential that these courses, which have the aim of "raising responsible and good citizens" as their main objectives, convey the activities that support the social dimension of sustainability goals to the students. This social dimension, of course, becomes active with how social and life studies lessons are integrated into the classroom rather than the curriculum. According to the examples given from the textbooks to support the findings of this research, life studies and social studies lessons were reflected in activities such as sustainable development goals in the curriculum. Ellien et al. (2018) stated in their studies that practices are more effective in integrating sustainable topics and ways of thinking into the classroom and in realizing their sustainability goals. In literature studies (Arslan & Yağmur, 2022; Demir, 2023; İşler, 2023) it was found that teachers are not sufficiently knowledgeable about sustainability. Teachers should be trained about this issue since they implement the curriculum.

Recommendations

In this study, the outcomes of life studies and social studies courses, the main objectives of which are "to give students life skills" and "to raise good citizens", were examined in terms of UN sustainable development goals. The limitation of the research is the data obtained from the primary school life science and primary school 4th grade social studies curriculum outputs. Based on these limitations, it can be said that the life studies and social studies course curricula that adopt an

interdisciplinary teaching approach are partially compatible with the sustainability goals, based on the overall research. In light of the results of the research, it has been suggested to curriculum developers that the outcomes can be presented about more than one goal and that sustainability as an interdisciplinary education can be transferred to the students in a richer way.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interests.

Funding

No funding was received.

Ethical Standards

We have carried out the research within the framework of the Helsinki Declaration.

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Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Sağar, M. E., & Sağar, S. (2023). Predictors of smartphone addiction in teacher candidates: self-control and communication skills. *Osmangazi Journal of Educational Research, 10*(1), 47-62.

Submitted: 07/02/2023 **Revised:** 09/04/2023 **Accepted:** 04/08/2023 **DOI:** 10.59409/ojer.1248743

Predictors of Smartphone Addiction in Teacher Candidates: Self-Control and Communication Skills

*** Mehmet Enes Sağar, **Süleyman Sağar**

Abstract. In this study, the predictive role of self-control and communication skills on smartphone addiction levels of teacher candidates was examined. The research was conducted based on the relational survey model. The research group consisted of 378 teacher candidates, 181 (45.9%) males and 197 (54.1%) females. The age range of the research group is between 18-29 and the average age is 21.96. "Smartphone Addiction Scale-Short Version", "Brief Self-Control Scale", "Communication Skills Scale" and "Personal Information Form" were used as data collection tools. The data obtained in the study were analyzed by the multiple linear regression analysis (stepwise) method. As a result of the research, it was determined that the variables of self-control and communication skills significantly predicted smartphone addiction.

Keywords. Teacher candidates, smartphone addiction, self-control, communication skills.

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As a result of global developments in information, communication and internet opportunities, smart phones have become one of the indispensable parts of life. Smartphones offer many conveniences to individuals such as communication, entertainment, digital camera, information and document sharing, education, easy access to the internet and touch operation. This situation seriously affects the lives of individuals and causes them to use smart phones problematically. Smartphone addiction draws attention as one of these negative effects (Panova & Carbonell, 2018; Sağar, 2022a, 2022b; Kwon et al., 2013a; Kwon et al., 2013b).

Smartphone addiction, which is described as one of the generalized internet addictions (Chen et al., 2020), is defined as people encountering problems in their daily life activities due to excessive and problematic smartphone use (Kwon et al., 2013a; Kwon et al., 2013b). In other words, the inability to regulate the use of a smartphone causes negative consequences and clinical deterioration in daily life (Billieux, 2012). Although it is described as behavioral addiction by some researchers (Haug vd., 2015; Kwon vd., 2013b) and problematic smartphone use by some researchers (Panova & Carbonell, 2018), it is seen that there is no diagnosis of smartphone addiction in the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) yet. Although a diagnosis of smartphone addiction is not made in this book, a diagnosis of "game disorder on the Internet" is included (APA, 2013). This diagnosis is considered as a positive step on the subject of smartphone addiction and research to be carried out in this field (Sağar, 2022a, 2022b). Although there is no diagnostic and diagnostic criteria in DSM-V yet, diagnostic criteria are recommended by some important researchers regarding smartphone addiction. These criteria are a) being busy with smartphone use throughout the day, b) developing tolerance in the tendency to use the smartphone more with the increase in smartphone use, c) being aware of the harmful effects that may occur due to excessive use of the smartphone and not limiting the use of smartphones, d) smartphone use. feeling anxious and restless when not in use, wanting to use the smart phone severely, e) experiencing smart phone deprivation, f) feeling the need to check the smart phone by waking up repeatedly during sleep, g) tending to sleep with the phone (Alosaimi et al., 2016; Kwon et al., 2013a; Lanaj et al., 2014). In this context, smartphone addiction can be expressed as a problem that leads to loss of control and control of the person and loss of functionality in personal, social and other vital areas of activity due to unhealthy smartphone use (Sağar, 2022a, 2022b).

Smartphones with users of all ages are widely used, especially among young population and university students (Boumosleh & Jaalouk, 2018; Roberts et al., 2014). In addition to communication, smart phones have many different features such as fast message transmission, fast access to the

internet and social media, having multimedia players, playing games, having electronic books and photo albums, and using cameras (Ting & Chen, 2020). When the literature is examined, findings proving that smartphone addiction is related to different issues such as stress, anxiety, depression, loneliness, subjective well-being, psychological well-being, life satisfaction, happiness have been found (Choi & Kim, 2018; Hawi & Samaha, 2017; Kim et al., 2019; Kim & Choi, 2017; Kwon & Paek, 2016; Mahapatra, 2019; Tangmunkongvorakul et al., 2019; Wu et al., 2020). Considering the variables examined in the current studies in the literature, it is thought that the variables of self-control and communication skills in this study will offer a different alternative perspective to other studies. For these reasons, in this study, the relationships between self-control and communication skills variables and smartphone addiction and how these variables predict smartphone addiction were examined.

The first of the variables examined as a predictor of smartphone addiction in this study is self-control. Self-control, which is described as an effort to control oneself, is expressed as a central function of the self and an important key to success in life (Baumeister et al., 2007). Self-control is defined as successful overriding of one's impulses (Baumeister et al., 1998). It is also described as making one's reactions conform to certain standards such as moral values and social expectations (Baumeister et al., 2007). It is the ability of people to delay their instant gratification, not act impulsively, and regulate their physical and emotional reactions (Rosenbaum, 1980). It is also the ability to direct one's own behavior towards more appropriate ways (Baumeister et al., 1994). According to Rosenbaum (1980), there are four dimensions for a person to develop self-control. These dimensions are a) using one's own instructions to control physiological and emotional reactions, b) applying strategies for problem solving, c) the ability to delay instant gratification to achieve high-level goals, and d) perceived self-efficacy. Self-control, the ability to exercise control over the self, is critical to central human behavior in achieving one's goals, successfully fulfilling one's duties, and in the overall organization of one's life (Baumeister et al., 1998). In general terms, self-control refers to the ability to suppress or change one's internal impulses and to avoid undesirable behavioral tendencies and avoid doing those (Tangney et al., 2004). In this context, self-control can be expressed as self-control and discipline against one's desired impulses (Sağar, 2021a, 2021b). Otherwise, low self-control leads to many behavioral problems, including severe antisocial behavior (Baumeister & Heatherton, 1996). In this context, when the subject is evaluated within the scope of the research, it can be said that teacher candidates who cannot regulate themselves by controlling their instant impulses can limit other life areas by focusing on a single life area such as smartphone

addiction, cannot regulate themselves, and therefore exhibit some problematic behaviors. Therefore, it is thought that smartphone addiction may be related to the self-control variable

Another variable that is thought to be related to the smartphone addiction variable in this study is communication skills. Communication refers to the ability to interact in a quality manner using verbal and nonverbal methods or the process of exchange of meaning between the informant and the person receiving the information (Chen & Starosta, 1996; Seiler & Beall, 2005). Stewart et al. (2005) emphasize that the quality of communication is directly related to the quality of life. At this point, communication skills are of great importance in terms of a quality life and healthy communication. Communication skills are some of the skills that can be learned and taught, such as being understood, understanding, respecting, and conveying emotions and thoughts correctly. (Egan, 1994; Johnson, 1996; Verdener, 1999). In general terms, communication skills that enable a healthier communication are the ability to listen and react effectively (Egan, 1994). Considering the time period in which communication skills are important for a quality life, smart phones, one of the modern communication tools of the age, have many communication features and besides making phone calls to their users, information, entertainment, taking photos and videos, meeting, messaging, entering social networks. It offers many features such as sharing and surfing the internet (Haug et al., 2015; Kwon et al., 2013a; Kwon et al., 2013b; Sağar, 2022a, 2022b). In this way, smart phones provide active communication to their users through communication applications (such as social networks). As a matter of fact, people who have communication problems have difficulty talking to other people, causing problems in establishing personal relationships in the real world and a desire to seek alternatives. This situation leads to a decrease in the communication skills of the person, a qualitative change in the personal relationships of the person, and together with the anonymity feature in the virtual world, it can cause smartphone addiction (Sok et al., 2019). When the subject is evaluated within the scope of the research, it can be said that teacher candidates who cannot regulate their responsibilities and human relations by being caught up in the communicative and other features of smartphones may face a problem such as smartphone addiction. Therefore, it is thought that smartphone addiction may be related to the variable of communication skills.

Smartphones, which spread globally and have users of all age levels, can threaten the mental health of individuals by causing loss of function in different areas. In terms of teacher candidates, smartphone addiction can be considered as an important problem that needs to be emphasized. For this reason, it is thought that revealing the variables that may be related to smartphone addiction in teacher candidates will contribute to a better understanding of this problem and to preventive and

curative mental health studies to be carried out in this context. In the literature review conducted on smartphone addiction, it has been determined that there are studies that examine smartphone addiction with different variables. In addition to and alternatively to these studies, the research conducted in terms of examining the smartphone addiction variable with the variables of self-control and communication skills is considered important and valuable for the field. In this context, the aim of the study was to examine how self-control and communication skills variables predicted the smartphone addiction levels of teacher candidates. In the research conducted for this purpose, do the variables of self-control and communication skills significantly predict the smartphone addiction levels of teacher candidates? The answer to the question has been sought.

Method

Research Model

The research was conducted based on the relational screening model. The relational screening model is a research model for determining the existence or degree of co-variance between two or more variables (Karasar, 2016).

Study Group

The research group of this study consisted of a total of 378 teacher candidates, 181 (45.9%) male and 197 (54.1%) female, studying at different universities in Turkey in the 2021-2022 academic year. The age range of the research group is between 18-29 and the average age is 21.96.

Data Collection Tools

Smartphone addiction scale- short version. The Turkish adaptation of this scale developed by Kwon et al. (2013), was made by Noyan et al. (2015). This scale aims to determine the smartphone addiction levels of individuals. It is in 5-point Likert type and consists of 10 items in total. The points that can be taken from the scale are 10-60. The internal consistency of the scale was calculated as .86. In this study, the internal consistency of the total scores of the scale was determined as .91 and the McDonald's Omega (ω) reliability coefficient value was determined as .91.

Brief self-control scale. The Turkish adaptation of this scale developed by Tangney et al. (2004) was made by Nebioglu et al. (2012). This scale aims to determine the self-control levels of individuals. It is in 5-point Likert type and consists of a total of 13 items. The scores that can be obtained from the scale are 13-65. The internal consistency of the scale was calculated as .83.

(Nebioglu et al. 2012). In this study, the internal consistency of the total scores of the scale was determined as .69 and the McDonald's Omega (ω) reliability coefficient value was determined as .69.

Communication skills scale. It was developed by Korkut-Owen and Bugay (2014). This scale aims to determine the communication skills levels of individuals. It is in 5-point Likert type and consists of 25 items in total. The points that can be taken from the scale are 25-125. The internal consistency of the scale was calculated as .89. (Korkut-Owen & Bugay, 2014). In this study, the internal consistency of the total scores of the scale was determined as .92 and the McDonald's Omega (ω) reliability coefficient value was determined as .92.

Personal information form. The personal information form was created in order to learn the gender and age information of the research group.

Data Collection

Research data was collected via Google Form online method. In this direction, data collection tools prepared via Google Form were sent via e-mail and teacher candidates were invited to the research. Participation of volunteers in the study was based on, and informed consent was obtained from the individuals before participating in the study. In addition, the confidentiality principle was taken into account during the data collection process and individuals were informed about this issue. The online data collection process took fifteen days.

Data Analysis

In the study, firstly, the normality and linearity of the data sets were evaluated to determine whether the data were suitable for multiple linear regression analysis. The presence of extreme values that make the normality (multivariate) and linearity assumptions difficult was examined according to mahalanobis distance (16.27), cook's (Cook'<1) and leverage values (.000 - .020). In addition, the data sets were examined in terms of kurtosis, skewness values (+1/-1), scatter and histogram graphics. In addition to meeting the linearity and normality conditions of the data sets, the sample size was also found to be appropriate based on the number of predicting variables. Another assumption of the multiple linear regression analysis was the absence of a high correlation coefficient between the predictor variables, and it was observed that there was no correlation value above .80, which can be defined as multicollinearity between the predictor variables (Table 2). It was determined that tolerance values were higher than .20, VIF values were less than 10 and CI values were less than 30. The Durbin-Watson value was examined to examine the condition of the errors being independent, and it was seen that the value was between 1 and 3 (DW = 1.89) and it was not a problem. It was

determined that the data obtained depending on the examinations were suitable for multiple linear regression analysis. The data obtained in the study were analyzed with the multiple linear regression analysis (stepwise) method. The significance level of .05 was used in the study (Akbulut, 2010; Büyüköztürk, 2011).

Ethics

Ethics committee approval was received from Afyon Kocatepe University Social and Human Sciences Scientific Research and Publication Ethics Committee for the research (Decision Date: 30.09.2022, Meeting: 09, Number of Documents: 129420).

Results

In this part of the study, first the arithmetic mean and standard deviation values of the variables, then the simple correlation analysis coefficients and finally the multiple linear regression analysis (stepwise) results are given. The arithmetic mean and standard deviation values are given in Table 1.

Table 1.

Arithmetic Mean and Standard Deviation Values

	N	$\bar{X}$	**SS**
Smartphone Addiction (S.A.)	378	31.57	13.94
Self-Control (S.-C.)	378	54.33	45.53
Communication Skills (C.S.)	378	98.04	12.43

When Table 1 is examined, the arithmetic mean and standard deviation values of the research group were determined as smartphone addiction ($\bar{X}$ = 31.57; *SS* = 13.94), self-control ($\bar{X}$ = 54.33; *SS* = 45.53) and communication skills ($\bar{X}$ = 98.04; *SS* = 12.43). The relationships between smartphone addiction, self-control, and communication skills were examined using a simple correlation analysis method and the results are given in Table 2.

Table 2.

Simple Correlation Analysis Coefficients for Variables

	S. A	S.-C.	C.S.
Smartphone Addiction (S.A.)	-		
Self-Control (S.-C.)	-.405**	-	
Communication Skills (C.S.)	-.318**	.214	-

**p<.01

When Table 2 is examined, it has been determined that there is a significant negative relationship between smartphone addiction and self-control (r = -.405, p < .01), and a negative

significant relationship between smartphone addiction and communication skills (r = -.318, p < .01). In addition, when Table 2 is examined, it is seen that there is no correlation value above .80, which can be defined as multicollinearity among the predictive variables. Then, stepwise multiple regression analysis values were examined to reveal the predictive power of self-control and communication skills variables on smartphone addiction, and the results are given in Table 3.

According to the ANOVA table examined in the next step, it was determined that the explained variance or regression model was statistically significant ($F_{1/376}$ = 73.93; $F_{2/375}$ = 52.97; p < .01). In this context, it can be said that the predictor variables successfully performed the prediction process on the model.

Table 3.

Multiple Linear Regression Analysis (Stepwise) Results on Predicting Smartphone Addiction

Model		**UC**	**SC**							
	B	***Std. Error***	***Beta***	***t***	***Zero-Order***	***Partial***	***R***	***R^2***	***F***	***Sd***
1. (C.)	38.323	1.02		37.47**						
S.-C.	-.124	.014	-.405	-8.59**	-.405	-.405	.405[a]	.164	73.93**	1/376
1. (C.)	64.087	5.06		12.65**						
S.-C.	-.108	.014	-.353	-7.57**	-.405	.364	.469[b]	.220	52.97**	2/375
C.S.	-.272	.052	-.242	-5.18**	-.318	-.259				

Not: **p<.01, S.-C.: Self-Control, C.S.: Communication Skills, (C.): Constant

According to Table 3, self-control and communication skills variables were included in the multiple linear regression analysis (stepwise) process, as they significantly predicted smartphone addiction. According to beta and correlation (binary/partial) values, there is a significant negative correlation between the smartphone addiction variable and the variables of self-control and communication skills. Self-control and communication skills variables together explain approximately 22% (R = .469; R^2 = .220, p < .01; $F_{2/375}$ = 52.97; p < .01) of the total variance regarding smartphone addiction.

In the first step of the multiple linear regression analysis (stepwise), it was determined that the beta coefficient of the self-control variable in predicting smartphone addiction was -.405, and the *t*-test result of the significance of the beta coefficient was also found to be at a significant level

(t = -8.59, p < .01). The self-control variable alone explains approximately 16% of smartphone addiction (R = .405; R^2 = .164; $F_{1/376}$ = *73.93*; p < .01).

In the second step of the multiple linear regression analysis, besides the self-control variable, the communication skills variable was also included in the model. Self-control and communication skills variables together explain approximately 22% of smartphone addiction (R = .469; R^2 = .220, p < .01; $F_{2/375}$ = 52.97; p < .01). The beta coefficient of the self-control variable was -.353; The beta coefficient of the communication skills variable was found to be -.242. In addition, it was determined that the t test results of the significance of the beta coefficient were also at a significant level (t_{SC} = -7.57, p < .01 / t_{CS} = -5.18, p < .01).

As a result of the multiple linear regression analysis (stepwise), it was seen that the variables of self-control and communication skills significantly predicted smartphone addiction. Considering the beta values of the variables in the model, it was determined that "self-control" in the first place and "communication skills" in the second place significantly predicted smartphone addiction.

Discussion and Conclusion

In this study, the predictive role of self-control and communication skills on smartphone addiction levels of teacher candidates was examined. According to the results of the research, it was determined that there was a significant negative correlation between the smartphone addiction variable, self-control and communication skills variables. In addition, as a result of this study, it was seen that the variables of self-control and communication skills were significant predictors of the smartphone addiction variable. Self-control and communication skills variables together explain approximately 22% of the total variance regarding smartphone addiction. It was determined that "self-control" and "communication skills" variables predicted smartphone addiction significantly, respectively.

As a result, it was determined that the self-control variable significantly predicted the smartphone addiction of teacher candidates and there was a significant negative correlation between them. In other words, it can be said that as the self-control level of teacher candidates increases, the level of smartphone addiction decreases. In this case, it can be said that teacher candidates with high self-control levels experience less smartphone addiction problems. In line with this result, when the literature was examined, it was seen that the results of the research conducted by Cho et al. (2017), Geng et al. (2021), Ju et al. (2019), Kim et al. (2016), Lee and Park (2014), Sok et al. (2019) supported the results of this research that as the level of self-control increases, the level of smartphone addiction

decreases. Self-control is characterized as consciously suppressing one's unwanted actions, consciously following one's own action, and automatically restricting one's actions (Muraven & Baumeister, 2000). The fact that the person has a high level of self-control shows that he is in an effort to control himself, he can successfully invalidate his impulses, he can make his behavior comply with some standards such as moral values and social expectations, he is not behaving impulsively, and he can regulate his physical and emotional reactions (Baumeister et al., 1998; Baumeister et al., 1994; Baumeister et al., 2007). In this context, a person's high self-control may help him/her reduce his/her smartphone addiction. As a matter of fact, Heo and Lee (2018) emphasize that in order to manage smartphone addiction, it is necessary to encourage healthy use of smartphones and strengthen self-control. In addition, Lee and Park (2014) draw attention to the importance of developing self-control programs in individuals instead of making strict restrictions on smartphone use. When the current results in the literature and the result of this study are evaluated as a whole, it can be said that individuals who can provide self-control, which expresses self-control by self-regulation, can reduce smartphone addiction. In this context, it is thought that a high level of self-control has an important function in reducing the level of smartphone addiction of teacher candidates. In summary, it is expected that increasing self-control in teacher candidates can help reduce smartphone addiction.

According to another result reached in this study conducted with teacher candidates, it was determined that the variable of communication skills significantly predicted the smartphone addiction of teacher candidates and there was a significant negative correlation between them. In other words, as the level of communication skills of teacher candidates increases, the level of smartphone addiction decreases. In this case, it can be said that teacher candidates with high communication skills experience less smartphone addiction problems. In the context of this result, when the literature is examined, it is seen that the results of this research support the results of the studies conducted by Ayar and Gürkan (2022), Cerit et al. (2018), Kim et al. (2017); Khasanah and Daulay (2022), as the level of communication skills increases, the level of smartphone addiction decreases. Communication skills refer to all the skills that can be learned and taught in terms of both understanding and understanding verbal and non-verbal methods and realizing a healthy interaction (Chen & Starosta, 1996; Egan, 1994; Johnson, 1996; Seiler & Beall, 2005; Verdener, 1999). Having high communication skills can help reduce smartphone addiction. As a matter of fact, Kim et al. (2017) draw attention to the importance of communication skills in order to reduce smartphone addiction and regulate smartphone use. When the results of the studies in the literature and the result obtained

from this study are evaluated as a whole, it can be said that individuals who can establish and maintain healthy relationships by using their communication skills can reduce their smartphone addiction. In this context, it is thought that high-level communication skills are important in reducing the level of smartphone addiction of teacher candidates. In summary, it is expected that increasing the communication skills of teacher candidates can help reduce smartphone addiction.

Recommendations

This research revealed an important result regarding the self-control and communication skills variables being related to and predicting smartphone addiction. In addition, the research has some limitations. These limitations are some limitations such as having only teacher candidates in the research group, examining only the variables of smartphone addiction and self-control and communication skills, and conducting the research with quantitative data. In this direction, a similar study can be conducted on different research (primary and secondary school students, adolescents, university students, candidates for different professions, etc.) groups other than teacher candidates. In this study, smartphone addiction and only self-control and communication skills variables were examined, and other related psychological factors were not examined. In other studies to be conducted, the predictor of other variables on smartphone addiction can be examined. This study is a cross-sectional study. Therefore, this research does not reveal the cause-effect relationships between smartphone addiction and self-control and communication skills. In other studies, the cause-effect relationships between smartphone addiction and self-control and communication skills can be examined more comprehensively by using experimental methods. With this study, it was tried to both confirm the previous findings related to smartphone addiction studies and to reach original data about the prediction of smartphone addiction by self-control and communication skills. In this context, interventions aimed at increasing the level of self-control and communication skills of teacher candidates in their efforts to increase smartphone addiction can also be tried on smartphone addiction. Intervention programs and counseling activities can be prepared and practiced so that teacher candidates acquire variables that can help reduce the factors that may cause problems in their personal, social, academic and professional development, such as smartphone addiction, and accordingly can regulate themselves. On this subject, studies can be carried out to reduce the smartphone addiction of teacher candidates and to regulate their use of smartphones through group studies, seminars and training programs.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

The authors have carried out the research within the framework of the Helsinki Declaration

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Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Zora Öztürk L., & Saban Anapa, P. (2023). Examination of eighth grade students' statistical reasoning skills regarding pie chart. *Osmangazi Journal of Educational Research, 10*(1), 63-90.

Submitted: 27/02/2023 **Revised:** 09/08/2023 **Accepted:** 12/08/2023 **DOI:** 10.59409/ojer.1257451

Examination of Eighth Grade Students' Statistical Reasoning Skills Regarding Pie Chart

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Abstract. The aim of the study is to examine in depth the eighth-grade students' levels of statistical reasoning by pie chart by using "The Middle School Student Statistical Thinking Model". The study used the case study design, which is a qualitative research method. The study group consists of three eight-grade students attending a public school in İstanbul, Turkey. The activities developed by the researchers, the clinical interviews based on activities and the researcher notes were used as the data collection tools. The results indicated that in the process of describing data, the students' statistical reasoning levels decrease from high academic achievement to low academic achievement. In addition, the sub-process with the lowest reasoning levels of the students is to determine the effectiveness of data display types that representing data. It was determined that the most significant differentiation between the reasoning levels of the students is in the process of analyzing and interpreting data. Students mostly had difficulties in the sub-process of making inferences about a data display. In line with the finding of the study, recommendations for future studies were presented.

Keywords. Statistical reasoning, statistics education, M3ST Model, reasoning process.

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Note: This study is a part Leyla Öztürk Zora's master's thesis named "The Investigation of the Statistical Reasoning Levels of 8th Grade Students" completed in Eskişehir Osmangazi University in 2019.

In today's information society, statistical information emerges in a wide range of areas, such as population census, weather forecasts, election results, inflation rates, and fluctuations in the stock market. Individuals encounter these statistical data in newspapers, magazines, television, news websites, economic sections, or scientific articles, and they are required to think, interpret, and make inferences based on this data. In other words, reasoning on statistical information and data has become an indispensable part of daily life in contemporary conditions.

The fact that statistical information has an important place in real life and the necessity of being individuals who are productive, comprehend what they read, interpret the data they have, and make inferences has been demonstrated in studies conducted in the field of education (Gaise, 2016; Gal, 2002; Koparan, 2013; NCTM, 2000). For this reason, the importance of statistics and statistics education has started to be emphasized more in the mathematics curricula of most countries (CCSSI, 2010; MEB, 2018; NCTM, 2000; NGSS, 2013). Although there are ongoing questions about the nature of mathematics and how it should be taught, there is a strong consensus about the direction in which statistics education is heading at all grade levels (Greer, 2000). Because statistics is basically a process in which students collect data for problem situations, consider the reasons for data collection, how to organize the data, and the inferences that can be made (Cockcroft, 1982 as cited in Yıldız, 2022). However, studies indicate that students are unable to use statistical reasoning in a meaningful way because of the emphasis on calculation type studies in educational environments (Ben-Zvi and Garfield, 2004; McGatha, Cobb and McClain, 2002; Utts, 2003). Because statistical reasoning is not just about performing statistical calculations or defining concepts; it involves interpreting, reasoning, making inferences and generalizations based on data and graphical representations (Garfield and Ben-Zvi, 2008; Lovett, 2001; Mooney, 2002). In addition, conceptual understanding of important ideas such as graphical representations, measures of central tendency and distribution, and the relationship between variables are at the core of statistical reasoning (Kazak, 2015).

In the literature, there are various frameworks that have been put forward to examine the statistical reasoning processes of individuals at different levels of education and that deal with statistical reasoning in different aspects. For instance, Wild and Phannkuch (1999) focused on the thinking processes of higher education students in solving statistical problems. They defined a research cycle called the PPDAC (Problem, Plan, Data, Analysis, Conclusion) model for solving statistical problems in a real-life context. Chan, Ismail and Sumintono (2016) and Groth (2003) defined a framework to examine high school students' statistical reasoning processes. Chan et al.

(2016)'s statistical reasoning framework is defined as five levels of statistical reasoning and four key constructs which are describing data, organizing and reducing data, representing data, and analyzing and interpreting data. In addition to these four key constructs, Groth (2003) includes the process of "collecting data" in his framework. Mooney (2002) developed the Middle School Student Statistical Thinking (M3ST) framework to investigate middle school students' statistical reasoning processes. This model is based on the framework previously developed by Jones, Thorton, Langral, and Mooney (2000) for elementary school students.

In the study, Mooney's (2002) M3ST framework for middle school students was used. M3ST framework includes the four key statistical processes mentioned above, as well as sub-processes defined within each statistical process. "Describing data" process is the ability to read data in different visual displays; "organizing and reducing data" refers to arranging data using measures of center and spread; "representing data" is the capacity to construct different visual displays of the same data; and "analyzing and interpreting data" involve making inferences and predictions about statistical data (Mooney, 2002). Also, "sub-processes of describing data" are (i)to demonstrate awareness of the display features, (ii)to recognize the same data in different data displays, (iii)to evaluate the effectiveness of data displays in representing data, (iv)define units of data values; "sub-processes of organizing and reducing data" are (i)grouping or ordering data, (ii)describing data using measures of center, (iii)describing the spread of data; "sub-processes of representing data" are (i)to construct a data display for a given data set (ii)to complete a partially constructed data display (iii)to construct an alternate data display for data in a given data display; "sub-processes of analyzing and interpreting data" are to make (i) comparisons within data sets or data displays, (ii)comparisons between data sets or data displays (iii)inferences from a given data set or data display (Mooney, 2002). According to Mooney (2002), students' progress through four levels of reasoning in each of these processes: Level-1/Idiosyncratic, Level-2/Transitional, Level-3/Quantitative and Level-4/Analytical. In Level 1, students' reasoning is limited to subjective reasoning that is unrelated to the given data and often focuses on personal experiences or beliefs. In Level 2, students can show little awareness of the context, give partially correct answers but it is still not sufficient at this level. In Level 3, students can explain a problem mathematically and do not deal with irrelevant aspects of the problem. In Level 4, students can carry out all procedures without any error; they can fully read the data, make calculations and connections correctly as well as explain the aim of using different data displays, make transitions between them, draw meaningful conclusions, and generalize from the data.

In this study, the M3ST framework was used because the study group consisted of middle school students, and it provided the opportunity to examine the four key processes and sub-processes of statistical reasoning, just like the frameworks mentioned above. As a matter of fact, it is seen in the literature that students' statistical reasoning skills are also examined within the framework of these four key processes. In the describing data process, Oruç and Akgün (2010) emphasize that although 7th grade students are successful in one-dimensional graphs, they have difficulty in interpreting graphs in questions involving more than one graph; Koparan and Güven (2013) emphasize that 7th and 8th grade students can mostly read data in graphical representations at an analytical level; Tosun (2021) emphasizes that 8th grade students do not have the necessary reasoning skills for between-data and beyond-data reading levels. In the organizing and reducing data process, it was observed that students had the most difficulty in interpreting measures of central tendency and distribution (Çakmak and Durmuş, 2015; Koparan and Güven, 2013; McGatha et al., 2002) and tended to use the wrong data belonging to the graph (Koparan and Güven, 2013). In the representing data process, it is stated that students are successful in both reading and interpreting graphs, but they have more difficulty in constructing of data display (Gültekin, 2009; Tairab and Al-Nagbi, 2004), and they are inadequate in constructing an appropriate display representing the data set and evaluating the effectiveness of data display features based on the context in which the data is presented and the display features (Koparan and Güven, 2013). In the analyzing and interpreting data process, Tosun (2021) emphasizes that 8th grade students are successful in bar charts, Kaynar (2012) in line charts; Polat (2016) emphasizes that middle school students are successful in bar, line and pie charts, and Bursal and Yetiş (2020) in line, bar and pie charts, respectively.

In the literature, when the studies on statistical reasoning processes are evaluated together, it is seen that different results are obtained for the same statistical process (Bursal and Yetiş, 2020; Koparan and Güven, 2013; Oruç and Akgün, 2010; Polat, 2016; Tosun, 2021). This might be due to the context of the questions in the data collection instrument or the fact that statistical processes are considered as a whole, and sub-processes are not evaluated separately. Because in some studies conducted on the representing data process, it is stated that students are generally able to construct at least one of the bar, line or pie charts asked from them, but they cannot determine the most appropriate graph representing the data set (Gürbüz and Şahin, 2015; Hacısalihoğlu Karadeniz, 2016; Koparan and Güven, 2013; McGath et al., 2002; Özsevgeç and Yayla, 2014). Therefore, it can be said that it is important to examine students' reasoning in statistical processes based on each sub-process. In addition, the studies focusing on reasoning in four key statistical processes were limited to data

collection instruments including bar and line graphs (Koparan and Güven, 2013; McGatha et al., 2002). However, in a few studies focusing on pie chart, it has been stated that students have difficulty in explaining graphical relationships and deciding on the most appropriate type of graph to represent data (Şahin, 2020) and that they cannot choose appropriate strategies to solve pie chart questions (Diezmann and Lowrie, 2009). In this context, it can be said that there is a need to examine students' statistical reasoning processes for pie chart in the context of statistical reasoning process and sub-processes. In line with these reasons, in this study, it was aimed to examine the statistical reasoning processes of eighth grade students towards the pie chart in depth within the framework of the M3ST model. In line with this purpose, answers to the following questions were sought:

1. What are the statistical reasoning levels of eighth grade students in the process and sub-processes of describing data in pie chart?

2. What are the statistical reasoning levels of eighth grade students in the process and sub-processes of organizing and reducing data in pie chart?

3. What are the statistical reasoning levels of eighth grade students in the process and sub-processes of representing data in pie chart?

4. What are the statistical reasoning levels of eighth grade students in the process and sub-processes of analyzing and interpreting data in pie chart?

Method

In this study, statistical reasoning processes of three eighth grade students were described individually. Each activity was handled separately for each student, but as a holistic situation. A case study is a research design in which a limited system, an individual, a group and a phenomenon are described and analyzed in depth (Merriam, 2013).

Regarding this study,

- It is related to the process because it is aimed to investigate the statistical reasoning levels of the students,
- It is descriptive in that it describes the decision-making and action processes of the students in-depth,
- It is inductive in that it deals with students' statistical reasoning levels based on statistical reasoning sub-processes,
- One of the researchers acted as a teacher, administrator, and researcher during the activity.

In addition, the research was limited to the eighth-grade acquisitions in the field of data processing learning in the mathematics curriculum. Data for these attainments were collected with more than one data collection tool. Based on the data obtained, students' statistical reasoning levels were examined in depth by focusing on "how" and "why" questions. With these aspects, the research is a case study.

Study Group

The study group of this study, which was determined using the purposive sampling method, consists of three eighth grade students in a public school in Istanbul in the 2018-2019 academic year. The reason why the study group consisted of eighth grade students is that all the learning outcomes addressed in the study are at this grade level and are associated with different subject areas. Besides, when the study group was selected, attention was given to ensure that the students were heterogeneous in terms of their academic achievement. Hence, it was aimed to obtain enriched data on how the reasoning processes of students at different academic levels differed in the same activity. The students in the study group have been studying in the same class since the 5th grade, and the researcher has been the course teacher at the school during this period. Therefore, students learned the topics with the same method and technique. During the teaching process, examples of the use of graphs in different disciplines were presented, and class discussions were held on which graph might have been preferred according to the context and why. In addition, both routine and non-routine problem situations were studied. Students were selected not only based on their performance in the course in which the topic was studied, but also based on their grade point average and the teacher's observations. In addition, the selection of students who have communication skills and are able to give appropriate answers to the research problem was taken into consideration. For the research ethics, the study group was created on a voluntary basis and consent forms were obtained from the students and parents. In addition, the real names of the participants were not used in the study.

The students in the study group have been studying in the same class since the 5th grade and their achievement levels are different from each other. The achievement levels of the students were classified according to their grade point averages in mathematics courses in the 5th, 6th, and 7th grades, as indicated in Table 1.

Table 1.

Student Code Names According to Achievement Levels

Student Code Names	**Achievement Levels**	**Grade Point Averages**
Zehra	High Achievement (HA)	98.86
İlayda	Medium Achievement (MA)	76.55
Damla	Low Achievement (LA)	48.50

Data Collection Tools

The data collection tools of this study consisted of the activities developed by the researchers, the clinical interviews based on the activities, and the researcher notes. In the process of preparing the activities, initially, a literature review on the subject of statistical reasoning was conducted. When the related studies are examined, it is suggested that (i) "how and why" questions be asked, (ii) the use of statistical concepts be justified, (iii) real data be included, and (iv) interdisciplinary contexts be used for the development and observation of statistical reasoning in students (delMas, 2002; Gaise, 2016; Savard & Manuel, 2016). Considering these results, three activities were prepared: “Area of Continents”, “Summer Olympics” and “School Canteen”. The questions in the activities were designed to allow the observation of the processes and sub-processes defined in the M3ST model (see Appendix-1). In addition, the activities were prepared in different disciplines, real data were used, and why and how questions were included to enable students to explain their reasoning.

The activities, for which expert opinion was taken, were applied to two students with high and low academic achievement, and the pilot implementation of the activities was carried out. During the pilot implementation process, no negative comments were received from the students about the activities. The questions in the activities and which sub-process they are related with are shown in Table 2.

Table 2.

Distribution of Questions in Activities for Pie Charts

Describing Data (DD)		
DD-1 Surface Area of Continents Question-1	DD-2 Surface Area of Continents Question-4	DD-3 Surface Area of Continents Question-2
Organization and Reduction Data (OR)		
OR-1 School Canteen Question-1	OR-2 Summer Olympics Question-2	OR-3 Summer Olympics Question-5
Representing Data (RD)		
RD-1 Summer Olympics	RD-2 Summer Olympics	RD-3 Summer Olympics

Question-3	Question-1	Question-6
Analyzing and Interpreting Data (AI)		
AI-1	AI-2	AI-3
Surface Area of Continents Que	Summer Olympics Question-4	Summer Olympics Question-7

*Sub-processes and abbreviations are explained under the heading of Analysis of Data.

Process

The research data were collected through three sessions held four weeks after the students learned the subject, based on the developed activities. Each session was held in the form of a one-on-one interview by making an appointment at the appropriate time intervals for the participants. In the research, only one activity was applied to three different students in each session.

Participants were informed that during the data collection process, the session would be recorded, but their faces would not be captured. It was clarified that their responses to the questions would only be used for this study and would not be evaluated as grades. As the researcher was also their teacher, participants did not feel uneasy and provided responses genuinely. In addition, audio recordings were taken during the interview. During the session, tools such as pencil, compass, miter, protractor, and ruler were provided. Immediately after the statistical reasoning activities for the pie charts were given to the students, necessary information was given, and an explanation was made as "you can start with any question you want". Just after the students answered the questions in the activity, a clinical interview was held for the relevant activity. In Table 3, the activity in each session, the duration of the interviews with the participants and the total duration of each session are given.

Table 3.

The Duration of Interviews with Participants

	ZEHRA(HA)	İLAYDA(MA)	DAMLA(LA)
SESSION-1 Activity: School Canteen	2' 11''	3' 16''	4' 32''
SESSION -2 Activity: Surface Area of Continents	8' 30''	16' 15''	16' 36''
SESSION -3 Activity: Summer Olympics	14' 41''	27' 21'	29' 15''

Data Analysis

Data analysis in qualitative research involves preparing and organizing the data for analysis, then coding the data and creating themes, and finally presenting the data (Creswell, 2018). However, this is a general process and there may be some differences according to the method of the research.

In this study, initially, transcripts of audio recordings obtained from student interviews were created. Subsequently, the transcribed data was classified into the levels of statistical reasoning described in the M3ST framework. Statistical reasoning processes and sub-processes in the defined framework are as follows:

The Sub-Processes of the Describing Data (DD) Process

DD-1: Awareness with data display feature

DD-2: Evaluating the effectiveness of data display in representing data

DD-3: Identification units of data values

The Sub-Processes of the Organizing and Reducing Data (OR) Process

OR-1: Grouping or ordering data

OR-2: Describing data using measures of center

OR-3: Describing the spread of data

The Sub-Processes of the Representing Data (RD) Process

RD-1: Constructing a data display for a given data set

RD-2: Completing a partially constructed data display

RD-3: Constructing an alternate data display for data in a given data display

The Sub-Processes of Analyzing and Interpreting Data (AI) Process

AI-1: Comparing within a data display

AI-2: Comparing between data display

AI-3: Inferring from data display

According to the defined framework, firstly, students' statistical reasoning levels were examined according to each sub-process and classified as Level-1/Idiosyncratic, Level-2/Transitional, Level-3/Quantitative and Level-4/Analytical. At this stage, the double-coding procedure defined by Miles and Huberman (2015) was used. The answers of the students were analyzed independently by two researchers according to the framework defined in the M3ST model. Independently from each other, two researchers determined the students' reasoning levels according to the definitions in the framework. While doing this process, the researchers determined for which description the student answers were more appropriate and assigned the given answer to the levels

defined in the frame. During the determination of the levels, two different situations were encountered: (i)the frame includes a description suitable for the answer, (ii)descriptions in the framework are insufficient.

When the first of these two situations were encountered, the definition was thought to be appropriate, but when the second situation was encountered, the literature was searched again, and some changes were made in the existing definition and the missing parts were completed. Then, students' statistical reasoning levels according to the sub-processes were classified. In this context, the agreement in the evaluations of the researchers was calculated based on Miles and Huberman's (1994) percentage of agreement = [agreement / (agreement + disagreement)] x 100. As a result of this calculation, the percentage of agreement was found to be 84.8%. Reliability calculations over 70% are considered reliable for research (Miles and Huberman, 2015). Although a reliable percentage was obtained, the two researchers and the expert performing the data analysis came together again and discussed the points of disagreement until an agreement was reached.

Finally, student's statistical reasoning levels in each process were determined by calculating the mean value of the statistical reasoning levels in the sub-processes. Finally, student's statistical reasoning levels in each process were determined by calculating the mean value of the statistical reasoning levels in the sub-processes. Mean values that were halfway between two levels were rounded down to the lower level. Thus, a student receiving a mean value of 1.0 to 1.5 for a particular process would be coded as being a Level 1/idiosyncratic. A mean value of greater than 1.5 and less than or equal to 2.5 would be coded as a Level 2/transitional and so forth (Mooney, 2002).

Results

The results obtained in the study are presented in the order of sub-problems below.

The Results Related to the Describing Data Process and Sub-processes

The questions asked to the students for each sub-process of the describing data process and the responses given to the questions are presented in Table 4.

Table 4.

The Student Responses to the Questions Asked During the Describing Data Sub-Process

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
	What information can be obtained from the graph of Area of Continents? Explain.		
DD-1	*At first glance, I can tell which continent takes up how much land in the world.* *Asia has the largest area (30%) and Australia the smallest (5%).* *The area of an average continent. However, since the data groups are not very close here, I have to comment by looking at the one in the middle.*	*In the distribution of the landmass, the Asian continent got the most share as a percentage.* *With a share of 5%, the smallest piece of land is Australia.* *If Europe and Australia unite, they will be equal to South America.*	*Most landmass is in Asia.* *Australia's landmass is the least.* *South America is more than Antarctica.* *Europe is more than Australia.*
	Can the data in the Area of the Continents pie graph be displayed with a different graph type? If so, what type of display would be more useful?		
DD-2	*Bar chart because it allows comparing the area of continents. Since the line chart is used to look at the increase and decrease of data, but the areas do not change constantly. If the goal is to compare data, a bar chart should be used, and if the purpose is to look at their distribution, a pie graph should be used.*	*It can be compared with a bar chart. ... The bar chart is used to compare data. Here we look at which continent is bigger and which continent is smaller. That's why a bar chart is appropriate.*	*It should be compared with the line chart because the increases and decreases between them are more pronounced.* *...* *I can't make the pie graph. It is difficult for me, so it should not be shown with a circle. The line is easier to interpret.*
	Which two continents have the surface area equal to half the area of the Earth?		
DD-3	*Considering that the whole of the Earth, that is, the land on the Earth, constitutes 100% of the surface area, I thought which two continents I should take to make 50%. The Asian continent has 20% land and Africa 30%, and since the sum of the two is 50%, they have half of the Earth's landmass.*	*If I add them all together, it's 100%. Accordingly, I need to think about which continents half, that is, 50%, is equal to the sum of. When I look at the graph, the sum of the surface areas of the African and Asian continents is 50%, that is, it is equal to half the surface area of the Earth.*	*How do I compare it to the Earth, I don't know the size of the Earth. ... How will I find it now? I have to choose two continents, Africa and Asia have the largest numbers then let these two be.*

Considering the student responses presented in Table 4, the statistical reasoning levels of the students in each sub-process of the describing data process were examined in Table 5.

Table 5.

The Reasoning Levels of the Students in the Sub-Processes of Describing Data

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
	Level-4 / Analytical	Level-3 / Quantitative	Level-2 / Transitional
DD-1	Reaches information read directly from the graph. Reaches information that is not read directly from the graph (such as mean value or median). Associates variables with each other. Explains quantitatively.	Reaches the information read directly from the graph. Associates variables with each other. Explains datasets quantitatively.	Reaches the information read directly from the based on the graph's visual characteristics. Does not associate variables with each other. Does not use quantitative values when describing datasets.
	Level-4 / Analytical	Level-2 / Quantitative	Level-1 / Transitional
DD-2	Determines the graphs that are appropriate and not appropriate for displaying the dataset. Evaluates appropriate graphs with both the property of the graph and the property of the dataset.	Accurately determines the graphs that are appropriate for displaying the dataset. Decides the appropriate graph by only looking at the characteristic of the graph.	Cannot determine the graph appropriate for the display of dataset.
	Level-4 / Analytical	Level-4 / Analytical	Level-1 / Transitional
DD-3	Reads labels. Explains quantitatively. Recognizes general data unit (%).	Reads labels. Explains quantitatively. Recognizes general data unit (%)	Shows no awareness of data units.

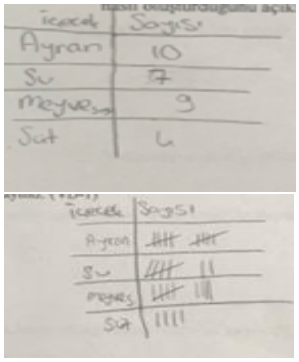
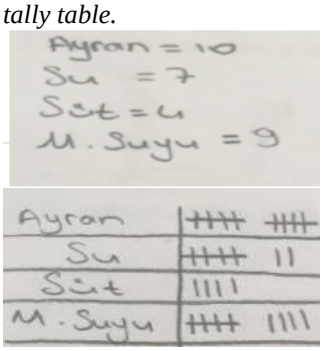
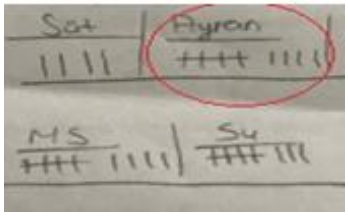
In Table 5, it is seen that Zehra (HA)'s statistical reasoning level is Level-4/Analytical in all sub-processes of the describing data process. İlayda (MA) is Level-4/Analytical only in DD-3. Damla (LA)'s statistical reasoning level is Level-2/Transitional in DD-1, Level-1/ Idiosyncratic in DD-2 and DD-3. In addition, in the description data process related to the pie chart, it is seen that the differentiation between the statistical reasoning levels is the most in DD-2. Within describing data process when the mean value of students' reasoning levels in sub-processes is calculated, it can be said that the statistical reasoning levels of Zehra, Dilara and Damla are Level-4/Analytical, Level-3/Quantitative and Level-1/Idiosyncratic, respectively.

The Results Related to the Organizing and Reducing Data Process and Sub-processes

The questions asked to the students for each sub-process of the organizing and reducing data and the responses given to these questions are presented in Table 6.

Tablo 6.

The Student Responses to the Questions in the Organizing and Reducing Data Sub-Process

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
	Arrange the data given in the table with a tally table and a frequency table. (School Canteen)		
OR-1	*First, I determine what types of drinks there are. First, I will determine the frequency table, then the tally table.* 	*I remember the tally table but not the frequency table. First, I'll identify the types of drinks and how many of each, and then draw the tally table.* 	*I remember the tally table but not the frequency table.* (There are missing data in Damla's tally table) 
	What is the average number of athletes participating in the Rio Olympics? Explain what your result means. Prerequisite: Determining the number of people by using a pie chart. (Summer Olympics)		
OR-2	*To find the average of athletes, I find how many people participated in each branch and divide it by the number of sports branches.* *... I don't know wrestling and shooting in the graph. We know how many degrees of slices they have in their pie graph, so I can easily find these branches by proportions.* *... Having an average of 12 means that an average of 12 athletes from a sport branch participated.*	*To find the average number of athletes, I first need to find the number of athletes participating in each branch. ... First, I will find the number of athletes in shooting and wrestling by using the central angles given in the pie graph. Then I will divide the total number of athletes by 5.* *... I don't know what it means to have an average of 12. That's how it was calculated.*	*I find the total number of athletes and divide it by the number of sports branches available.* *To find the info not provided, I divide 360^0 by each central angle.* *... The average was 11. All summed and divided gives 11.*
	Find the range in the number of athletes participating in the 2016 Rio Olympics and the 2012 London Olympics. Explain what your result means. (Summer Olympics)		
OR-3	*The range is found by subtracting the smallest number from the biggest number in a dataset.* *The range of Rio is 26, and London Olympics is 24. A smaller range means that the number of athletes participating is closer to each other. ... In London, the number of athletes in each sport branch is closer.*	*The range is the difference between the largest number and the smallest number in a dataset.* *...The range is 24 at the 2012 London Olympics, and 26 at the 2016 Rio Olympics.* *The range is greater in 2016.*	*The range is the subtraction of the largest value and the smallest value in the data set. Therefore,* ***the range of London is 26, and the range of Rio is 24.*** *...* *What does such range mean? Well, one is bigger than the other.*

Considering the student responses presented in Table 6, the statistical reasoning levels and indicators of the students in each sub-process of the organizing and reducing data process are given in Table 7.

Table 7.

The Reasoning Levels in Organizing and Reducing Data Sub-Processes

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
OR-1	Level-3 / Quantitative Grouping the data in multiple ways Not being aware of the intended use of tables	Level-3 / Quantitative Grouping the data in a single way Not being aware of the intended use of tables	Level-1 / Idiosyncratic Grouping the data such that it does not represent the data set
OR-2	Level-4 / Analytical Proportional thinking Explaining the arithmetic mean both operationally and conceptually	Level-3 / Quantitative Proportional thinking Explaining the arithmetic mean only operationally	Level-2 / Transitional No proportional thinking Explaining the arithmetic mean only operationally
OR-3	Level-4 / Analytical Explains and calculates the range both operationally and conceptually.	Level-3 / Quantitative Explains and calculates the range only in operational terms.	Level-2 / Transitional Explains the range operationally but cannot calculate it. (misreading the chart)

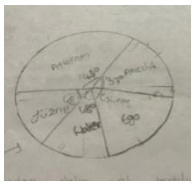
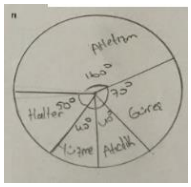
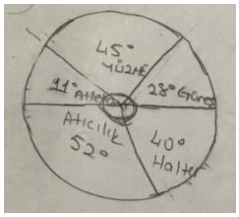
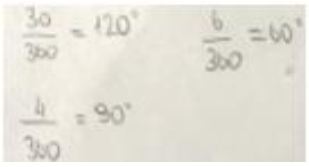
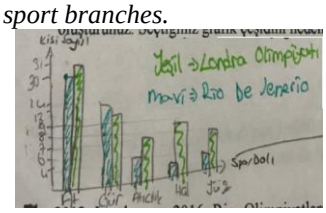
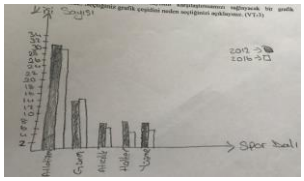
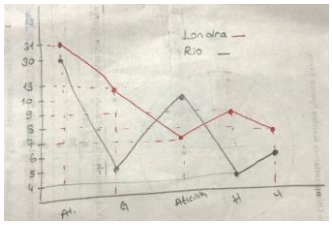
In Table 7, it is seen that the statistical reasoning level of İlayda (MA) in all sub-processes of the organizing and reducing data process is Level-3/Quantitative. While Zehra (HA)'s statistical reasoning levels were Level-3/Quantitative in OR-1, Level-4/Analytical in OR-2 and OR-3. Damla (LA) is in Level-1/Idiosyncratic in OR-1, while in Level-2/Transitional in OR-2 and OR-3. Within organizing and reducing data process when the mean value of students' reasoning levels in sub - processes is calculated, it can be said that the statistical reasoning levels of Zehra, Dilara and Damla are Level-4/Analytical, Level-3/Quantitative and Level-2/Transitional, respectively.

The Results Related to the Representing Data Process and Sub-processes

The questions asked to the students for each sub-process of the representing data process and the responses given to the questions are presented in Table 8.

Table 8.

The Student Responses to Questions Asked During the Representing Data Sub-Process

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
	Construct a graph showing the distribution of data shown in the bar chart. (Summer Olympics)		
RD-1	*Pie chart because when it comes to the graph showing the distribution in the questions, there is always a pie chart in the options. ... I do the proportion. But the central angles are not integers so let me take the integer part…But the sum of the angles is not 360°. I better round the numbers (to the ones digit).* 	*I will form a pie graph since it says distribution of data. Line is doesn't fit anyway, because the line chart was used to look up increase and decrease.... The result is not an integer, I will take an approximation of the numbers (in the tens digit).* 	*Since it says distribution, I'll draw a circle. Because in the previous question, he said the distribution of athletes and drew a circle.* *I divide each number in the bar graph by 360°.* 
	Complete the partial pie chart according to the information given in the table. (Summer Olympics)		
RD-2	*The circle segments of the two sports branches are shown in the graph. We need to place the data in the table in the rest of the circle. So, I'm going to add up the angle of wrestling and shooting, subtract it from 360°, and set up a proportion.* **Completed the chart correctly**.	*I must sum all the data in the table, make a ratio of 360° and find the angle of each sport.* (When forming the chart) *I miscalculated because it* ***has already filled two slices in the pie chart****. Here I should subtract the sum of these two slices from 360° and since will place the remaining part in the table.* **Completed the chart correctly**.	*When the circumference of the circle is 360°, I will divide the number of people given in the table by the circumference of the circle.* 
	Create a graph to compare the number of athletes in both Olympics. (Summer Olympics)		
RD-3	*Line graph doesn't fit because the number of athletes* ***did not*** *change* ***constantly****. Also, I can't show two data in the same pie chart. But I can show both data groups in one bar graph and compare the number of athletes more easily according to the sport branches.* 	*I would use a bar chart to compare the two. It would be difficult for me to show it in a pie graph, the line chart is also suitable for looking up and down, so it's a bar chart.* 	*Line chart because increases and decreases are more visible.* 

Considering the student responses presented in Table 8, the statistical reasoning levels and indicators of the students in the data display sub-processes are given in Table 9.

Table 9.

The Reasoning Levels of Students in Representing Data Sub-Processes

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
	Level-3 / Quantitative	Level-3 / Quantitative	Level-1 / Idiosyncratic
RD-1	Forms a pie graph even if the dataset is not an integer multiple of 360°. Proportional thinking The heading of the graph is missing.	Forms a pie graph even if the dataset is not an integer multiple of 360°. Proportional thinking The heading of the graph is missing.	Not being able to transform bar chart into pie graph. No proportional thinking. The heading of the graph is missing.
	Level-4 / Analytical	Level-4 / Analytical	Level-1 / Idiosyncratic
RD-2	Complete the chart to represent the dataset. Proportional thinking	Complete the chart to represent the dataset. Proportional thinking	Completing the chart incorrectly and not representing the dataset. No proportional thinking.
	Level-3 / Quantitative	Level-3 / Quantitative	Level-1 / Idiosyncratic
RD-3	Selecting and forming the appropriate graphical display, considering the features of more than one graphical display and the dataset. The heading of the graph is missing.	Selecting and forming the appropriate graphical display by looking only at the property of the graphical displays. The heading of the graph is missing.	Selecting and forming inappropriate graphical display. In the generated chart, the chart does not represent the dataset.

When Table 9 is examined, it is seen that the statistical reasoning level in all sub-processes of the representing data process of Damla (LA) is at Level-1/Idiosyncratic. Zehra (HA) and İlayda (MA) are at Level-4/Analytical reasoning levels in the RD-2 sub-process, while at Level-3/Quantitative in RD-1 and RD-3. Within representing data process when the mean value of students' reasoning levels in sub -processes is calculated, it can be said that the statistical reasoning levels of Zehra, Dilara and Damla are Level-3/Quantitative, Level-3/Quantitative and Level-1/Idiosyncratic, respectively.

The Findings Related to Analyzing and Interpreting Data Process and Sub-processes

The questions asked to the students for each sub-process of the analyzing and interpreting data process and the responses given to the questions are presented in Table 10.

Table 10.

The Student Responses to Questions Asked During Analyzing and Interpreting Data Process

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
«Area of Continents» If the area of the continent of Europe is approximately 10 million square kilometers, approximately how many square kilometers would the surface area of the Earth be?			
AI-1	*... If 7% of it is 10 million km^2, I need to find 100% of it. ... I wish you had given 4% or something. ...I will round to the ones digit, ignoring the decimal point. The surface area of the Earth is one billion four hundred and twenty-eight million five hundred seventy-one thousand four hundred and twenty-eight km^2*	*Europe covers 7% of the Earth and 7% of it is 10 million, then 70% would be 100 million. But how much is 30%? 28% make 40 million. So, I found 98%, but I don't know how to find the remaining 2%.* *I will say an estimation, it will definitely be more than 140 km^2, so it is about 140.2 km^2.*	*How will I do it now? Am I going to write this (7%) as a fraction?* *...* *I don't know, there are 7 continents. So, it can be 700 million km^2.*
«Summer Olympics» Compare the distribution of players in the Rio and London Olimpics.			
AI-2	*... If the total number of players participating in the Olympics had been the same (it is not the same) it would have been more accurate to compare them on the bar graph, but they did not participate, so I will make the comparison according to the pie graph.* *.. For example, in the London Olympics, there are 31 more people in athletics, but it is shown with a 164° circle. In Rio, it is 30 people, but the circle zone is 180°. That is, the number of people and their ratio are different.*	*...since it asks to compare according to their distribution, I will compare by looking at the pie graphs.* *... 160 people participated in athletics in London. In fact, more people participated in athletics at the Rio Olympics, but more people participated in other sports in London.* *...I looked at their people, I looked at their degrees, so the number of people in athletics is higher in Rio and in other sports branches in London.*	*I will compare the data given in the bar and pie graph. I add up all the numbers.* *...* *There are 55 people in the Rio Olympics and 68 people in the London Olympics, the difference between them is 13 people.*
«Summer Olympics» The numbers and distribution of athletes participating in the 2012 London and 2016 Rio Olympics are given in the graphics above. What** can be **the total number of athletes who will participate in the five branches (athletics, wrestling, shooting, weightlifting and swimming) in the summer Olympics to be held in Tokyo in 2020?			
AI-3	*It could be 64. I took the average of the two. One has 60 participants and the other 68 participants. I think the middle of them might be 64.*	*In fact, fewer people participated in the Rio Olympics than in London. Therefore, it may decrease further in 2020. In other words, 8 people decreased in 4 years. In the 2020 Olympics, 8 people may decrease. Considering that there is a pattern, 52 people can participate.* *...* *I can't say anything about sports branches.*	*...I don't know, there is much time to 2020, anything can happen.*

Regarding the student responses in Table 10, the statistical reasoning levels, and indicators of the students in the analyzing and interpreting data sub-processes are explained in Table 11.

Table 11.

The Reasoning Levels in Analyzing and Interpreting Data Sub-Processes

	Zehra (HA)	**İlayda (MA)**	**Damla (LA)**
	Level-4 / Analytical	Level-2 / Transitional	Level-1 / Idiosyncratic
AI-1	Comparing the part with the whole Proportional thinking	Ability to think proportionally when the whole is an exact multiple of the part Partially correct comparison	Inability to relate the part to the whole Makes inaccurate comparisons
	Level-4 / Analytical	Level-1 / Idiosyncratic	Level-1 / Idiosyncratic
AI-2	Makes accurate comparisons between multiple data displays	When comparing multiple pie graphs, she thinks that the central angles represent the number of people. Makes inaccurate comparisons	Selecting the wrong charts when comparing between data displays Makes inaccurate comparisons
	Level-1 / Idiosyncratic	Level-2 / Transitional	Level-1 / Idiosyncratic
AI-3	Non-data-based prediction in graphical displays.	Ability to estimate partially correct based on data	Not attempting to estimate

When Table 11 is examined, it is seen that Damla (LA) uses Level-1/Idiosycratic reasoning in all sub-processes of the analyzing and interpreting data process. While İlayda (MA)'s statistical reasoning levels are at Level-2/Transitional in AI-1 and AI-3 sub-processes, she is at Level-1/ Idiosycratic in AI-2. It is noteworthy that Zehra (HA) is at Level-4/Analytical reasoning in AI-1 and AI-2 sub-processes, while she is at Level-1/ Idiosycratic reasoning level in AI-3. Within representing data process when the mean value of students' reasoning levels in sub -processes is calculated, it can be said that the statistical reasoning levels of Zehra, Dilara and Damla are Level-3/Quantitative, Level-2/Transitional and Level-1/Idiosyncratic, respectively.

Discussion and Conclusion

In this study, when the responses to the sub-processes of describing data were analyzed, it was seen that the high academic achievement student is at Level 4/Analytical reasoning in all sub-processes, while the reasoning levels of other students differed. In particular, it was observed that students with low academic achievement generally are at Level-1/ Idiosyncratic reasoning. When the studies conducted in this field were examined, it was seen that seventh and eighth grade students generally reasoned at the Level-4/Analytical in describing data (Koparan and Güven, 2013; Mooney,

2002; Tosun, 2021). Therefore, it can be said that the results of this study differ from the related studies. However, in the detailed analysis, it was seen that the study group of Tosun (2021) consisted of students with high academic achievement, whereas in the studies of Koparan and Güven (2023) and Mooney (2002), no questions were asked about the pie chart. Therefore, in this study, students might have struggled to read the data in the pie chart and recognized the parts of the data values.

When the sub-processes of describing data, awareness of the data display feature (DD-1) and identification units of data values (DD-3) were considered together, it was observed that students who were able to define data value units interpreted graphs by focusing on numerical quantities rather than the visual features of the graph. Similarly, Pfannkuch and Wild (2004) and Mooney (2002) stated that students focused on the visual features of the graph rather than numerical data. In this regard, it can be said that the awareness of the data units in the process of describing data positively affects the level of awareness about the display features of the graph. In the process of describing data, the sub-process in which the students' reasoning levels are the lowest is the evaluating the effectiveness of data display in representing data (DD-2). As a matter of fact, this result shows parallelism with studies in the literature emphasizing that students are insufficient in evaluating the effectiveness of data display features (Koparan and Güven, 2013; Mooney, 2002).

The results showed that students with high, medium, and low academic achievement reasoned at Level-4/Analytical, Level-3/Quantitative and Level 2/Transitional, respectively, when all sub-processes of organizing and reducing were evaluated together. It is stated in the literature that most middle school students reason at Level-1/Idiosyncratic (Koparan and Güven, 2013); Level 2/Transitional and Level-3/Quantitative (Mooney, 2002). Although the related studies examined students' reasoning about the organizing and reducing data in table, line, and bar graphs, it is noticeable that there were no Level-4/Analytical reasoning students. As a matter of fact, many studies in literature emphasize that students have more difficulty in pie charts than other graphs (Bursal and Yetiş, 2020; Çakmak and Durmuş, 2015; Kaynar, 2012; Polat, 2016). In the detailed analysis conducted with this perspective, it was seen that the study groups of both studies consisted of students at different grade levels. When the findings of the studies are analyzed, it is seen that almost half of the 8th grade students in Koparan and Güven's (2013) study reasoned at Level-4/Analytical, while students in Mooney's (2002) study reasoned at Level-4/Analytical in some sub-processes. Based on these results, it can be said that the type of graphic representation of the data could not be related to the level of statistical reasoning in the organizing and reducing data process.

In the sub-process of grouping and ordering data (OR-1), which is one of the sub-processes of the organizing and reducing data process, it has been determined that although the students can form the tables formally, they are not aware of the purpose for which the tables are used. Similarly, Hacısalihoğlu Karadeniz (2016) and Selamet (2014) in their studies aiming to reveal the perceptions of fifth grade students about data processing, stated that almost all the students had difficulties in forming a frequency table and summarizing the data shown with a frequency table. In the sub-processes of describing data using measures of center (OR-2) and describing the spread of data (OR-3), all the students could not explain conceptually, although they could explain how the arithmetic mean and range could be calculated operationally. For this reason, students with high and medium academic achievement were included in Level-3/Quantitative in OR-2 and OR-3 sub-processes. The student with a low level of academic success, on the other hand, could not read the data in the pie chart, so she calculated the central tendency and distribution measures incorrectly. For this reason, the student took place in Level-2/Transitional in OR-2 and OR-3. In this context, it can be said that the difficulties experienced in the process of identification of data negatively affect the process of organizing the data. The results obtained from the OR-2 and OR-3 sub-processes are similar to the studies in the literature that emphasize that while students are more successful in routine problems based on formulas related to central tendency and distribution calculations, deficiencies arise in questions about where and for what purpose these calculations should be used (Cai, Moyer and Grochowski, 1999; Çakmak and Durmuş, 2015; Gal, Rothschild and Wagner, 1989; Koparan and Güven, 2013; McGatha et al., 2002; Mokros and Russel, 1995; Strauss and Bichler, 1998; Toluk Uçar and Akdoğan, 2009; Watson and Moritz, 2000).

In all sub-processes of the representing data process, it was determined that the students with medium and high academic achievement have Level-3/Quantitative reasoning, while students with low academic achievement have Level-1/Idiosyncratic reasoning. It is thought that the reason for this difference in the statistical reasoning levels of the students is due to the lack of knowledge about the concepts of ratio, proportion, percentage, and angle. In literature, there are studies emphasizing that angles, percentages, and proportions are necessary preliminary learning in the process of constructing a pie chart (Çakmak & Durmuş, 2015; Savard & Manuel, 2016; Schield, 2001; Schield, 2006). Thus, the concepts belonged to mathematics (angles, percentage, circle), but were used for creating statistical displays, in this case a pie chart. This finding suggests that making pie charts cannot be done in the statistical context alone.

In the sub-processes of data representation, students with high and medium academic achievement reason at Level-3/Quantitative reasoning in constructing a data display for a given data set (RD-1) and constructing an alternate data display for a given data display (RD-3). On the other hand, students with low academic achievement have Level-1/Idiosyncratic in all sub-processes of data representation. It is stated that students reason at Level 2/Transitional by Mooney (2002); at Level-1/Idiosyncratic by Koparan and Güven (2013). Although these results are similar for students with low academic achievement, they differ for other students. Students with high and medium academic achievement are aware of data representation features and which graph type is used for which purpose. However, all three students did not put titles on the graphs they created. This differentiation may have resulted from the difference in the study group. As a matter of fact, in related studies, it has been stated that 6th and 7th grade students especially have difficulty in creating graphical representations and determining their effectiveness (Koparan & Güven, 2013; Mooney, 2002). In addition, it can be said that students with low academic achievement have more difficulty in constructing circle graphs than others (Kaynar, 2012).

Within the statistical reasoning sub-processes of the M3ST model in the research, the most significant difference between the reasoning levels of the students was experienced during the analysis and interpretation of the data. In the sub-processes of making comparisons between (AI-1) and (AI-2) data display of the process of analyzing and interpreting the data, the high-achieving student was able to use proportional reasoning skills both when making a part-whole comparison in a pie chart and when comparing different pie charts. Therefore, the reasoning level was determined as Level-4/Analytical. The medium-achieving student, on the other hand, makes Level-2/Transitional reasoning when comparing the data in a pie chart (AI-1) within himself, as she can use proportional reasoning if the whole is a solid multiple of the part. In addition, she developed the perception that the central angle represents the number of people in the graph while making comparisons (AI-2) between multiple pie charts, and therefore, statistical reasoning in AI-2 was determined as Level-1/Idiosyncratic. The student with low academic achievement, on the other hand, made erroneous comparisons both within a pie chart (AI-1) and between more than one pie charts (AI-2) and could not use proportional reasoning skills. Therefore, statistical reasoning in AI-1 and AI-2 was determined as Level-1/Idiosyncratic. Making inferences in data display (AI-3) was determined as the sub-process that students had the most difficulty regardless of their academic achievement levels. In AI-3, only moderately successful students could partially estimate based on the data in the pie chart, while high and low achieving students made wrong estimations or did not even attempt to estimate. Therefore,

in AI-3, students' statistical reasoning levels varied as Level-1/Idiosyncratic and Level-2/Transitional. This result shows parallelism with the results of the studies in the literature emphasizing that students have difficulty in making inferences and estimations from a data display (Jones et al., 2000; Koparan and Güven, 2014; Mooney, 2002). It can be thought that the reason for this difficulty is that the students have not encountered tasks based on inference and interpretation before. As a matter of fact, Yanık, Özdemir and Eryılmaz Çevirgen, (2017) examined the student textbooks in the context of statistical problems and determined that the tasks requiring inference were limited in the 5th, 6th and 7th grades, and that there were no tasks at the 8th grade level. Tasks requiring forward-looking estimations were not encountered at any grade level Jones et al. (2015) stated that when the textbooks focus heavily on operational skills, students will develop limited skills in problem solving, interpretation and estimation skills. For this reason, it is thought that focusing on interpretation and estimation skills in addition to procedural skills in textbooks and learning environments will positively affect students' reasoning skills.

Recommendations

Since this study is limited to three sub-processes of the data identification process, it is recommended to conduct a study that addresses all the sub-processes of describing data. In addition, in the process of describing data, it was determined that there were differences in the reasoning levels of the students in the national and international literature. The reasons for this situation can be investigated in future studies.

In the field of data processing learning, students' reasoning levels can be examined at different grade levels other than 8^{th} grade and with larger samples.

Also in future studies, students' reasoning levels can be examined according to different statistical reasoning models other than M3ST model.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

We have carried out the research within the framework of the Helsinki Declaration. The participants are volunteers.

ORCID

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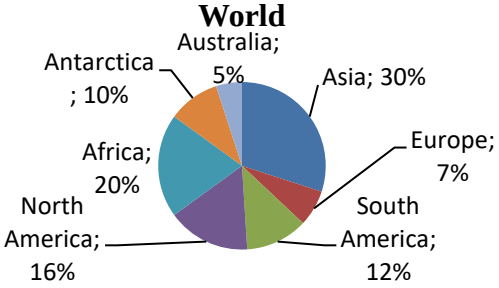
Appendix

AREA OF THE CONTINENTS

Distribution of Land Pieces in the World

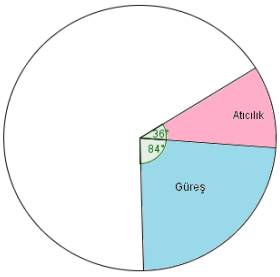


1. What information do you get from the graph above? Please explain. (DD-1)
2. Which two continents have half the surface area of Earth? (DD-3)
3. If the area of the continent of Europe is approximately 10 million square kilometers, approximately how many square kilometers would the surface of the earth be? (AI-1)
4. Is there a different type of chart that represents the dataset given in a pie chart? Which chart type do you think would be more useful to show the data above? Please explain with reasons. (DD-2)

SUMMER OLYMPİCS

The pie chart below shows the distribution of athletes participating in the 2016 Rio De Janeiro Summer Olympics from five different branches. However, only the distribution of athletes participating in wrestling and shooting branches is given in the table. The number of athletes from athletics, weightlifting and swimming sports branches are given in the table.

Number of Athletes from Turkey Participating in the 2016 Rio Olympics



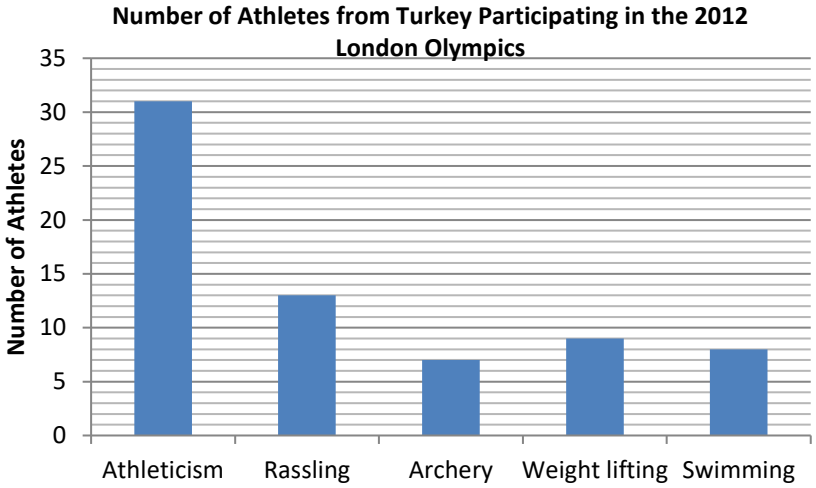
Number of Athletes from Turkey Participating in the 2016 Rio Olympics	
Spor Dalı	**Kişi Sayısı**
Atletizm	**30**
Halter	**4**
Yüzme	**6**

Cited: (**http://www.olimpiyatkomitesi.org.tr)**

1. Complete a partially constructed pie chart above based on the table. Explain how you completed the graph. (RD-2)

2. What is the average number of athletes participating in the 2016 Rio Olympics from Turkey? Please explain. (OR-2)

3. The bar chart below shows the number of athletes from Turkey participating in the same sport at the 2012 London Summer Olympics. Create a chart that shows the distribution of the number of athletes in a bar chart. Please explain. (RD-1)



4. Compare the 2012 London Olympics and the 2016 Rio Olympics according to the distribution of athletes? Please explain. (AI-2)

5. How many athletes from Turkey participated in the 2016 Rio Olympics and 2012 London Olympics? Explain how you calculated the range and compare results focusing on the meaning of the range. (OR-3)

6. Create a table to compare the number of athletes in both Olympics. Explain why you chose the chart type you chose. (RD-3)

7. The numbers and distribution of the athletes participating in the 2012 London and 2016 Rio Olympics are given in the graphics above. Guess the total number of athletes participating in the summer Olympics to be held in Tokyo in 2020 in five branches (athleticism, rassling, archery, weightlifting, swimming)? (AI-3)

Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Yenilmez, K., & Okuyucu, İ. (2023). Investigation of secondary school students' processes of constructing area and volume relations of rectangular prisms. *Osmangazi Journal of Educational Research, 10*(1), 91-119.

Submitted: 15/03/2023 **Revised:** 12/04/2023 **Accepted:** 01/08/2023 **DOI:** 10.59409/ojer.1265693

Investigation of Secondary School Students' Processes of Constructing Area and Volume Relations of Rectangular Prisms

***Kürşat Yenilmez, **İlhan Okuyucu**

Abstract. The purpose of this study is to examine the knowledge construction processes of 5th grade students, who do not have any knowledge about the surface area and volume of the rectangular prism, within the framework of the observable epistemic actions of the RBC (Recognizing, Building-with, and Constructing) abstraction model. This study was carried out according to the case study pattern, which is one of the qualitative research types. The study was carried out in the 2021-2022 academic year. For the research, six students were selected by the maximum diversity sampling method. Three homogeneous groups were formed and semi-structured interviews were conducted. An activity paper consisting of eight problems was used to obtain data. The obtained data were evaluated in the context of observable epistemic actions of RBC. Only a student with a low level of mathematics achievement couldn't construct knowledge of the surface area of the prism. All students have found the number of unit cubes that can fit inside the rectangular prism. However, three students with a high level of success were able to construct and use volume formulas. In the research, it has been seen that recognition and building-with actions are easier to perform than construction action. As the level of mathematics achievement decreased, the speed and success of abstraction decreased.

Keywords. Surface area, volume, abstraction, RBC+C.

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Note: This article is the summary of the second author's master thesis entitled "Investigation of Secondary School Students' Processes of Constructing Area and Volume Relations of Rectangular Prisms" under the supervision of the first author.

In the information society, which has a dynamic structure, the accumulation of knowledge is increasing every day and becoming complex. For this reason, education systems focus on individuals who can access information and use the obtained information in solving any problem, instead of raising individuals who memorize everything. In this context, the Ministry of National Education [MoNE] made a radical change and adopted the constructivist education approach (İlhan & Aslaner, 2018). The constructivist approach focuses on how knowledge is formed in the process of learning, which is a personal phenomenon (Delil & Güleş, 2007). The student should be actively involved in the learning process. He can learn by doing, experiencing, thinking about the concept and discussing his ideas about the concept with others (Baykul, 2014). In this process, it is aimed to abstract the operational and conceptual information by using together.

Mathematics, based on some characteristics of concepts and objects, provides the possibility to classify, establish certain relationships and make generalizations. Mathematics is an abstract subject and the abstraction of information requires a process. Dienes (1963) abstraction, classification of common aspects in different situations (cited in Altaylı Özgül & Kaplan); Hershkowitz et al. (2001) defines it as "the activity of vertically rearranging previously acquired mathematical knowledge to form a new mathematical structure". There are two basic approaches to abstraction. One of these approaches is the cognitive approach and the other is the socio-cultural approach. RBC is a socio-cultural theory that approaches abstraction. According to the socio-cultural approach, personal characteristics, use of tools, social interaction and environmental conditions are important in the abstraction process (Altun & Yılmaz, 2008; Hershkowiz, et al., 2001; Yeşildere & Türnüklü, 2008). Abstraction is related to the individual's past learning, the socio-cultural and physical environment in which learning activities are performed, and the structures obtained from the results of previous learning activities (Hershkowitz et al., 2001; Schwarz et al., 2009). Therefore, activities should be organized by considering the contextual factors affecting the abstraction process. Considering all these contexts, Hershkowitz et al. (2001) suggested that abstraction includes some observable actions. These actions are recognizing, building-with and constructing. Recognizing, recall of familiar structures (Bikner-Ashbash, 2004); building-with, the use of known knowledge in solving the problem (Tsamir & Dreyfus, 2002); constructing is the vertical restructuring of familiar constructions and the construct of new constructions (Bikner-Ahsbahs 2004). Constructing, includes recognizing and building-with and building-with includes recognizing (Hershkowitz, et al., 2001). The three epistemic actions are intertwined. This shows that actions do not always occur sequentially, but can occur simultaneously

(Dreyfus, 2007; Hershkowitz et al., 2001; Tsamir & Dreyfus, 2002). Based on these actions, the RBC theory has been developed. According to the RBC theory, abstraction occurs in three stages (Hershkowitz et al. 2001).

a) The need for a new construction.

b) The constructions existing in the mind are used for the construction of a new abstract entity in a process in which recognition and building-with are dialectically intertwined.

c) Consolidation of the new abstract entity for easy recognizing and building-with in subsequent abstractions.

Mathematics education consists of many interconnected subjects. In any matter, how abstraction processes take place can be demonstrated through epistemic actions of the RBC model. One of these issues is the surface area and volume of the rectangular prism, which is located in the geometry and measurement learning area. According to Bal (2012), geometry allows students to start their mental activities, produce various ideas, carry out problem-solving processes, compare the properties of objects, make generalizations and abstractions. However, studies on this issue show that students cannot perceive the properties of prisms and have misconceptions about measuring the surface area and volume of prisms (Avgören, 2011; Ben-Haim, Lappan, & Houang, 1985; Dağlı, 2010; Ergin, 2014; Gökdal, 2004; Okuyucu, 2019; Okuyucu & Kurtuluş, 2019; Olkun, 2003; Tan Şişman & Aksu, 2009; Voulgaris & Evangelidou, 2004). However, researches show that students try to reach the result without making sense of the concepts of area and volume, by memorizing the formula and only through procedural knowledge (Aydın Karaca, 2014; Çavuş Erdem & Gürbüz, 2018; Gürefe, 2018; Olkun, Çelebi, Fidan, Engin, & Gökgün, 2014; Tan Şişman & Aksu, 2009). One of the reasons leading to this situation is that focusing on the result rather than the process in mathematics teaching leaves the student out of the process (Altaylı Özgül, 2018). According to Okuyucu & Kurtuluş (2019, p. 1027), students find it difficult to make a connection between the two concepts. In the mathematics curriculum, the separation of these two concepts and their processing at different grade levels can be seen as another factor that prevents students from establishing the connection between the two. Considering all these, in this research, it is desired to focus on the formation process of the surface area and volume information of the rectangular prism, and to reveal the connection between them. In this research, a problem solving activity prepared on the surface area and volume of prisms, which is a geometry issue that students have difficulty with, will be presented. Throughout the activity process, the way students construct knowledge will be

examined according to the RBC abstraction model. Difficulties and deficiencies encountered in constructing knowledge will be tried to be determined. In this context, it is aimed to examine how the secondary school 5th grade students, who have not seen the surface area and volume of the rectangular prism before, process the knowledge about these issues. It was found worth investigating how the students formed knowledge during the process of constructing the surface area and volume formulas of the rectangular prism. In the literature, there are studies examining the surface area and volume of the rectangular prism. These studies generally examine students' misconceptions, teachers' content knowledge and the effect of any teaching method or theory on teaching the issue. In the issue of surface area and volume of prisms, students' knowledge construction processes have not been examined within the theoretical framework of RBC. In this respect, it is thought that the research will contribute to the literature.

Method

In this section, the type of research, select of participants, data collection tools, data collection process and data analysis have been presented.

Research Model

The design of this research was determined as a case study, which is one of the qualitative research methods. Qualitative research offers the researcher the opportunity to look at the situation through the eyes of the participants (Coşkun, 2019). In qualitative research, it is aimed to obtain in-depth knowledge on the subject from a small number of participants and to evaluate the the data within certain criteria. One of these methods is case study. In case studies, the system, individual, group or phenomenon is described and analyzed in depth within certain limits (Merriam, 2013).

Study Group

Participants of the study were selected through maximum variation sampling, which is one of the purposive sampling methods. In order to observe the construction of a new knowledge, students must be seeing that subject for the first time. For this reason, fifth grade students who have not yet seen the attainment of the surface area and volume of the prism were included in the study. The study was carried out in the fall semester of the 2021-2022 academic year in a state secondary school affiliated to the Ministry of National Education in the Odunpazarı district of Eskişehir. The fact that the researcher works in this school has been effective in choosing the school. The study was carried out with six students at the fifth grade level. A code between S1 and S6 was assigned to

the students who participated in the application. The researcher is coded with a "T". While coding, it was started from the student with the highest mathematics achievement level. In the selection of students, first mathematics written grade and 4th grade mathematics grade averages were taken into consideration. Accordingly, two students were selected from 100-85, two students from 84-70 and two students from 69-45 grades.

Data Collection Tools

In the study, an activity sheet consisting of eight problems was given to the students as a data collection tool. The problems were prepared within the framework of the attainments in mathematics curriculum and the explanations of these attainments. Two of these problems are about calculating the surface area of the rectangular prism, one problem is determining the number of cubes in the structures formed from unit cubes, two problems are calculating the amount of unit cubes that can fit inside the rectangular prism, two problems are using the volume formula of the rectangular prism, and the last problem is using the area and volume information. The reason for the problem-oriented preparation of the activity is that the observable epistemic actions of the RBC model, which are recognizing, building-with and constructing, can be observed more easily in problem solving activities. It is thought that the intertwined structure of epistemic actions, students' mathematics achievement and learning speed will be effective in this process.

Process

In this study, semi-structured interview technique, which is one of the interview types, was used. Because this technique gives the interviewee the opportunity to express himself and the analysis of the data is easy (Büyüköztürk, et al., 2018). Semi-structured interview technique consists of open-ended questions related to the main topic. The interviewee is directed to conduct an in-depth examination. In this way, it is ensured that he answers open-ended questions freely (Memnun, 2011). The interviews were conducted in two parts, one hour apart, during the day (See Table 1.). All interviews were video recorded.

Table 1.

Interview Duration

Group	**Group 1**		**Group 2**		**Group 3**	
Chapter	Chapter 1	Chapter 2	Chapter 1	Chapter 2	Chapter 1	Chapter 2
Duration (min.)	33	23	36	32	40	37

The students were asked to write the answers to the questions on the problem solving paper provided and hand them over to the researcher after the interview. In the interviews, guiding questions were asked according to the answers and reactions of the students. These questions were used to enable students to fully reveal their thoughts and to clear possible blockages in the process. The videos obtained as a result of the interviews were analyzed.

Data Analysis

The video recordings of the semi-structured interviews with each group were transcribed and written down. The data obtained were subjected to descriptive analysis within the scope of the epistemic actions of the RBC theory. In this context, the data obtained from the semi-structured interviews, observations and answer sheets of the students were evaluated according to the predetermined themes. During the analysis, student dialogues were directly quoted and images from student solutions were included.

While analyzing the data, some key statements were determined in order to observe and reveal the epistemic actions of the RBC theory. Key phrases were used to determine which actions were taken in the discourses and behaviours of the students during the solution process. Key phrases and the epistemic actions they refer to are given in Table 2. Thus, the interpretation of the findings has become easy. Some discourses do not always require observing the same epistemic action. This is due to the intertwined nature of actions.

Table 2.

Key Phrases Used to Identify Epistemic Actions (Altaylı Özgül, 2018)

Recognizing	Building-with	Construction
Remembering Exemplification Expressing the property of a geometric shape or object	Problem solving Make assumptions Defending a proposal Reasoning Explaining a situation Building relationships	Building relationships Building new structure Mathematical language development Reasoning

There are a number of ways to ensure credibility (internal validity) in a qualitative research. According to Lincoln and Guba (1985), these ways are the long-term interaction provided throughout the research, deep focused data collection, diversification, expert review and participant confirmation (Cited by Yıldırım & Şimşek, 2016). The problems prepared in this study were examined by field education experts. In addition, the credibility of the research was ensured by

using different methods such as observation, interview and document review. Participants with different mathematical achievements were selected for the research and the data obtained were described in detail. According to Yıldırım & Şimşek (2016), purposive sample selection and descriptive direct citation of the data increase the level of transferability (external validity) of the research. According to Yıldırım & Şimşek (2016), purposive sample selection and descriptive direct citation of the data increase the level of transferability (external validity) of the research.

In order to ensure the consistency (internal reliability) of a research, the research should be evaluated by a different expert than the researcher (Yıldırım & Şimşek, 2016). For this reason, all the data obtained from the research were examined by the researcher and a field expert. The results of both reviews were compared and it was seen that the comments made were consistent. Finally, a qualitative research must be verifiable (external reliability). According to Guba & Lincoln (1989), verifiability means impartiality. This is possible by minimizing the subjective judgments of the researcher (Cited by Aydın Çınar, 2019). For this reason, the results of the researcher should be verified with the data he has obtained and researcher should provide logical explanations (Yıldırım & Şimşek, 2016). In this case, the chain of evidence formed increases the reliability of the research. In this research, the results of the researcher were constantly compared and confirmed with the findings obtained from the video transcripts and student papers.

Results

In this section, the results obtained from the application are given. Results were analyzed under a different heading for each question.

Results from the First Problem

In this problem, the surface area of an open rectangular prism is asked. Students are expected to perform the actions of *recognizing* and *bulding-with* the properties of the prism and the area of the rectangle. The answers given by the three groups and the results of the epistemic actions they have taken are given below.

19T: Since you are asking the area of the rectangle, how is it calculated?

20S1: By multiplying one side with the other. I mean the long side and the short side (Feature speaking - Recognition).

...

1T: What geometric shape do the black lines form when you cut this cardboard, S3?

2S3: Rectangle (Recognition).

3T: In this question, "how much cardboard do you need?" he asks, what does he mean?

4S4: How many cm will the rectangle consist of.

5T: cm or cm²?

6S4: Cm².

7T: If cm², what are we trying to calculate?

8S4: Field (Recognition).

12S3: 12S3: Multiply the short side and the long side of the rectangle (Recognition).

...

2S5: He was going to make a parcel out of rectangular cardboard. He asks us how many cm² of cardboard we need?

3T: OK (the student is considered to have understood the question).

4S5: There is 20 cm there. 20 cm in the middle? (It shows on the figure). 20 cm next to it. Opposite is 20 cm. There are 35 cm. It is also 35 cm above (Recognition).

In this problem, all groups realized that the given shape consists of rectangles and that the areas of these rectangles must be found (20S1, 2S3, 8S4, 2S5). The students of the first two groups recognized the area relation of the rectangle. The third group was reminded by the researcher.

5T: What do we call this object, which is formed as a result of folding, mathematically?

6S1: We say rectangular prism (Recognition - Recognition).

...

19T: What geometric object do we get when we fold this cardboard and form a parcel?

20S3: Is it a cube?

21S4: Cube (Incorrect recognition).

22T: If all the lengths were the same, we would have obtained the cube.

23S4: Square (Incorrect recognition).

Only one student recognized the information that the given figure is the expansion of a rectangular prism (6S1). While the students in the second group gave the answer of square or cube (20S3, 21S4), the students in the third group could not give any answer.

21T: How to find the area of the rectangles here?

22S1: One side of the rectangle I showed is 35 cm, and the other side is 20 cm. If we multiply 35 by 20, we can find the area of that rectangle (Building-with).

23T: How much?

24S2: 700.

25S1: The short side of the rectangle next to it is 8 cm. Since its long side is equal to the other side, it becomes 20 cm (Specification - Recognition).

26T: What is its area in cm²?

27S1: 20 × 8 becomes 160.

36T: Now that we have found the area of all the rectangles, can we figure out how much cardboard is needed?

37S1: If we add all of these, we can find out how much cardboard is needed. It becomes 2280 cm² (Reasoning – Building-with).

...

14S3: The area of the rectangle you showed is 700 cm² (Problem solving – Building-with).

15T: What would be the area of the small rectangle I showed next to that? How can we find it?

16S3: Teacher, the short side of the rectangle with an area of 700 cm² is 20 cm. The long side of the rectangle you show is also 20 cm. If we multiply 20 by 8, 160 cm² (Feature speaking - Recognition) (Reasoning - Problem solving – Building-with).

38T: What would be the area of this carton?

43S3: I found 2280 (Problem solving - Building-with).

44S4: I found 2120.

...

33S5: Sorry, one side is 35 cm. We're going to multiply 35 by eight. Subtract 280. The upper side is also 280 (Reasoning - Using).

34T: What would be the area of the whole carton?

35S5: We will add them all, 2270 (wrong account).

36T: What is the unit of 2270? (S5 thought but did not answer). How much do you think it will be S6?

37S6: 2280.

Students recognized the properties of the prism, the quality to be measured and the area relation of the rectangle. Then, they used this information to solve the problem. None of the groups had any problems while calculating the area (22S1, 24S2, 14S3, 16S3, 33S5). As seen in Figure 1,

the students summed up the results after calculating the areas of the rectangles. But, they sometimes made a mistake (37S1, 43S3, 44S4, 35S5, 37S6).

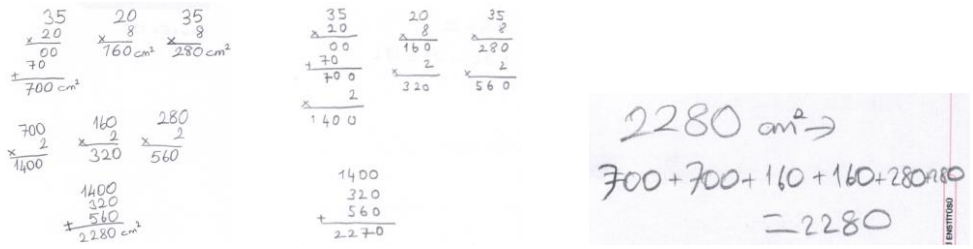

Figure 1. The Operations of the Students for the Solution of the First Problem.

In this problem, the students reached the aim by performing the actions of recognition and building-with. However, S1 developed a mathematical language by expressing that the required amount of cardboard is the sum of all the surface areas of the prism (39S1). This statement shows that the student has made progress in constructing knowledge.

Results from the Second Problem

In this problem, a question prepared for calculating the surface area of the container in the form of a rectangular prism, which is closed, was directed to the students. In addition to the recognition actions in the solution of the first problem, students were expected to construct surface area knowledge. The answers given by the three groups and the findings of the epistemic actions they have taken are given below.

1S1: If we calculate and add up the areas of the surfaces again, we can arrive at the result (Recognition – Recognizing).

2S2: I also think like S1.

3T: Calculate. Tell me the answers too. For example, what would be the area of the face I show?

4S1: 4 times 3 is 12. There are two of these 24 (Reflecting a process – Building-with).

5S2: The other is 2 times 3 out of 6. Above is 4 times 2 (Reflecting a process - Building-with).

6T: What about the whole field?

7S1: 52 m² (Problem solving - Building-with).

8S2: 52 (Solving the problem - Building-with).

9T: What have we found here?

10S1: The sum of the areas of the surfaces of the container.

...

2S4: We will add up the areas (Recognition – Recognition).

10S4: Multiply four by three, 12m² (Reflecting a process - Using).

13S3: It becomes 6 m² (Reflecting a process - Using).

14T: How long will the lower and upper face be?

15S4: We multiply four by two (Reflecting a process - Using).

19S4: Add 12 and 12 to get 24; rear and front 6-6 becomes 12 m; Add 8 to 8 to get 16. After that, the sum of 24 and 12 is 36. If we add 16, we get 52 (Problem Solving - Using).

20T: What attribute of the container did we find?

21S3: His area.

22S4: His area.

23A: S3, how much did you find the result?

24S3: I found 52 (Problem solving - Using).

...

7S5: We will multiply three by two, six. We are going to multiply four by three 16 (Problem solving - Using).

8S6: Makes 12 (Social learning).

11S5: Multiply 6 by 2, 12 by 2, and 8 by 2. 12, 24, this is 16. We will add up all of these (Problem solving - Using).

12T: Add up and tell me the result.

13S5: 52.

16S5: This is the same as the first question we did (Recognition - Recognition).

17T: What is the similarity with the first question?

18S5: In both, we found the sides and multiplied and found the area (Defend a proposal - Do not use).

19T: If we open the container, can we get the cardboard in the first question?

20S5: Yes. It would be exactly the same shape.

21T: How many did you find S6?

22S6: I found 56.

All students associated this problem with the previous one (1S1, 2S2, 2S4, 16S5, 20S5). They recognized the properties of the rectangular prism and the area knowledge of the rectangle. They quickly calculated the areas of the rectangles and solved the problem (4S1, 5S2, 10S4, 13S3, 15S4, 7S5, 8S6). As seen in Figure 2, all students added the measurements of the areas obtained and found

the area to be painted (7S1, 8S2, 19S4, 24S3). However, only the first group used the area unit. S1 continued to defend the knowledge he obtained by stating that he found the area of all edges of the container, as in the previous problem (10S1). This situation supports the thoughts that the student has reached the constructing step. S3 and S4 stated that they found the area of the container (21S3, 22S4). It can be thought that the students construct the surface area calculation knowledge. S5 and S6 do not have any statements to construct the surface area knowledge of the prism.

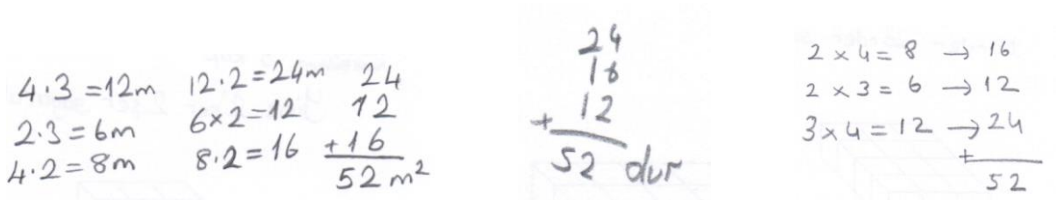

Figure 2. The Operations Performed by the Groups to Solve the Second Problem.

Results from the Third Problem

In this problem, constructions in the form of rectangular prisms construct from unit cubes are seen. The students were asked how to find the number of unit cubes contained in these constructions. It is aimed to discover the knowledge that the number of unit cubes that construct an object is the volume of that object. The answers given by the three groups and the findings of the epistemic actions they have taken are given below.

4T: How did you find it?

5S2: I counted (Reasoning - Using).

6S1: I found it by counting (Reasoning - Using).

7T: How many cubes are in the second figure? What do you think?

8S2: There are eight cubes.

9S1: Eight.

10S2: Counting again (Reasoning - Using).

11S1: We counted (Reasoning - Using).

12T: How did you count?

13S2: I counted twos.

14S1: Counting each cube since we know the shape of the cube. I counted by twos like S2.

15T: How else can we count?

16S1: Four by four.

...

11S3: I found it by counting again (Reasoning - Using).

12S4: Counting (Reasoning - Using).

13T: How did you count?

14S4: Four by four or one at a time.

...

13S5: I also counted four.

14S6: I multiplied four by two (Relating – Using).

In the first two constructions in this problem, the students found the number of unit cubes by counting (11S3, 12S4). They said that they counted the cubes as one, two, three and four (14S4). Only S6 used multiplicative reasoning in the second way (14S6).

19S1: A solution came to my mind. In the previous questions, we multiplied one side length by the other side length to find the area. Here, if we multiply the number of cubes on one edge by the number of cubes on the other edge, we can find out how many cubes there are (Associating – Using) (Reasoning – Creating).

...

16S5: There are 12 cubes. I got it by multiplying four by three.

In the last two constructions, students preferred multiplicative reasoning (16S5). In fact, S1 associated the number of cubes in a layer with the area calculation of the rectangle. Based on this, he multiplied the number of unit cubes arranged along two edges (19S1). S1, S4 and S5 adapted this method to the last figure. These three students first found the number of unit cubes in a layer in order to reach the number of unit cubes that make up the construction. Then he multiplied the result with the number of unit cubes along the third edge (See Figure 3.).

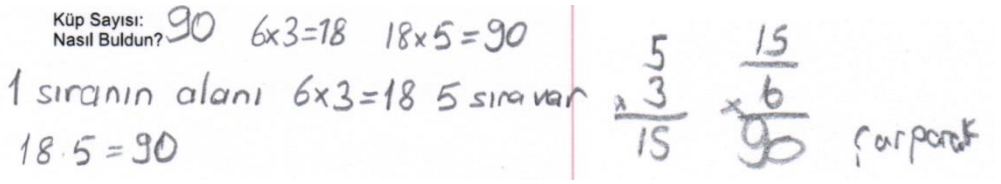

Figure 3. S1and S4's Answers for the Last Construction in the Third Problem.

All students remembered rhythmic counting and multiplicative reasoning. Recognizing and building-with actions have taken place. However, S1, S4 and S5 discovered a new way for them to find the number of unit cubes. Therefore, it is thought that three students constructed the knowledge to find the number of unit cubes that can fit inside the rectangular prism.

Results from the Fourth Problem

In this problem, a rectangular prism is given in the base layer and with a known number of unit cubes arranged along its height. Students are expected to use the formula *number of cubes = number of cubes in the base layer × height* and create the formula *volume = base area × height.*

1S1: I think like we just did. We know the height and width. If we multiply the width, length and height, we find both the area and how many unit cubes will fit inside (Recognition - Recognition).

2S2: I think so too.

3T: How many results can we find?

4S1: I found 192 (Reflecting a process – Using).

...

2S3: We will do it from width and height. Height is six units, four units are on the side, the bottom is the same as the top. (After showing six and four on the figure) Here is eight (showing the front of the object) (Reflecting a process – Using).

3T: What are we going to do then?

4S4: We will multiply.

5S3: I found 192.

...

8S5: Base 32.

9T: There are 32 cubes in the base. How many cubes would it be if we filled the entire prism?

10S5: If we count the bottom layer, there are six upwards. Multiplying six by 32 is 192 (Reflecting a process – Using).

In solving this problem, all groups tried to use the knowledge they gained from the previous problems (1S1, 2S3, 4S4). Four students found the cubic unit amount in the base layer by multiplicative reasoning. Then they thought that there would be six of these layers and multiplied the result by 6 (4S1, 5S3, 8S5, 10S5). For this reason, it is thought that the students proceed in the direction of constructing the *volume = base area × height* formula using the generalization of *cube unit number = unit cube number in the base layer × height* (See Figure 4.).

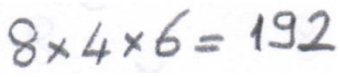

Figure 4. S1's Operations for the Solution of the Fourth Problem.

9S2: Thirty-two.

10T: How did you find it?

11S2: Multiplying four by eight. Here, I did not take six as one was given full. I took five and multiplied by 32. I found 160 (Reflecting a process – Using).

12T: Is the bottom part not included in this object?

13S2: I counted it.

14T: How many layers did you put on it?

15S2: Five floors. Hmm... then it would be 192 (Reasoning – Using).

...

11T: Do you think S6?

12S6: I counted the ones below 32. We multiply five by 32, then add 32.

S2 and S6 kept the lowest layer separate from the others. Therefore, he multiplied 32 by 5 (11S2). Then he added 32 to the result (160 br³) and found the answer as 192 br³ (15S2, 12S6). The solution steps of S2 and S5 are shown in Figure 5.

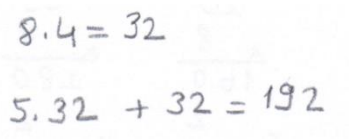

Figure 5. The Operations Performed by S5 for the Solution of the Fourth Problem.

Results from the Fifth Problem

In this problem, the students are asked how many cubes can fit inside a rectangular prism given the number of unit cubes arranged along its three sides. Students are expected to multiply the number of unit cubes arranged along the sides. Students are expected to form the generalisations *unit cube number = base area × height or unit cube number = width × length × height.*

2t: The number of unit cubes that can fit inside the prism shows which property of the object?

3S1: It can be area or volume. (He may have remembered the concept of volume from here because it is a concept in the 4th grade science lesson). But if we found the area, we would multiply the areas of their surfaces. So it can be volume (Recognition - Recognition).

4S2: We will use the same method as before. We multiply four by four. Then we multiply the height. 160 (Reflecting a process – Using).

...

1S3: Firstly, I multiplied four by four to find the cubes on the first floor and found 16. The length of this is 10 floors. Then I multiplied 16 by 10 and found 160 cubes (Reflecting a process - Using).

While solving the problem, S1, S2 and S3 established a relationship with the previous problem. As seen in Figure 6, three students found the number of unit cubes in a layer by multiplying the number of cubes arranged along two base edges. Then, they multiplied the result by the number of layers to find the number of unit cubes that could fit inside the object. It is seen that these three students constructed the aimed knowledge.

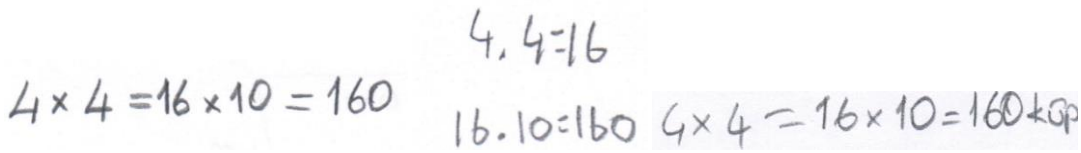

Figure 6. The Operations Performed by S1, S2 and S3 to Solve the Fifth Problem.

2S4: Everything will be reciprocal. Four cubes against four cubes. Two opposite him (he thinks a little). We will take the height as 10. (He starts over again) Four cubes there and four cubes there make 16 cubes. If we take the height as two, that's 20 cubes. If we multiply 16 by 10, we get 160 cubes. If we add them all together, we get 180 cubes.

...

1S5: There are 10 cubes upwards. At the bottom, on the left edge, there are four cubes. There are two cubes in the middle. To fill the gaps, I multiply four by 10, that's 40. I multiply 10 by two, that's 20. In the same way, I multiply four by 10 and two by 10. 40 + 40 = 80. 20 + 20 = 40. When I add it up, I get 100.

...

5S6: I do (after thinking for about two minutes). I found 92.

6T: How did you find 92?

7S6: It has four sides. I found it by multiplying.

S4, S5 and S6 determined the number of unit cubes arranged along the edges. However, he could not relate to the solution of the previous problem. Therefore, they could not give meaningful answers for the solution of the problem.

Results from the Sixth Problem

In this problem, the amount of load that a trailer with given edge lengths can take is asked. Students are asked to remember and use the knowledge they obtained from construction with unit cubes. They are expected to relate this information to a construction free of unit cubes and formulate the volume formula.

3S2: We multiply them all

4S1: Multiply the width, length and height (Recognition).

5T: How many?

6S2: We multiply three by two, six. We multiply six by eight, 48 (Reflecting on a process - Using).

...

12S3: Can we do it like this? Shall we multiply three by two and then multiply it by eight?

16S3: We can find the trailer of the truck by thinking like a rectangular prism. There are 48.

S1, S2 and S3 recognized the *unit cube number = number of unit cubes in the base layer × height* in order to find the number of cubes in construction with unit cubes. They adapted and used the knowledge they created from the previous problems (4S1, 6S2, 12S3, 16S3). They transferred the knowledge to a different structure by multiplying the width, length and height (3S2, 4S1). They rearranged the knowledge obtained from the constructions with unit cubes and adapted them to the prism given the edge lengths. The students restructured the existing knowledge in their minds and created a volume formula independent of unit cubes. It is seen in Figure 7 that S2 and S3 multiplied the width, length and height. S4 first made wrong inferences and performed wrong operation. Then, he did multiplication based on the statements of his group mate and was able to reach the result. It is thought that the student has realized the act of *building-with* but has not reached the stage of *constructing.*

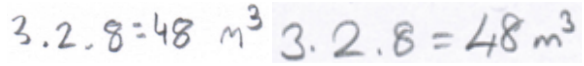

Figure 7. The Operations S2 and S3 Do to Solve the Sixth Problem.

8S5: We can find the width × length × height (Reflecting on a process - Using it).

9T: How do we do it?

10S5: Width 2, length 3, sorry, length 8, height 3. We multiply them (Reflecting a process - Using).

11S6: I don't understand what we multiply.

12T: It will multiply the three lengths given here.

13S5: If we multiply 3 and 2, we get 6. If we multiply 6 and 8, we get 48 (Solving the problem - Using).

At first, S5 could not recognize the knowledge he had created in the previous process. For this reason, he could not find the amount of load the trailer would take. Then, with the guidance of the teacher, he was able to relate the previous problems to this problem. He reached the solution by multiplying the width, length and height. He found the result as 48 m^3 (12S5, 15S5, 17S5). S5 recognized and used the unit cube finding knowledge. However, since he did this with the guidance of the researcher, it cannot be said that he formed the general volume formula. S6 could not make any contribution to this question and could not reach the solution. Therefore, he could not formulate the general volume formula.

Results from the Seventh Problem

In this problem, it is requested to construct a rectangular prism with a definite volume with the help of unit cubes. It has been observed whether the epistemic actions are carried out in the process.

1S1: He was putting what he produced in a box and those boxes in another box. It's 27 boxes. When we find the area of a shape, we multiply its width and length, that is, its long side and its short side. If we multiply a number that will result in 27 by another number, we can find what we are going to design. Multiplying nine by three is 27 (confusing area with volume).

2T: How did you line up the boxes when multiplied nine by three? In a row? Side by side?

3S1: It goes like this (He shows by drawing. He draws three lines in a row and writes nine on them. He draws another line from the side and writes three on it). They do not overlap, in a single row. If it had a height, we would have found its volume. We can directly multiply nine by three to find the number of boxes it can contain.

4T: In this parcel you have designed, you have lined up the boxes nine at a time, one after the other. What would be the height if the length is nine and the width is three?

5S1: (Thinks for a bit) Then its height will be one (Notice – Recognition).

6T: Then just multiplying nine by three isn't enough. What should it be?

7S1: 9 × 3 × 1 (Reasoning – Using).

...

1S3: The edge length is one unit. He wanted us to equate to 27. If its length was nine and its width was 3 units, we would have it equal to 27.

2T: You said the length is nine units and the width is three units. What about the height?

3S3: If we make two units....

4T: What is the height, the result of multiplication is 27?

5S3: One.

6T: Such a box can be designed. Is there any other alternative?

7S4: We swap nine for three.

S1 and S3 reasoned that two numbers with 27 multiplications could be the solution (1S1, 1S3). However, this reasoning is incomplete in that it contains two edges instead of three. Then they showed how they arranged the boxes by drawing models. S1 said that if he had a height in his drawing, he would have found the volume (3S1). After the researcher asked the question about height, they completed the missing information and concluded that the height was 1 br (5S1, 5S3). Two students showed that they abstracted the volume knowledge by saying "the multiplication of width, length and height is equal to volume" (See Figure 8.). S4 stated that the same result could be reached by taking the width as nine and the height as three (7S4). S4, on the other hand, stated that the same result can be achieved by taking the width as nine and the length as three (7S4). This situation is considered to be affected by S3's answer. This situation is considered to be affected by S3's answer. The deficiencies in *recognising* and *building-with* show that S4 could not perform the act of construction and therefore could not abstract the knowledge.

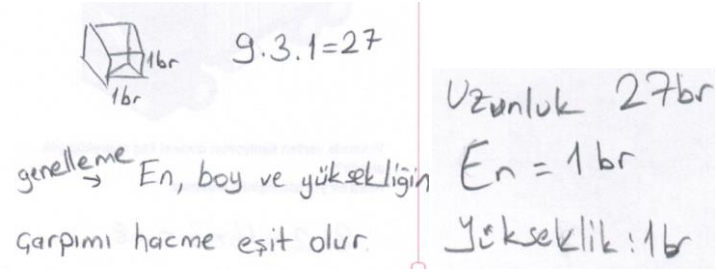

Figure 8. The Operations and Generalization of S1 and S3 to Solve the Seventh Problem.

S2, S5 and S6 could not find any idea for the solution. They could not reflect the experience they gained during the activity to this problem. Although S2 and S5 advanced in abstracting the information about finding volume in the previous problems, they could not find the edge lengths of a given volume. This situation indicates that the act of construction was not fully realised.

Results from the Eighth Problem

The students were expected to use the knowledge they had been trying to construct since the beginning of the activity in a problem in a different context. In this way, it was observed whether they could realise the act of construction. In this problem, a prism model is given whose volume and one of the segment lengths are certain. Students were expected to find other edge lengths and *surface area.*

1S2: There is a pool here. Ask how much water it takes. Only the length is given. We can divide.

2T: What do we divide?

3S2: Divide 480 by 20 (Reasoning – Using).

4T: 480 equals what?

5S1: width × length × height (Noticing - Recognising).

6T: What is 480 divided by 20?

7S2: 24.

8T: What does 24 tell us?

9S1: The multiplication of width and height (Relating - Using).

10T: If you wanted to design such a pool, what would you say about the width and height of this pool?

11S2: It can be three and eight (Solving the problem - Using).

12S1: It can be six and four (Solving the problem - Using).

...

9S3: We multiply the width and length and then multiply by the height.

10S4: Multiply the width, length and height and equal 480. We write 20 instead of width (Reasoning - Using).

12S4: We can say the length is 10. The height will be 200. But we can increase it. For example, as I said; 20 × 20 is 400. The rest will be 80.

18S3: For example, if we say the length is 3 metres. We multiply 20 by three, 60. The height is eight. If we multiply 60 by 8, we get 480.

23T: Is there another alternative?

24S4: We can choose from the divisors of 480.

25S3: If we make its height 6, we get 120 (multiplied by 20), and if we multiply it by 4, we get 480.

S1 and S3 are aware that the result of 480 is obtained from the formula *volume = width × length × height.* It is understood that they performed the act of recognition (5S1, 9S3). They divided 480 by 20 and said that the multiplication of width and height would be 24 (7S2, 9S1). Based on this, Ö1 found a width of 6 m and a height of 4 m (See Figure 9.). S2 and S3 stated that the edge lengths could be 8m and 3m (11S2, 18S3). It can be seen in Figure 9 that the students used the unit of meters for lengths, but did not use any units for area and volume while performing the operations. On the other hand, S4, S5, and S6 either could not make up their minds or could not reach a conclusion by reasoning incorrectly. As a result, it is seen that three students recognized and use the volume formula very easily. The self-confidence of the students while solving the question and the fact that they used the volume knowledge directly means that they have constructed the volume knowledge.

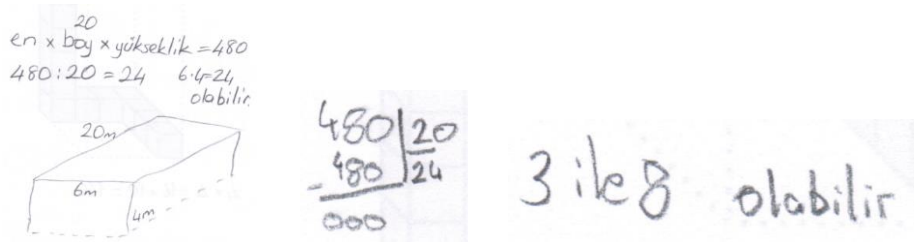

Figure 9. The Operations S1 and S2 Do to Solve the First Part of the Eighth Problem.

14S1: (After some reflection) He asks us not the width × length × height in this question, but the sum of the surface area of a shape, namely the pool, as in the first two questions, we did (Recognition – Recognition).

15T: Could you solve the question and tell me how you did it?

16S1: First, I multiplied six by four and got 24. Since there are two of these, I multiplied 24 by two and got 48. Then I multiplied 20 by four to get 80. Since there are two, I multiply by two to get 160. I multiplied 20 by six to get 120. There is one of these. It only has the bottom. The pool model has no upper face. We do not find its area. I added them all together and found 328 m² (Solving the problem - Using).

17T: What did you find Ö2?

18S2: I could not find it.

...

26S4: We multiply them all. Hmm... This question is similar to the first one we solved (Recognition – Recognition).

30S3: Height 3 m. If we tile on the long side, we multiply 20 by 3, if we tile on the short side, we multiply 8 by 3. Since they also have opposites (reciprocal congruent surfaces), we add both results with them (Reflecting a process - Using).

31T: How many surfaces will be tiled?

33S3: Isn't it five?

34T: So what should we do?

35S4: Just like we found the trailer of the truck (Relationship – Using).

36S3: Then we multiply 20 by eight, 160.

37T: What area of the pool (160m2) is this?

38S3: Base. We add this to the result.

In the second part of the question; S1, S3 and S4 made a connection between the question and the first two problems (14S1, 24S4, 35S4). They realized that they needed to calculate the surface area of the created pool. However, only S1 and S3 recognized the surface area knowledge that was constructed in the previous problems and used it in solving the problem (16S1, 30S3, 36S3, 38S3). In addition, S1 and S3 thought that the upper part of the pool was a void and did not include it in the calculation (See Figure 10.). Although S4 made a connection with the first two problems, he could not use the knowledge and could not reach a conclusion. As in the first stage of the problem, S1 and S3 easily realized the *recognition* and *building-with* actions at this stage. It is understood that both of them construct the surface area knowledge. Other students could not reach any solution in the second stage of the problem.

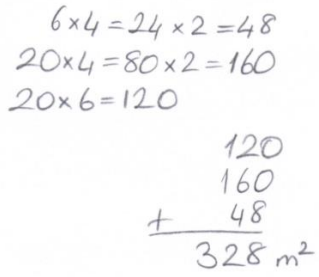

Figure 10. S1's Actions to Solve the Second Part of the Eighth Problem.

Discussion and Conclusion

In the first and second problems, two groups with high and medium achievement levels recognised the quality to be measured, the properties of the prism and the area relation of the rectangle. However, the group with low achievement level could only recognise the properties of the prism. They remembered the area relation of the rectangle with the guidance of the teacher. All students succeeded in using the area relation of the rectangle. In other words, the epistemic actions of *recognition* and *building-with* were realised. The use of the terms "bottom floor - top floor" instead of "base", "size" instead of "length", and "edge" instead of "side" can be given as examples of such misnaming. This situation is similar to the use of words such as "distance, line, length, perpendicular, line, vertical, edge" instead of the concept of "height" in the study of Gürefe & Gültekin (2016).

S1's statement that he found "the sum of the areas of all surfaces" and S3 and S4's statement that they calculated "the area of the container" can be considered as they progressed in constructing surface area knowledge. The fact that S2 and S5 calculated the surface area directly and without hesitation in the second problem can be interpreted as they constructed the surface area knowledge. S6, who had a low level of achievement, could not reach the construction stage. It is thought that S6 did not know the characteristic of area and had deficiencies about calculating the areas of geometric shapes. This situation prevented S6 from reaching the construction stage.

In the secondary school mathematics curriculum, "the number of unit cubes that can be placed in an object in such a way that there is no gap" is defined as the volume of that object. Students easily found the number of unit cubes in constructions consisting of unit cubes by using additive and multiplicative reasoning. In addition, it was not difficult to find the volume of the prism given the number of cubes in the base layer and along its height. They found the number of cubes in the base and multiplied by the number of cubes lined up along the height. This result agrees with the results obtained in the studies of Camci (2018) and Battista and Clements (1998). In this context, it can be said that the students started to construct the *base area* × *height* knowledge to find the volume. However, S4 with moderate mathematics achievement and two students with low achievement (S5 and S6) could not calculate the volume of a prism with a certain number of cubes arranged along its three edges. It has been observed that students with high success levels use the *base area* × *height* method faster.

According to the results obtained in the research, S4 with a medium level of mathematics achievement and S6 with a low level of mathematics could not establish a relationship between structures with and without a unit cube. Other students calculated the volume of the prism by multiplying the measurements of the width, length and height. It is seen that all students, except S4 and S6, made progress in constructing knowledge for calculating volume.

According to another result of the research, most of the students could not find the edge dimensions of a rectangular prism given the volume. Especially the group consisting of low-achieving students could not make any idea about this situation. However, S1 and S3 who reached the conclusion noticed the two edges of the prism and had difficulty in the third edge.

Another result is related to students' use of units. It has been observed that the measurement unit is not used in some cases. It has been observed that the measurement unit is not used in some cases. Students sometimes used the unit of length instead of the unit of area. It is understood that the students could not establish the connection between the quality to be measured and the unit used to measure that quality, or they did not care about using units. This result also agrees with the result of the study of Tan-Şişman & Aksu (2009). This result is also consistent with the result of Tan-Şişman & Aksu's (2009) study. The reason for this may be that the students had deficiencies in measurement in their previous term learning.

In order for the abstraction to be fully realised, it is expected that the constructed knowledge is directly used in problems with different contexts. S1 and S3 were able to use their surface area and volume knowledge in the last problem. S2 was able to reuse only the volume knowledge. It is seen that students with higher achievement level realise *recognition, building-with* and *construction* actions faster. It is understood that as the achievement level decreases, the acts of abstraction decrease. This result coincides with the results of the studies conducted by Ayanoğlu (2012), Aydın Çınar (2019), Hasar (2019), Memnun (2011), Temiz (2019), Ulaş & Yenilmez (2017), Yenilmez & Yüksel (2018) and Yeşildere & Türnüklü (2008).

Epistemic actions are intertwined, simultaneous and observable actions (Dreyfus, 2007; Dooley, 2007). According to the results of the research, the students performed the actions of *recognition, building-with* and *construction* sometimes sequentially and sometimes simultaneously. This result is consistent with the studies of Akkaya (2010), Altaylı Özgül & Kaplan (2016), Dinç (2018), Dreyfus (2007) and Eldekçi (2019).

Recommendations

It is seen that the recognized or created formula structures can be easily used by the students, but the connection between the operations and the concepts cannot be established. Activities for calculating surface area and volume without using formulas should be included. It is suggested to focus on the quality of the prism that the result obtained after performing the operation belongs to.

Mostly, it is seen that students have difficulties in applying the constructed knowledge to different problems. For this reason, it is recommended to include different activities at regular intervals after knowledge structures are established. In this way, permanent abstraction of the constructed knowledge can be ensured.

In the study, students working as a group showed that social learning environments were positive in terms of abstraction. Learning environments can be created to enable interaction within or between groups in the teaching of the issues.

One of the important concepts for measurement is the unit. In this study, it was observed that the students had problems in using units. They experience confusion in determining the unit of property to be measured. For this reason, examining the processes of constructing the concept of unit will help to eliminate such problems and help students to establish a connection between measurement and property.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

This research was carried out in accordance with the decision number 9 taken at the meeting of Eskişehir Osmangazi University Social and Human Sciences Research and Publication Ethics Committee dated 25.03.2020.

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Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Demir, G., & Seçkin Kapucu, M. (2023). Ethnomathematics approaches at middle school textbooks. Osmangazi journal of educational research article template writing guide. *Osmangazi Journal of Educational Research, 10*(1), 120-141.

Submitted: 22/03/2023 **Revised:** 03/08/2023 **Accepted:** 07/08/2023 **DOI:** 10.59409/ojer.1269449

Ethnomathematics Approaches at Middle School Textbooks

***Gülsüm Demir, **Munise Seçkin Kapucu**

Abstract. In this research, Middle School Mathematics Curriculum and Middle School Mathematics Textbooks were examined in terms of ethnomathematics approach. Answers were sought to the questions of 'how is it related to culture?' within the subject of acquisitions, content (lecture), learning-teaching process (activities) and evaluation (questions) in the books prepared within the scope of the Middle School Mathematics Curriculum implemented in Türkiye. In this study, document analysis -which is a qualitative research method, was conducted. Examples of mathematical tasks suitable for these achievements were examined in the textbooks of all Middle school grades (5-8th grades) published by the Ministry of National Education, which were prepared in accordance with the Mathematics Curriculum (5-8th Grade) published in 2018 and the curriculum. The examinations were made in the context of the relationship between acquisitions, content, learning-teaching process and evaluation with culture. Considering these four titles, only two acquisitions were associated with culture in the Mathematics Middle School Curriculum, which includes a total of 52 acquisitions in the sources examined. When the textbooks are examined in terms of content, activity and evaluation, it is seen that culture is emphasized in subjects such as Numbers and Operations, Geometry and Measurement, Algebra, Data Processing as a field of learning. The emphasis on culture in terms of content and learning-teaching process is equal when examined of these two titles. Association with culture is rare (with 6 question) in the evaluation part.

Keywords. Ethnomathematics, mathematics education, culture, curriculum.

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Many concretizing objects, especially technology-supported materials, are used and new approaches are being discovered in the field of mathematics education every day (Akkaya, 2016). Although it has not been newly discovered, one of the approaches whose field of study has increased recently in today's mathematics education is 'ethnomathematics' (François & Kerkhove, 2010).

Ethnomathematics was first introduced to the world of mathematics in 1985 by Ubiratan D'Ambrosio, a mathematics educator and historian. According to Brazilian mathematics educator D'Ambrosio (1985), ethnomathematics is a step towards revealing different mathematical ideas by creating a bridge between anthropologists, cultural historians and mathematicians. At the same time, he defined ethnomathematics as the examination of the relationship between culture and mathematics and the emergence of the mathematical thought in different cultures (D'Ambrosio, 2001). At the first sight, culture and mathematics can be seen as two separate disciplines. However, contrary to what is thought, they are in a close relationship with each other.

Ethnomathematics, which proposes to do today's mathematics education with the help of culture, has an important place in the world of mathematics. According to D'Ambrosio (1985), the reason for the failure in mathematics is that mathematics applications modified from their original form are taught to students under the name of mathematics. When this expression is considered, it is advocated that a mathematics education should be built by adding each country's own culture to the base of mathematics. Gerdes (1995) lists the main features of ethnomathematics as follows: First, ethnomathematics considers mathematics as a broad concept that includes activities such as counting, measuring, designing, playing games, and explanation. Second, he emphasizes and analyzes the influence of sociocultural factors of ethnomathematics on learning, teaching and the development of mathematics. Thirdly, it treats mathematics as a cultural product, and lastly, each person, each culture and subculture creates its own mathematics. Mathematics, which is a cultural product, has a history and mathematics is an activity that all people do all over the world (Bahadır, 2021).

Although mathematics as a science has a history that is equal to the history of humanity, it has a long history of events and ups and downs. In the first years of known history, there is no precise information about whether the word "math" was used. This although it is not known when and where the word took shape and came into use, it has always been. It is a fact that it has always been used by people (Nasibov, Kaçar, 2005). One of the research topics in the philosophy of mathematics is the original starting point of mathematics. If mathematics is explained to students with this starting point, it may be easier for them to learn mathematics. The mathematical examples around each student are

different. This difference is determined by the culture and nature they live in. Let us first examine the two accepted views of the starting point of mathematics: Is mathematics a science discovered by humans using nature or is it a science created in a virtual environment? Let's examine the answer to this question, which is studied as a research subject by researchers, with a few examples: For example, considering numbers, the equation 1+1=2 is an abstract operation. If we want to embody this process, that we take one apple in our right hand and one apple in our left hand and we have 2 apples in total. The number 2 is defined as two objects of the same type. When you look at the apples in your hand, it would not be correct to say that they look exactly alike. One can be red and the other green, or one can be light in tone and the other dark. Maybe one is spotted and the other is not. In other words, we cannot find objects that are exactly alike in the universe. As can be understood from these examples, mathematics is a very abstract science. If we apply this idea to geometry: For example, when looking at the sky, it is quite common for a middle school student to think that the Sun sees as a circle and it is. However, when examined with a telescope, it is seen that there are chemical reactions and explosions on the Sun, and that it is in a constant state of change. When we look at all the examples given, we can see that mathematics is not a purely abstract science, but that mathematics takes place in nature in a concrete form. All research on the starting point of mathematics contributes to mathematics education. Mathematics teaching can be facilitated by giving examples from nature, which is also the starting point of students in mathematics teaching. However, these examples should be specific to the society. The examples used in each society may be different. A student living in the Amazon should be given an example related to his/her own culture, while a student living in Asia should be given an example that he/she may encounter in Asia. This literature has woven a rich mosaic of conceptions of the nature of mathematics, ranging from axiomatic structures to generalized heuristics for solving problems. These diverse views of the nature of mathematics also have a pronounced impact on the ways in which our society conceives of mathematics and reacts to its ever-widening influence on our daily lives (Dossey, 1992).

One of the biggest difficulties experienced in mathematics education systems result of this abstractness of mathematics. Visualization approaches are frequently used to overcome this difficulty and to provide students with permanent learning. Visualization has been defined as the process of transforming the visual model into a mental structure (Schnot et al., 1991). One of the most effective of these visualizations is examples from daily life. In mathematics education, it is aimed to achieve a permanent learning by associating the knowledge learned by the student with the schemes. They have by giving examples from daily life. Visualization, as a different perspective, has been expressed as a

bridge between the world of experimentation and the world of thinking and reasoning (Konyalıoğlu, 2003). In general, visualization has an important place in mathematics education. These objects should be chosen correctly. They should be supportive in teaching the subject. Cultural learning can be used in this subject. Visual elements have an important place in the cultures of societies. Examples such as carpet patterns, figures used in architecture, patterns on clothes... These visual materials can be used with the visualization approach in mathematics. These visuals can contain many educational materials for mathematics. With this understanding, each society can adopt a unique mathematics teaching approach. An educational approach should be adopted without societies losing their core values. The basic principle of this educational approach should be to raise individuals who can think multidimensional, evaluate subjects from different perspectives, conduct interdisciplinary studies, and develop logical, different, creative and effective solution strategies for the problem situations they encounter (Çalık & Sezgin, 2005).

Mathematics education that does not include cultural elements and nature can be challenging for students. When the part we call pure mathematics is only given, students develop learning difficulties and prejudice about what they cannot do against the lesson. Predominantly Greek-based, Eurocentric mathematics has become the standard way of understanding the mathematical world (Ascher & D'Ambrosio, 1994). Due to this restrictive attitude towards mathematics, it started to be known with a bad reputation. In order to get rid of this perception, the parameters of school mathematics should be expanded and made more inclusive. One of the ways to achieve this aim is ethnomathematics. As each country attaches importance to the uniqueness of mathematics education, it is thought that the efficiency of mathematics education given to students will increase.

When the studies conducted within the scope of mathematics education and culture are examined, mathematics is frequently used in Turkish Culture and Architecture (Öztürk & Türkoğlu, 2016). While giving mathematics education to students who grow up in this geography, it is important for students to provide this education by integrating it with the culture we have. It will both facilitate the education served to students and provide them with information about their own culture (Dambrosio, 2011; Rosa & Orey, 2011).

According to Öztürk and Türkoğlu (2016), we can categorize geometric motifs in Anatolian architecture as interlacing, geometric compositions developed from the line system, and geometric compositions consisting of closed shape interlacing. In other words, it is not possible to separate architecture in Türkiye from mathematics. Using our cultural structures, which are so related to

mathematics, in mathematics teaching both facilitates the mathematics education given to the students and can prevent them from being ignorant of the culture.

According to D'ambrosio (2001), values, traditions, beliefs, language and habits that reflect the culture of students are ignored in mathematics education. In such situations, the ways in which children invent personally meaningful conceptualizations are not expected. Children are expected to memorize predetermined procedures without having to gain a deeper and conceptually meaningful understanding of the mathematics they are studying. This may lead to the training of students with a low success profile in mathematics.

In Rosa & Orey's (2011) study, it is stated that this association to be made in the curriculum and the textbook will help educators and teachers develop students' imaginations and critical thinking and analysis skills by incorporating the ethnomathematics perspective into the mathematics curriculum. In other words, mathematics education may be more meaningful for a student who has an ethnomathematics perspective.

Every society, in order to ensure its continuity, tries to teach and adopt its own culture to its citizens on the one hand, and on the other hand, to provide them with behaviors that will enable them to keep up with the advances in the world society of which they are a member. For this purpose, it is stated in the curricula which behaviors are desired to raise people who have acquired these behaviors. Education and training activities to be given for all courses, these objectives is tried to be done by taking into account (Çilenti, 1988). The Middle education program published by the Ministry of National Education (MEB) was examined. There are 13 items in the Specific Objectives of the Mathematics Curriculum. Some of the examples of specific objectives that can be considered appropriate for the ethnomathematics approach are as follows: 'Will be able to use the meaning and language of mathematics to make sense of the relationships between people and objects and the relationships of objects with each other' in Article 5 and 'Will be able to recognize the relationship between mathematics and art and aesthetics' in Article 12. When these specific objectives are examined, it is seen that they can be related to the connection between mathematics and culture.

In this study, the Mathematics Curriculum implemented in schools in Turkey was examined in terms of content. The 5th, 6th, 7th and 8th grade achievements in the program and the explanations of these achievements were examined. In this examination, attention was paid to whether cultural elements were included or not. In the second stage of the research, the Middle School Mathematics Curriculum and Middle School mathematics textbooks implemented in Turkey were examined in

terms of ethnomathematical approach. In line with this purpose, answers were sought to the questions of how the relationship between culture and acquisitions, content (lecture), activities in the learning and teaching process, and evaluation (questions) in the books prepared according to different grade levels within the scope of the Middle School Mathematics Curriculum implemented in Turkiye.

Method

Research Model

This study is an example of qualitative research. Qualitative research can be defined as "research in which qualitative data collection techniques such as observation, interview and document analysis are used and a qualitative process is followed to reveal perceptions and events in a realistic and holistic way in a natural environment" (Yıldırım & Şimşek, 2008, p. 39). Document analysis model was used in this research. Document analysis is a scientific research method that can be defined as collecting, reviewing, questioning and analyzing various documents as the primary source of research data (Sak et al., 2021). In this study, the Middle School Mathematics Curriculum and textbooks were examined to see whether they contain traditional motifs, concepts and visuals belonging to Turkish society. The documents were examined with these criteria.

Documents Used in the Research

In this research, Middle School Mathematics Curriculum and textbooks prepared by two different publishers were selected as documents. The first source is the Mathematics Education Program published by the Board of Education (5-8th Grades) in 2018, and the second source is the Middle school mathematics textbooks prepared on the basis of the Primary Education Mathematics Curriculum used in Turkey. The textbooks used in this and other grades do not come out of a single publisher. There are textbooks belonging to private publishers. In this study, at least one textbook prepared by private publishers for each grade and textbooks published in 2021 prepared by the Ministry of National Education were used. The publications related to the examined books are presented in Table 1.

Table 1.

Publisher and Publication Year of the Reviewed Books

Grade Level	Publishers	Publication Year
Grade 5	MEB	2021
	Koza	2021-2022
Grade 6	MEB	2021
	Koza	2019
Grade 7	MEB	2021
	Koza	2019-2020
Grade 8	MEB	2021
	Koza	2019-2020

According to Table 1, two different publications (MEB, Koza) were analyzed at each grade level. A total of 8 books were analyzed.

Data Analysis

In this study, data were collected by document analysis. Document review is a research method that can be defined as the collection, review, questioning and analysis of various documents as the primary source of research data (Sak et al., 2021). The relationship between acquisitions, content, learning-teaching process and evaluation with culture was chosen as document review criteria. While analyzing the obtained data, descriptive analysis technique was used. One of the strengths of document analysis is long-term and time-spanning data analysis (Yıldırım & Şimşek, 2021). Document analysis was carried out in five stages: accessing the documents, checking their authenticity, understanding the documents, analyzing the data and using the data. (Foster, 1995, akt.Yıldırım & Şimşek, 2021).

Validity and Reliability

The concept of credibility and transferability was adopted to ensure internal validity and external authenticity (Lincoln & Guba, 1985). Accordingly, for internal validity, the data were interacted with for a long time and expert review was utilized. For external validity, the research process was described in detail. In order to ensure the internal and external reliability of the study, answers were sought to some questions related to validity and reliability put forward by Miles and Huberman (1994). For internal reliability, the research questions were determined in a detailed and purposeful manner, and the data were analyzed by more than one researcher. At this point, consensus

was achieved between the researchers on the codes obtained in the research. For external reliability, the researchers tried to explain all stages of the research clearly and in detail. The results were associated with the data. The data obtained in this context were supported with sample quotations.

Results

The data obtained in this section were analyzed and presented in line with the purpose of the research. The findings regarding the relationship between the acquisitions, content (lecture), activities in the learning and teaching process, and evaluation (questions) in the books prepared for different grade levels within the scope of the Middle School Mathematics Curriculum implemented in Türkiye are given below.

Examining in Terms of Acquisitions

First of all, the achievements given in the curriculum were separated according to learning areas and grade levels and their relationship with culture was examined. The Ministry of National Education has specially determined achievements for each grade. The table 2 below shows what these achievements are.

Table 2.

Acquisitions with Cultural Emphasis in Learning Areas

Grade Level	Learning Area	Acquisition
5th Grade	Numbers and Operations	Acquisition number M.5.1.1.3. Explanation of the acquisition: b) Examples of our historical and cultural artifacts (architectural structures, carpet decorations, rugs, etc.) are given to the figure patterns.
8th Grade	Geometry and Measurement	Acquisition number M.8.3.2.3. Explanations of the acquisition: b) Studies to determine translation or reflection transformations in patterns, motifs and similar images are included. c)Examples of our traditional arts (tile, ceramics, weaving, etc.) are also taken into account.

When the acquisitions with the emphasis on culture in the learning areas in the 5th grades are examined, it is seen that only an acquisition in the learning area of Numbers and Operations is associated with culture (Table 2). In other learning areas, an acquisition or an explanation under the acquisition related to this subject has not been found. There are 56 acquisitions in total in the 5th grade mathematics course.

When the **acquisitions** with cultural emphasis in the learning areas in the 8th grades are examined, it is seen that there are 5 learning areas and only one acquisition in the Geometry and Measurement section is associated with culture (Table 2). There is only one acquisition in this section. the 3-item explanation section under these acquisitions is given in table 2. In the table, the acquisition is not given, the explanation part is included. Since transformation geometry is a very suitable field to be discussed together with art, it is seen that it is also included in the Curriculum. In the learning and teaching process, attention has been drawn to the fact that teachers manage this process by making use of our culture related to the given subject. It is suggested to be presented by combining it with the culture-art relationship in the lecture or evaluation part. In the curriculum, there are a total of 52 acquisitions in Grade 8.

In other grades (6th and 7th grade), there are no acquisition associated with culture. Explanations of the acquisitions are given in Table 2. The acquisition in the curriculum are given below. In the explanation part of the acquisition numbered M.5.1.1.3: The rule creates the desired steps of the given number and shape patterns.), which belongs to the learning field of Numbers and Operations in the 5th grade and in the item b ((Examples of our historical and cultural artifacts (architectural structures, carpet decorations, rugs, etc.) are given to the figure patterns.)), there is a suggestion to use the works of our culture. At the 8th grade level, there are suggestions related to the use of our cultural elements while giving lectures or exemplifications, considering the parts in M.8.3.2.3 (M.8.3.2.3 It creates the image of polygons resulting from translations and reflections.), item b (Studies to determine translation or reflection transformations in patterns, motifs and similar images are included.) and c (Examples of our traditional arts (tile, ceramics, weaving, etc.) are also taken into account.) in the field of geometry and measurement learning (Table 2).

Content Review

In the Curriculum, there are topics and explanations that are aimed to be acquired by the students in the course content. The way this curriculum is implemented is in the textbooks. The data obtained as a result of the examination of the middle school (5th-8th grade) mathematics textbooks

approved by National Education and belonging to two different publishers at each grade level are given below. The textbooks that are used in mathematics education belongs to two different publications (MEB, Koza) when examined according to context obtained results given at Table 3.

Table 3.

Examining Textbooks in Terms of Content

Grade Level	Publisher	Learning Area	Chapter	Subject	Frequency of Example
5th Grade	MEB	Numbers and Operations	Chapter 1	Natural Numbers	2
	Koza	Numbers and Operations	Chapter 1	Natural Numbers	1
6th Grade	MEB	Numbers and Operations	Chapter 3	End of Chapter	1
		Algebra	Chapter 4	End of Chapter	1
	Koza	-	-	-	-
7th Grade	MEB	Numbers and Operations	Chapter 1	Multiplication by Integers	1
		Numbers and Operations	Chapter 4	Ratio and Proportion	2
		Geometry and Measurement	Chapter 5	Lines and Angles	1
		Geometry and Measurement	Chapter 5	Polygons	1
	Koza	Numbers and Operations	Chapter 1	Operations with Integers	1
8th Grade	MEB	Algebra	Chapter 3	Algebraic Expressions and Identity	1
		Algebra	Chapter 4	Equations with a First Order Unknown	1
		Geometry and Measurement	Chapter 5	Median, Bisector, and Elevation in a Triangle	1
	Koza	-	-	-	-

Considering the content of the textbooks at all grades, when the 5th grade level MEB and Koza publishers are examined, an emphasis on culture was found in the first chapter in the area of learning Numbers and Operations (Table 3). In the 5th grade textbook (MEB), before the subject is explained, *'In historical buildings, rug patterns, paving stones and tiles, geometric shapes are generally used in*

a certain order and number. Especially in historical artifacts, the presence of these shapes is clearly seen." Then carpet patterns and tiles are shown as examples. A similar example related to the same topic is given in the other textbook.

An emphasis on culture was found at the end of the Chapter 3 in the area of learning Numbers and Operations in the MEB publisher and at the end of the chapter 4 in the learning area of Algebra, at the 6th grade level. In grade 6 there is only culture-related content at the end of the chapter (Table 3). In this section at the end of Unit 3, Miniatürk in Istanbul is mentioned. Several different places that have an important place in Turkish History are introduced. At the end of the 4th unit, famous mathematicians related to the subject are mentioned. On this page there is 10 turkish lira. One of our important mathematicians Cahit Arf is also mentioned on the back of this money.

When looking at the 7th grade level, there are content found related to culture in the chapter 1 and 4 of the Numbers and Operations learning area, and the chapter 5 belonging to the Geometry and Measurement learning area in the MEB publications. Information about important Turkish mathematician such as Cahit Arf is given. Mathematical data on factors related to our culture such as the golden ratio in the most current symbol of the Turkish currency, the inclination of the minaret of the Great Mosque in Elazığ, and the ratio in the Turkish Flag are given in the related topic. In Koza publications, there is a place for cultural association during the lecture in the first chapter in the learning area of Numbers and Operations. When we look at the books of the two publishers, it is seen that the association related to the given content is in the areas of Numbers and Operations and Geometric Measurement.

In the field of learning Algebra, Geometry and Measurement at the 8th grade level, there are parts that help explain the subject related to culture. There is culture related part in Algebraic Expressions and Identity and First Order Equations in the learning area of Algebra. In one of the examples given on these topics, a map of Turkey was placed on the coordinate plane. Some provinces were marked on the map and the coordinate plane was explained to the students with an example they were familiar with. Also, in the Triangles that in area of Geometry and Measurement learning, there is a section where this association is made. In the introduction of the unit, 'Many civilizations in the past have used triangles in their works of art and structures. Especially in Seljuk and Islamic architecture, triangles have been a frequently used geometric element." explanations were made. Pupporting architectural visuals were used next to the explanation. In the textbook prepared by the 8th grade Koza publisher, there is no part of the content related to culture. In general, it has been

concluded that the sections prepared by making use of culture in the lecture, pre-topic preparation or end-of-topic sections are very inadequate or even absent in some classes.

Investigation in terms of Learning and Teaching Process

The events in the textbooks of the MEB and Koza publications regarding the learning and teaching process were examined with the ethnomathematics approach. The data obtained are given in Table 4.

Table 4.

Activities Related to Culture in Textbooks

Grade Level	Publisher	Learning Area	Chapter	Subject	Event Name	*f*
5th Grade	MEB	Geometry and Measurement	Chapter 3	Area Measurement	Cities on the Map	1
		Numbers and Operations	Chapter 3	Decimal Notation	Aircraft Mechanics	1
	Koza	Geometry and Measurement	Chapter 4	Triangles and Quadrilaterals	Motivation	1
6th Grade	MEB	Numbers and Operations	Chapter 1	Natural Numbers	Let's Learn Together	2
		Numbers and Operations	Chapter 2	Division by Fractions	Let's Learn Together	1
		Geometry and Measurement	Chapter 5	Land Measurement Units	Let's Learn Together	1
	Koza	Geometry and Measurement	Chapter 6	Volume Measurement Units	The Keban Dam	1
7th Grade	MEB	Algebra	Chapter 3	Equations with a First Order Unknown	Ministry of Justice Logo	1
		Geometry and Measurement	Chapter 5	Angles Made by Two Parallel Lines with an Intersect	Turkish Equivalents of Geometry Terms	1
	Koza	Numbers and Operations	Chapter 1	Operations with Integers	Holiday Allowance	1
8th Grade	MEB	Algebra	Chapter 3	Algebraic Expressions and Identities	Let's Explore Let’s Think	1
		Geometry and Measurement	Chapter 6	Transformation Geometry	Let's Do It Together 3	1
	Koza	Geometry and Measurement	Chapter 6	Transformation Geometry	Example 6	1

**f*: Frequency

At the 5th grade level, in the MEB publisher, in the chapter 3 in the area of Geometry and Measurement learning, there was a culture emphasis in the cities on the map activity on area measurement, and in the aircraft mechanics activity in the decimal representation in the Chapter 3 in the Numbers and Operations learning area while at Koza Publisher, there is an event in which cultural relations are held on triangles and quadrilaterals in the third chapter of the Geometry and Measurement learning area. Under the motivation title, there is a section where ethnic carpet patterns are found and the student wants to comment on it (Figure 1).

Figure 1. Geometric Objects on a Carpet Pattern.

In the textbook prepared by the MEB publisher at the 6th grade level, there are activities related to culture in the learning areas of Numbers and Operations and Geometry and Measurement. MEB publications offer an integrated activity with two cultures in the Let's Learn Together section on Natural Numbers in the first chapter. The question blended with our culture is presented in Figure 2. The other example includes a section that takes into account locally produced cereals in Turkey, an agricultural country. In the second Chapter, an activity related to culture was given in the Let's Learn Together section on division by fractions. In this example, hospitality in Turkish culture is touched upon. There is a section on Turkish coffee, which is served to guests who come to the house. There is an activity that emphasizes culture in the Let's Learn Together section in the sub-topic of Land Measurement units of the Geometry and Measurement learning area. In the 6th grade textbook prepared by Koza publications, there is an activity related to the Keban dam under the sub-topic of volume measurement units belonging to the Geometry and Measurement learning area. Keban dam is located in Elazığ and is the 2nd largest dam in Turkey. There is a section prepared on this subject.

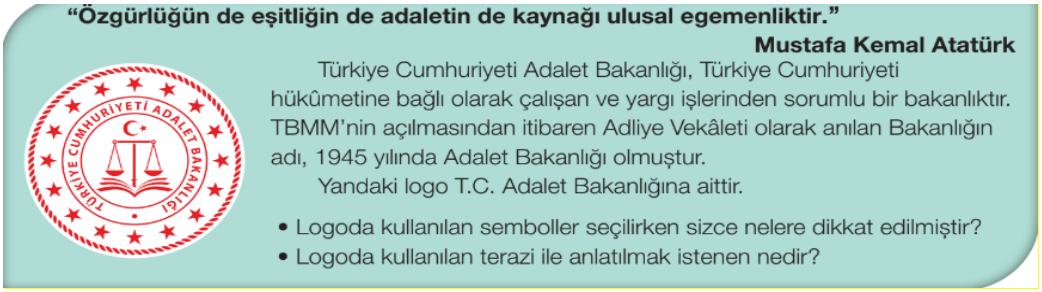

1272 yılında Kırşehir'de yapımı tamamlanan Anadolu Selçuklu Dönemi eseri olan Cacabey Medresesi, o dönemde astronomi araştırmalarının yapıldığı gökbilim merkezidir. Mimarisinde kullanılan kabartmalar dünyanın şeklini, küreler ise Güneş ve Ay'ı simgelemektedir. Füzeye benzeyen sütunlar ve bugün minare olarak kullanılan gözlem kulesi dikkat çekicidir. Ayrıca bilim adamlarının 2005 yılında dünyaya duyurduğu Güneş sisteminin 10. gezegeninin izleri yaklaşık 750 yıl önce medresedeki sütunlarda yerini almıştır.

Cacabey Medresesi'ni görmek isteyen bir grup öğrenci İstanbul'dan Kırşehir'e araçla yola çıkmış, 300 dakikada 450 km yol aldıktan sonra mola vermiştir. Moladan sonra aynı hızla devam eden bu aracın gideceği yere ulaşması için 180 km yolu kalmıştır. Buna göre aracın İstanbul-Kırşehir arasındaki mesafeyi kaç saatte tamamladığını bulalım.

Figure 2. Question Content is Culturally Appropriate.

The content in figure 2 is not included in the evaluation section. The reason is that it is a question that is presented to teach the subject and has solution steps underneath.

There are activities related to culture in the activities given in the area of learning Algebra and Geometry and Measurement in the MEB publisher, which is one of the publishers examined at the 7th grade level. In the field of learning Algebra, an activity was given over the logo of the Ministry of Justice on the subject of Equations with a First Order Unknown in the third chapter. An example of the data is shown in figure 3. The angles made by two parallel lines with an intersect, one of the sub-topics of the field of geometry and measurement learning, are included in the fifth chapter. In this topic, an activity with a content related to the Geometry book written by Atatürk is given. In this section, the Geometry book written by Atatürk is mentioned. There are words suggested by Atatürk in response to the geometry terms used in Ottoman Turkish. An activity has been prepared on the subject of operations with integers, which belongs to the field of Numbers and operations in Koza publisher and takes place in Chapter 1, by using one of our religious values, our holiday.


"Özgürlüğün de eşitliğin de adaletin de kaynağı ulusal egemenliktir."

Mustafa Kemal Atatürk

Türkiye Cumhuriyeti Adalet Bakanlığı, Türkiye Cumhuriyeti hükûmetine bağlı olarak çalışan ve yargı işlerinden sorumlu bir bakanlıktır. TBMM'nin açılmasından itibaren Adliye Vekâleti olarak anılan Bakanlığın adı, 1945 yılında Adalet Bakanlığı olmuştur.

Yandaki logo T.C. Adalet Bakanlığına aittir.

- Logoda kullanılan semboller seçilirken sizce nelere dikkat edilmiştir?
- Logoda kullanılan terazi ile anlatılmak istenen nedir?

Figure 3. Logo of the Ministry of Justice

There are activities related to culture in the activities given in the area of learning Algebra and Geometry and Measurement in the MEB publisher, which is one of the publisher examined at the 8th grade level. Ömer Hayyam was mentioned in the Let's Research and Learn section of the MEB

publications on algebraic expressions and identity in the 3rd chapter in the area of learning algebra. He has an important place in Islamic culture. Although he is not a Turk, he has a place in history as one of our religious values. In the field of geometry and measurement learning, there is an activity in which tile patterns are given in the section Let's do it together on Transformation Geometry in the Chapter 6. In Koza publisher, on the subject of Transformation Geometry in the Chapter 6 in the area of learning geometry and measurement, a relationship was made with culture in the activity whose title was prepared as Example 6. Considering the acquisitions of this subject in the Curriculum, there is an explanation that the motif/pattern to be associated with culture can be given. Accordingly, sample designs from our culture are shown in the questions given in the geometry section.

The activities in the textbooks of the MEB and Koza publications on the learning and teaching process have been examined with the ethnomathematics approach, but it is seen that there are not many cultural activities in all grade levels.

Examining it in Terms of Evaluation

The lecture and questions asked for evaluation at the end of the subject were examined at all grade levels and given in Table 5.

Table 5.

Examining the Questions Given in the Textbooks

Grade Level	Publisher	Learning Area	Chapter	Subject	Page/Test or Question Number	*f*
5th Grade	MEB	Numbers and Operations	Chapter 1	Natural Numbers	27	1
	Koza	Numbers and Operations	Chapter 1	Natural Numbers	54	1
6th Grade	MEB	-	-	-	-	-
	Koza	-	-	-	-	-
7th Grade	MEB	Numbers and Operations	Chapter 2	Addition and Subtraction with Rational Numbers	77	1
	Koza	-	-	-	-	-
8th Grade	MEB	Numbers and Operations	Chapter 1	Factors and Multiples	21	1
		Numbers and Operations	Chapter 1	Exponential Expressions	27	1
		Data Processing	Chapter 2	Data Analysis	67	1
	Koza	-	-	-	-	-

**f*: Frequency

A cultural element is encountered in the question on page 27 of the natural numbers topic in the first chapter in the learning area of numbers and operations at the 5th grade level of the MEB publisher. In this section, a pattern of ethnic patterned hexagons is given. The student was asked to find the other steps of this pattern. In the question on page 54 of the same learning area, chapter and subject in Koza publisher, the element of culture is encountered. (Table 5). In this section, an image about our culture is shared. The image shared to support the question belongs to Cappadocia in Nevşehir province.

At the 6th grade level, there is no evaluation section associated with culture in either publisher.

It's given the Rational Numbers subject in the 2nd Chapter in the area of learning numbers and operations in the textbook of the 7th Grade MEB publications, by integrating Ashura (Aşure), which belongs to the Turkish-Islamic culture and is cooked only in a certain time period, into the Rational Numbers subject. On the other hand, at Koza publisher does not have any evaluation section associated with culture.

In the MEB publisher, which is one of the publishers examined at the 8th grade level, there are activities related to culture in the questions given in the field of learning numbers and operations and data processing. In the learning area of numbers and operations of MEB publications, cultural elements were found in the question on page 21 of the multipliers and their multiples in the 1st chapter, and in the question on page 27 of exponential numbers. In the first one, April 23rd National Sovereignty and Children's Day was used as the context of the question. A question related to this was asked. In the other, Aşık Veysel was used as the context of the question. There is a cultural element in the question on page 67 about data analysis in Chapter 2 in the Data Processing learning area. March 18 Çanakkale Victory and Martyrs' Remembrance Day was used as the context for this question. However, there is no cultural integration that can be evaluated at a meaningful level for the student. In the 8th grade textbook prepared by Koza publisher, there is no part of the content related to culture.

Cultural relations were established in some of the questions prepared for evaluation purposes. However, this is not a relationship established by every publisher at every grade. A small number of questions were prepared for evaluation purposes. For a mathematics education that can be considered meaningful for students, the questions given should be more.

When looking at the general total according to grade levels, it was observed that a total of 26 culture-mathematics relations were established in the MEB publications and a total of 8 in

Koza publications. More culture-mathematics relations were found in MEB publications than in Koza publications.

Discussion and Conclusion

The results regarding the relationship between the acquisitions, content (lecture), activities in the learning and teaching process, and evaluation (questions) in the books prepared according to different grade levels within the scope of the Middle School Mathematics Curriculum implemented in Türkiye are presented in this section.

When the relationship between the acquisitions and culture is examined, it is seen that this association is made in the acquisitions of the 5th and 8th grade levels from the Middle school levels. At the other two grade levels, there are no acquisitions associated with culture. When all of the acquisitions given at these two grade levels are examined, it is seen that there is no different acquisition that encourages cultural learning in other acquisitions. Considering the total number of acquisitions, it can be said that the presence of an ethnomathematical approach in only two objectives in the Middle School Mathematics Curriculum is not sufficient for a meaningful mathematics education. The emphasis on the use of cultural relations in the acquisitions was made very little. It is very possible that the emphasis on culture is low in the textbooks prepared with reference to these acquisitions.

When the results regarding the relationship between content (lecturing) and culture are examined, the connection established with culture in the 5th grades is made only in the learning area of Numbers and Operations. In this learning area, it was done on only one subject. It can be seen as a facilitating factor for students when teaching mathematics that starting with an example from our culture while giving lectures, and that the objects used in the solved examples in the later parts of the subject are made up of cultural elements. However, when the whole subject is considered, these parts are not sufficient for the student to understand and assimilate the subject. In the 6th grade level, there is no cultural expression in the subject or in the introduction of the subject. However, in the information sections given at the end of the unit, there are parts related to the subject of our culture. While teaching the subject in two learning areas in the 7th grades, it is seen that the culture is reconciled. In the 8th grades, there are sections on Algebra and Geometry, 'Why should we learn?', during the lecture. In these parts, attention was drawn to our architecture and art. However, a meaningful cultural integration in these parts is not sufficient for mathematics education. In general,

during the lecture, some subjects were associated with culture at all levels. However, although these are not many in number, the association made is not instructive.

When the results regarding the relationship between the learning and teaching process (activities) and culture are examined, it is seen that the parts associated with culture in terms of the learning and teaching process at all levels consist of the learning fields of Geometry and Measurement, Numbers and Operations, and Algebra. In particular, activities that can attract the attention of students and appeal to their interests have been prepared. However, the prepared events are very few compared to the general number of events. When all grade levels are examined, it has been determined that there are activities integrated with our culture at every grade level, but they are few in number. For the ethnomathematical approach, more than a few examples given in the subject matter are needed. Achor and Uloko (2009) found in their study that the success of education using the ethnomathematical approach was higher. Educational materials prepared by adopting this approach can be even more effective.

When the results regarding the relationship between the evaluation (questions) and culture are examined, the use of cultural elements in the evaluation part is less preferred than the other titles. There is no evaluation section based on this association in Koza publications, which are publishers in other grade levels except for the 5th grade. In the 6th grade level, no cultural association was made in the evaluation part of the two publishers. Cultural elements are included in the subjects that are suitable for associating with culture. However, it is not sufficient. In the examples used, it can be said that the explanation of cultural elements in the Middle school curriculum is effective. However, these do not constitute an assessment scope that will be meaningful for the student. The section where the association with culture is the least with a total of 6 questions is the part where the evaluation is made. When examined in terms of content and process (activity), the emphasis on culture made under the two headings is equal.

Considering the whole grade level, it is seen that there are sections prepared with the ethnomathematics approach in every publisher at every grade. The class with the most relationships is 7th Grade. When looking at the general total according to grade levels, it was observed that a total of 26 culture-mathematics relations were established in the MEB publications and a total of 8 in Koza publications. However, these are not at a level to provide facilitators in mathematics learning for the student.

This research is limited to the 5th, 6th, 7th and 8th grade books published by MEB and Koza publishers within the scope of the Middle School Mathematics Curriculum implemented in Türkiye. In addition, the research is limited in terms of examining the books with the ethnomathematics approach within the scope of the sub-objectives (the relationship of the acquisitions, content, learning and teaching process and evaluation in the program with culture).

Recommendations

In this study, it is suggested that the objectives, content (lecturing), activities used in the learning and teaching process and assessment (questions) elements in the books prepared according to different grade levels within the scope of the Middle School Mathematics Curriculum implemented in Turkey should be reviewed, enriched and diversified in terms of cultural elements. In addition, this study was analyzed in terms of mathematics textbooks. The emphasis on ethnomathematics in other courses can also be examined.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

We conducted these studies within the framework of the Declaration of Helsinki. The research does not require any ethical permission.

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Osmangazi Journal of Educational Research **Volume 10(1), Spring 2023**

RESEARCH Open Access

Suggested Citation: Demirci, C., & Güven, A. (2023). The relationship between teachers' attitudes regarding the use of technology in lessons and lifelong learning. *Osmangazi Journal of Educational Research, 10*(1), 142-156.

Submitted: 20/12/2022 **Revised:** 23/04/2023 **Accepted:** 12/08/2023 **DOI:** 10.59409/ojer.1221967

The Relationship between Teachers' Attitudes Regarding the Use of Technology in Lessons and Lifelong Learning

***Cavide Demirci, **Ahmet Güven**

Abstract. This study aimed to determine the relationship between teachers' attitudes toward lifelong learning and technology usage. Correlational research design was used in the study. The universe of the study consists of a total of 8195 teachers working in Odunpazarı and Tepebaşı districts in Eskişehir city center. The sample of this study consists of 145 teachers determined by using the "easily accessible sampling" method. The data analysis showed that there is no significant relationship between teachers' attitudes about the use of technology and lifelong learning tendencies. As a result of the data analysis, it was concluded that the attitudes toward the use of technology did not show significant differences according to gender, age, and seniority.

Keywords. Teachers' technology usage, lifelong learning, relationship between lifelong learning and technology.

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Our lifestyles are changing rapidly. How we communicate, the way we get to our destination, the way we access information, and so many other things in our daily lives are being renewed. Many of us are adapting to this change. Education also takes its share from this change. The presentation of knowledge can be done in many ways, and the processes of learning and teaching are different from the past. The use of information technologies in education has undoubtedly made positive contributions. The Internet has allowed all computers on our planet to connect to each other under certain conditions and has revolutionized education as well as many other areas. The integration of technology in education has increased in recent years. Numerous forms of technology is being used in schools all around the world. Technology offers numerous benefits in education, such as enhancing student engagement, facilitating communication, and improving learning outcomes (Alzahrani & Ragab, 2021).

The speed and size of data communication allow easier access to information and faster transmission of information every day. With the spread of the use of the Internet, web tools defined as web 1.0 and where users unilaterally access information and do not interact with each other have become widespread. The concept of Web 2.0 has been defined by O'Reilly (2005) as a set of new applications and services that enable an engaged environment and structure to be created. As can be understood from this definition, unlike web 1.0, web 2.0 tools have an interaction between the user and the web page or application. For example, the user can upload and save data. It can rearrange the content according to its own use, share it with other users, and create a space of its own. This development has created a revolution in the use of technology in many areas and has spread the use of technological devices in many areas at a great speed. This situation has been reflected in schools and classrooms as lessons that go beyond the use of computers to access information or the use of projectors to reflect visuals, and with smartphones, tablets, smart boards and their interactions at the highest level. At this point, the Internet can be used effectively in the selection and preparation of teaching-related materials, in accessing information, communicating outside the classroom, in collaborative work and in developing communication skills (Malhotra, Dixit, and Uslay, 2002; Tutkun, 2011). These opportunities offered by the Internet to users also contribute to the effective use of IT in education (Akkoyunlu, 2002; Rogers and Finlayson, 2004). It would not be wrong to say that the internet and technology affect many areas of the educational process. At this point, the importance of the use of technology cannot be ignored, but it should also be possible to explain how and for what purpose technology is used in the education process.

There is a direct relationship between the use of technology in education and teachers' technological knowledge competencies (Doğru, Şeren, and Koçulu, 2017). However, Dargut and Çelik stated that in 2010, teachers often did not have enough knowledge about technology.

Teachers' Technology Usage

Research suggests that teachers' technology usage varies considerably, with some teachers integrating technology into their teaching practices extensively, while others use it minimally or not at all (Bai & Ertmer, 2018). Teachers have mastered every step of the educational process from the planning of the contents of the lessons, the preparation of the materials, the course materials, to the assessment and evaluation, and they can produce the content needed at every step. In some cases, the materials provided to the teachers may be insufficient or incomplete. However, sometimes teachers may not be provided with ready-made lesson materials or plans. In these cases, teachers can produce the materials and plans needed for the lesson thanks to the training they receive and the competencies in their fields. The use of technology in situations such as producing materials in needed times or for supporting and enriching the current lessons. The use of technology in education has been found to have numerous benefits for students. For example, technology can enhance student engagement, facilitate communication and collaboration, and provide access to a wide range of educational resources (Alzahrani & Ragab, 2021). Additionally, technology can support personalized learning, allowing students to work at their own pace and receive feedback tailored to their individual needs (Bai & Ertmer, 2018).

Lifelong Learning

Curiosity and learning have always had an important place in human life. However, education has been one of the basic phenomena of human societies. As formal education institutions, it would not be wrong to characterize schools as places where people receive a large part of their education. With developing technology and advancing science, 21. The century began as the years when people's access to information became faster and easier. In the absence of the Internet and computer technologies, the only resources from which a person could access any information were either a book or a teacher. The rapid change in human life has enabled people to access information quickly and at any time, and to obtain content on a wide range of topics such as videos, articles, directives, etc. on almost any subject. With this process, it has been accepted as a part of our lives by almost everyone that education can be done outside of formal education institutions, which have been questioned and harshly criticized from time to time, and that people can acquire many knowledge and skills through various sources if they wish. Diker Coşkun and Demirel (2012, p. 108). They

defined the concept of "Lifelong Learning" as people acquiring the knowledge and skills they need throughout their lives. In his radical critique of school, "The Unschooled Society," Illich said that people learn almost everything outside of school and through individual experience, stressing that school should be abolished altogether. As an alternative, he emphasized that the system he presented should provide the necessary resources to people who want to learn and help people who have knowledge to share their knowledge.

In 1972, when Illich published his book, he was criticized a lot for how these suggestions could be realized and emphasized that the alternative methods he presented could not be applied. When the concept of "Lifelong Learning" is considered as a whole and how it is applied with 21st century technologies, it would not be wrong to say that Illich's unschooled society is almost realized today. Of course, the big difference is that today there is no such thing as the disappearance of the formal education system and schools. Lifelong Learning is of great importance in terms of increasing people's personal development, knowledge and skills. In particular, the necessity for teachers to be in the understanding of constantly updating themselves shows how necessary the concept of lifelong learning is for educators.

Method

Purpose

The aim of the study is to determine the relationship between the attitudes of classroom teachers regarding the use of technology in lessons and their lifelong learning attitudes.

The sub-problems are,

1-Do teachers' attitudes towards the use of technology vary according to age, gender and seniority?

2-Do teachers' lifelong learning tendencies vary according to age, gender and seniority?

3-Is there a relationship between teachers' attitudes towards the use of technology and their lifelong learning attitudes?

Research Design

Correlational research design from quantitative designs was used in the study. Relational method is the research carried out to determine the relationship between two or more variables and to obtain clues about cause and effect (Büyüköztürk et al., 2012, p.184).

Universe and Sample

The universe can be defined as the group in which the results to be obtained by analyzing the data to be collected in the research will be valid and interpreted (Büyüköztürk et al., 2012, p.80). The universe of the study consists of a total of 8195 teachers working in Odunpazarı and Tepebaşı districts in Eskişehir city center. The sample is "a limited part of it selected from the universe in which work is being done to gather information about its properties; sampling defines the process of determining the properties of the universe and determining the appropriate samples to represent it in order to predict it and all the operations carried out in this process" (Büyüköztürk et al., 2012, p.81). The sample of this study consists of 145 teachers determined by using the "easily accessible sampling" method among a total of 8195 teachers working in Odunpazarı and Tepebaşı districts in Eskişehir city center.

Data Collection Tools

The data collection tools used in this context are the "Teachers' Attitudes towards Technology" Öztürk (2006), "Lifelong Learning Propensity" Gür (2016) scales in Annex-1. To obtain the research data, 300 scales were distributed and 157 of them were returned. 7 of these scales were outliers, they were removed. The data from the remaining 145 scales were analyzed.

Data Analysis

In the analysis of the data, "What are teachers' attitudes towards the use of technology?" and "What are the lifelong learning tendencies of teachers?" For the sub-problems, percentages, arithmetic means, and standard deviations of the answers given to the questions were calculated, and the results obtained were interpreted by showing them in tables. "Independent Sample T-test" and "One-Way Analysis of Variance (ANOVA) were used to determine whether teachers' lifelong learning tendencies and attitudes towards technology use differed in terms of age, gender, seniority variables. The correlation coefficient was examined for the sub-problem "Is there a relationship between attitude to the use of Technology and lifelong learning?" Before the correlation analysis, it was checked whether the data showed normal distribution. After it was determined that the data showed a normal distribution, correlation analysis was performed.

Results

Reliability Analysis

Cronbach's Alpha reliability coefficients for 145 questionnaires applied for the study are given in Table 1.

Table 1.

Reliability Statistics

Scale Coefficient Reliability	Item Number	Cronbach's Alpha
Reflection of Technology Usage to Teaching Process	16	0.898
Self-improvement in Technology Usage in Education	14	0.914
Use of Technology in Education and Classroom ıgement	9	0.895
Liflong Learning Propensity	17	0.992

When the reliability coefficients shown in Table 1 are examined, all parts of the two scales are close to 1.0. These statistics show that reliability is achieved.

Descriptive Statistics

Table 2.

Descriptive Statistics

		n	%
Gender	Male	60	41.4
	Female	85	58.6
Age	18-25	2	1.4
	26-30	10	6.9
	31-35	28	19.3
	36-40	17	11.7
	41 and over	88	60.7
Job Title	Teacher	130	89.7
	Paid Teacher	2	1.4
	Intern Teacher	0	0.0
	Deputy	7	4.8
	Manager	6	4.1
Professional	1-5	14	9.7
Seniority	6-10	13	9.0
	11-15	23	15.9
	16-20	14	9.7
	21 and over	81	55.9
State of Having a	No certificate	39	26.9
Computer Literacy	Obtained from a private institution	19	13.1
Certificate	Obtained with in-service training	87	60.0

According to the descriptive statistics, most of the participants (58%) are females, and the remaining part (42%) is male. When the data is examined in terms of age group, the age group of 41 and over constitutes the majority (61.3%). Most participants (90.0%) work as teachers. It can be seen that most of the teachers (55.3%) have a professional seniority status of 21 years or more.

Most of the participants (60.7%) obtained their computer literacy certificates through in-service training, the participants following this group (26.7%) provided their computer literacy certificates from a private institution, and the remaining participants (12.7%) did not have certification of computer literacy.

Participants' Attitudes towards Technology Use

The data obtained from the scale of technology use in education is examined. The “Teachers' Attitudes towards Technology" scale consists of 3 sub-dimensions. Dimension I is the reflection of the use of technology in education in the educational process, Dimension II, is personal development in the use of technology in education, Dimension III, is the use of technology and classroom management. Before parametric analyzes were performed, it was checked whether the data was distributed normally or not.

Table 3.

Flatness and Distortion Values

	n	Skewness	Kurtosis
Attitude to Use of Techno lucation	145	-.349	-.751
Lifelong Learning Propen	145	-1.271	.345

According to the analysis, we can say that the data are distributed normally in terms of flatness and distortion values.

Findings on Gender

Independent sample t-test was used to determine whether teachers' attitudes towards technology use varied according to gender. The findings obtained because of the analysis of the data are shown.

Table 4.

Findings on Gender

	Gender	n	X̄	S	SF	P
Reflection of Technology Usage hing Processes	Male	60	4.58	.43151	1.173	.281
	Female	85	4.57	.45228		
Self-improvement in Technolog e in Education	Male	60	4.32	.45429	2.264	.135
	Female	85	4.18	.54392		
Use of Technology in Education ;room Management	Male	60	4.37	.47463	7.040	.009
	Female	85	4.25	.67835		
Lifelong Learning Propensity	Male	60	3.61	1.37056	6.760	.010
	Female	85	3.93	1.11126		

The first sub-dimension in Teachers' Attitudes towards Technology scale, on the teaching processes does not show a significant difference in terms of gender (p> 0.05). The result of this analysis shows us that there is no significant difference between male and female in terms of the reflection of the use of technology on teaching processes. There was no significant difference between male and female participants in the second sub-dimension which is self-improvement of Teachers' Attitudes Towards Technology Scale There was no significant difference between male and female participants in the class management dimension, which is the last dimension of Teachers' Attitudes Towards Technology Scale.

Age-Related Findings

ANOVA (Analysis of Variance) from parametric tests was used to compare the average scores of the scale related to age.

Table 5.

Attitude Towards Technology, Findings on Dimension I (Age)

Dimension	Age	n	$\bar{X}$	Ss	F	P
Reflection of Technology Usage to ing Processes	18-25	2	4.6875	.00000	.602	.661
	26-30	10	4.6183	.59374		
	31-35	28	4.6563	.42236		
	36-40	17	4.6627	.35378		
	41 and over	88	4.5373	.45109		

As a result of the analysis of the variance analysis conducted to determine the difference between the sub-dimension scores of the use of technology in education on the teaching processes and the difference between the participant age groups, there was no significant difference between the sub-dimension scores of the reflection of the use of technology in education on the teaching processes and the participant age groups [p=0.661>0.05].

Table 6.

Attitude towards technology, Findings on Dimension II (Age)

Dimension	Age	n	$\bar{X}$	Ss	F	P
Self-improvement in Technology Usage in Education	18-25	2	4.6429	.10102	1.731	.146
	26-30	10	4.3500	.50893		
	31-35	28	4.4107	.51163		
	36-40	17	4.2647	.57464		
	41 and over	88	4.1640	.49465		

As a result of the variance analysis conducted to determine the difference between the self-improvement sub-dimension scores and age groups in the use of technology in education, no significant difference was found [p=0.146>0.05].

Table 7.

Attitude towards Technology, Findings on Dimension III (Age)

Dimension	Age	n	X̄	Ss	F	P
Use of Technology in Education and Classroom Management	18-25	2	4.5556	.47140	2.022	0.95
	26-30	10	4.4444	.67077		
	31-35	28	4.4841	.55532		
	36-40	17	4.2157	.77027		
	41 and over	88	4.1540	.57363		

The use of technology in education and classroom management sub-dimension scores and variance between age groups were analyzed. As a result of the analysis, there was no significant difference between the use of technology in education and classroom management sub-dimension scores and age groups [p=0.95>0.05].

Table 8.

Lifelong Learning Propensity Age-related Findings

Dimension	Age	n	X̄	Ss	F	P
Lifelong Learning	18-25	2	5.0000	.00000	1.237	.298
Propensity	26-30	10	4.1765	1.16531		
	31-35	28	3.5531	1.45551		
	36-40	17	3.5433	1.48092		
	41 and over	88	3.8603	1.10429		

One-way Anova test was performed to look at the participants' lifelong learning tendencies and whether there was a difference between their age groups. As a result of the analysis, there was no statistically significant difference between the participants' lifelong learning propensity scores and age groups [p=0.298>0.05].

Findings on Seniority

ANOVA (Analysis of Variance) from parametric tests was used to compare the scale score averages related to occupational seniority.

Table 9.

Attitude towards Technology, Dimension I Findings on Seniority

Dimension	Seniority	n	X̄	Ss	F	P
Reflection of Technology Usage to Teaching Processes	1-5	14	4.6693	.50606	.814	.519
	6-10	13	4.5000	.39198		
	11-15	23	4.6855	.40839		
	16-20	14	4.6473	.39193		
	21 and over	81	4.5405	.45679		

As a result of the analysis of variance conducted to determine the difference between the scores of the self-improvement sub-dimension and professional seniority in the use of technology in education, no significant difference was found [p=0.519>0.05].

Table 10.

Attitude Towards Technology, Dimension II Findings on Seniority

Dimension	Seniority	n	X̄	Ss	F	P
Self-improvement in Technology Usage in Education	1-5	14	4.4796	.48318	2.059	.089
	6-10	13	4.2802	.58209		
	11-15	23	4.4037	.44898		
	16-20	14	4.2449	.60978		
	21 and over	81	4.1499	.49107		

As a result of the analysis of variance conducted to determine the difference between the self-improvement sub-dimension scores and the occupational seniority groups in the use of technology in education, no significant difference was found [p=0.089>0.05].

Table 11.

Attitude towards Technology, Dimension III Findings on Seniority

Dimension	Seniority	n	X̄	Ss	F	P
Use Of Technology in Education and Classroom Management	1-5	14	4.4762	.58215	1.634	.169
	6-10	13	4.3675	.51197		
	11-15	23	4.3816	.72073		
	16-20	14	4.3413	.71007		
	21 and over	81	4.1399	.56704		

As a result of the analysis of variance conducted to determine the difference between the scores of technology use and classroom management sub-dimension in education and professional seniority groups, no significant difference was found [p=0.169>0.05].

Table 12.

Lifelong Learning Propensity Findings on Seniority

Dimension	Seniority	n	X̄	Ss	F	P
Lifelong learning propensity	1-5	14	4.1020	1.32681	1.901	.114
	6-10	13	3.1584	1.32937		
	11-15	23	3.8107	1.44871		
	16-20	14	3.3235	1.63094		
	21 and over	81	3.9325	1.01226		

As a result of the analysis of variance performed to determine the difference between lifelong learning propensity scores and occupational seniority groups, no significant difference was found [p=0.114>0.05].

The relationship between teachers' attitudes towards technology use and lifelong learning tendencies

Pearson correlation analysis was performed to determine the relationship between teachers' attitudes about technology use and lifelong learning tendencies. The findings are shown in the table.

Table 13.

The Relationship between Attitudes towards Technology Use and Life-Long Learning

	n	Pearson R	p
Reflection of Technology Usage to Teaching Processes	145	-.014	.866
Self-improvement in Technology Usage in Education	145	.002	.979
Use of Technology in Education and Classroom Management	145	-.066	.428

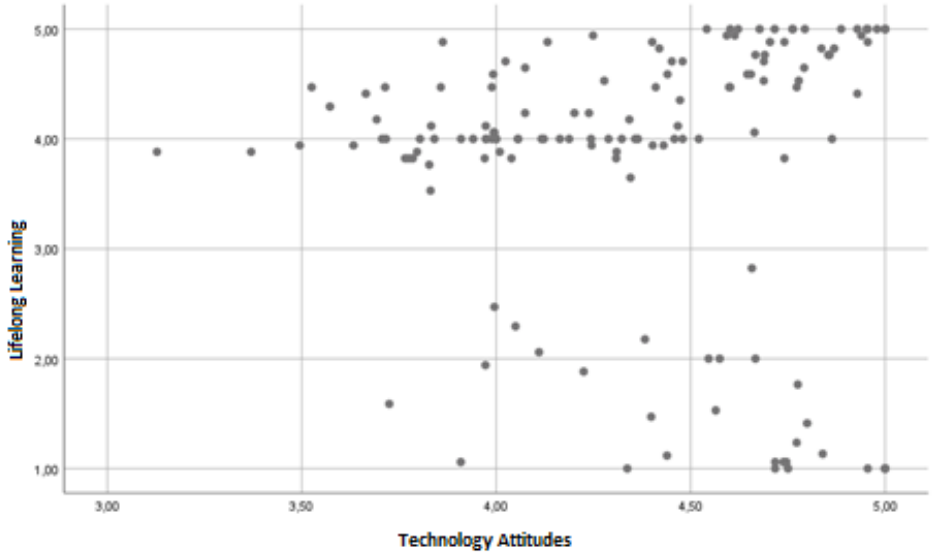
When the relationship between teachers' attitudes towards the use of technology and lifelong learning tendencies is examined, it is seen that there is no significant relationship between the dimension of the reflection of the use of technology in education on teaching processes and lifelong learning tendencies. [r= -0.14, p=0.866 >0.05]

It is seen that there is no significant relationship between the self-development dimension and lifelong learning tendencies in the use of technology in education. [r= 0.002, p=0.979 >0.05]

It is seen that there is no significant relationship between the use of technology in education and the classroom management dimension and lifelong learning tendencies. [r=-066, p=0.428>0.05]

Table 14.

Scatter-Dot Graph of Lifelong Learning Tendencies and Attitudes towards Technology



Scatter-dot graph shows that there is no relationship between two variables.

Conclusion and Discussion

No matter how good the professional skills of teachers are, the use of technology is important for implementation of these skills. At this point, it can be said that the use of technology is a necessity for every teacher. In the past years, student grades, records, attendance, and many other works were carried out with pen and paper, while at the end of the twentieth century, as in most jobs, many tasks were carried out on computer and internet basis. In addition, technological devices, and software such as smart boards, internet, computers are used in the education process. At this point, it is indispensable for teachers to use technology.

The process in which teachers use technology and develop it themselves recalls the concept of lifelong learning. Lifelong learning means that people improve themselves, learn new things, and therefore be in a constant state of updating. When these two concepts are considered, the question of whether there is a relationship between these two concepts occurs. Studies on this subject are very limited. In a study conducted by Özçiftçi and Çakır, (2015) in which the lifelong learning tendencies of teachers and their self-efficacy in educational technology standards were examined, a moderate and positive and significant relationship was found between these two variables. While

educational technology standards self-efficacy and attitudes towards using technology are different concepts, they are basically similar issues that express teachers' use of technology.

In this study, no significant relationship was found between teachers' attitudes about the use of technology and lifelong learning tendencies. As a result of the analysis made in the study, it was concluded that the attitudes towards the use of technology did not show significant differences according to gender, age and seniority, and it was seen that this result coincided with many studies in the literature. Among similar research, Torkzadeh (2002), Türel (2012), Koçak and Gülcü (2013), Yörük (2013), Çınarer, Yurttakal, Ünal and Karaman (2016) did not find it statistically significant according to gender in using educational technologies.

In the study, it was concluded that teachers' attitude towards the use of technology was positive. Similarly, in a study conducted with teacher candidates, Korkmaz (2011) found that teacher candidates' attitudes towards instructional technologies were at a good level. It’s not surprising to see results of research showing teachers incorporating technology into their teaching practices especially during COVID-19 many teachers relied on technology to deliver their lessons remotely. It wouldn’t be wrong to say that technology has the potential to improve the quality of education.

Teachers' technology usage is becoming increasingly common in the classroom. In order to take full advantage of technology hardware and software in schools must be complete and usable and must be periodically updated and renewed. Considering that teachers' use of technology is a necessity, in-service training can be organized for the software that teachers use most. Also when we take into account that teachers will use technology intensively while performing their profession, various courses related to this subject can be included in the curricula of education faculties.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

There is ethics committee approval for this research.

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