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The Effect of Flipped Learning Model on Pre-Service Science Teachers' Laboratory Practices

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Abstract

The aim of this study is to reveal the effect of the flipped learning model used in the laboratory practices course of pre-service teachers on their conceptual understanding and to evaluate their opinions about this model. In order to achieve this aim, science teaching laboratory applications course was conducted with the flipped learning model with undergraduate students studying at the education faculty of a state university in a metropolitan city in Turkey in the spring semester of the 2021-2022 academic year. The research was carried out with 47 pre-service teachers studying in the department of science teaching. The study was carried out with the mixed research method in which quantitative and qualitative models were used. In the quantitative part, the quasi-experimental design with the pre-test post-test control group was used, while the case study was used in the qualitative part. The Force and Motion Conceptual Comprehension Test, developed by Thornton and Sokoloff in 1995 and adapted in to Turkish by Kanlı and Gülçiçek in 2006, was used to collect data in the quantitative part of the study. For the qualitative part, a semi-structured interview form was used. Quantitative data were analyzed using the SPSS package program. Qualitative data were analyzed by descriptive analysis method according to the themes determined by two researchers. At the end of the study, no difference was found between the post-tests of the conceptual understanding levels of the groups. The pre-service teachers expressed the positive aspects of the flipped learning model as follows: it offers the opportunity to prepare before the lesson, being able to repeat the lessons, experience different classroom environment, facilitating the applications in the lesson, being student-centered, contributing to the individual learning speed, providing learning by understanding. In addition, according to the pre-service teachers, it was observed that this model expressed opinions such as it is difficult to cooperate, time cannot be used efficiently, interaction is low, learning by doing is limited, and it does not improve teaching skills.

Introduction

As a result of advances in technology and science, the needs of individuals and even societies have changed. In order for individuals to keep up with these changes, innovations and developments have been experienced in learning-teaching theories and approaches, and in this context, the roles of individuals have also been affected (Ministry of National Education [MoNE], 2018). The coronavirus disease (COVID-19), which emerged in 2019 and affected the whole world, has made the transition to distance education compulsory for children in primary, secondary, high school, college and vocational schools and university students (Hoofman MS2 & Secord MD, 2021; Tarkar, 2020). While the changes and developments in the field of technology contribute to the quality of education, the coronavirus disease, which causes the global epidemic, has also revealed the importance of utilizing technology in education. The COVID-19 epidemic, which has affected almost every field, especially education and training activities, which has become a global problem by affecting the whole world, has been one of the biggest problems that education systems have faced so far.

It has been tried to ensure the continuation of the education process with distance education solutions, which is a mandatory choice with the epidemic. A well-planned distance education process has the effect of providing many opportunities to students and teachers (ETF, 2018). In general, it is stated that countries continue to work to make the distance education process efficient and to increase its quality (Daniel, 2020). In higher education institutions, opportunities should be created for planning education for unexpected situations and for students and academicians to continue their education and research in a safe and healthy way.

In teaching practices, models/simulations are considered the heart of scientific research and are therefore emphasized as cornerstones for developing knowledge about the nature of science (NRC, 2000). In the framework program titled Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas on the teaching and applications of concepts in science education, the importance of scientific methods was emphasized. The understanding of avoiding monotony with different methods and techniques was adopted (NRC, 2012). In order to better understand the pedagogical functions of simulation/modeling teaching, one of the results reached in a review study conducted in the last ten years is: Conceptual understanding is the most common pedagogical element defined for simulation/modelling, but it has been noted to be of little use in developing applications and understanding science. (Campbell et al., 2015). At the same time, it is a common finding reached as a result of studies in which learning through modeling supports conceptual understanding (Hafner & Stewart, 1995; Sunyono, Leny & Muslimin, 2015; Thomson & Stewart, 2003). Another important point mentioned in the literature on this subject is that Gilbert (1991) agrees with the idea that simulation/models should be used by teachers and students in order to understand scientific knowledge and the nature of science.

Science course contains abstract concepts such as cell, DNA or molecular structure that cannot be seen or reached. In teaching such subjects, teachers use different technological approaches, simulation, video, model or modeling both in the classroom and out-of-class environments, enabling the subjects to be embodied and simplified, thus enabling them to understand science concepts and explore their functions. Simulation used in science education, etc. With these activities, students can learn cognitive skills such as matching, classification, analysis, synthesis, and problem solving by using variables. The flipped learning model, which removes the limitations of time and space and offers a brand new understanding of education as a model in which technology is actively used by simulation, gains importance in this context.

The flipped learning model contributes to learning by offering advantages such as high-level learning as a result of cooperative learning, a personalized learning environment with individual study, the opportunity to listen to the videos again whenever they want for course activities in online environments, providing student centered environments, and permanent learning with the use of multiple learning tools (Bergmann & Sams, 2012; Bishop & Vergeler, 2013).

Flipped Learning Model

Flipped learning model is defined as the process of students studying the subjects at home by watching lecture videos and then doing activities and experiments on these subjects in the classroom (Bretzmann, 2013). The flipped learning model is the teaching of the subjects learned in the classroom environment, with the guidance of the teachers, and the self-study learning of the students at home, homework/activity etc. It is expressed as doing the situations in the classroom (Bergmann & Sams, 2012; Strayer, 2012). While students spend time in the classrooms to learn the content of the subject with the traditional approach, in this model, this time spent in the classroom with the support of technology is transferred to the home environment, and the activities in the classroom become a pedagogical process in which more dynamic and interactive studies take place.

The flipped learning model, which is accepted as the education model of the future, covers the opposite of traditional learning (Debbağ & Yıldız, 2021; Ozdamli & Asiksoy, 2016). In the traditional education system, while the knowledge and concepts are transferred to the students in the classroom environment by the educator, it is tried to assimilate the knowledge with the homework and projects given to be done at home. In the flipped learning model, the videos prepared/recorded by the trainer before the day of the lesson are given through certain platforms. Before the students come to the lesson, they watch the videos about the lesson at any time and place, take notes and prepare their questions for situations that they do not understand. When it comes to the classroom environment, there are activities that support the active participation of students, such as group work, problem-solving activities, for assimilation of information and understanding of concepts.

The Role of the Teacher in the Flipped Learning Model

As the most important factor, the teacher prepares the videos that the student should watch at home and presents them to the student. In the classroom, he/she prepares materials to reinforce learning and acts as an observer and intervenes where necessary. To prepare the videos, the teacher must have the necessary knowledge and equipment. The role of the teacher is to prepare short, clear and understandable videos and to deliver them to students via online platforms. (Bergmann & Sams, 2012). It is thought that it would be appropriate to share

simulation activities that will make students more active instead of videos in undergraduate education. Through simulation activities, it is possible to contribute to students' use of scientific process skills (Chang & Hwang, 2018), to reach problems to the level of invention and innovation with an interdisciplinary perspective, and to create products using the knowledge and skills they (MoNE, 2017).

The Role of the Student in the Flipped Learning Model

Students can individually control their speed by determining the time and place of study. Since students are responsible for their own learning, it has been argued that there will be a positive development in their learning (Bergmann &Sams, 2012; Cole & Kritzer, 2009). The first encounter of students with the subject content outside the classroom is described as a new learning and teaching paradigm (Lopes & Saures, 2018). Adapted from the studies of Akın and Akın (2020), the stages that teachers and students will perform according to the Flipped learning model before and during the lesson are presented in Table 1 and Table 2.

Table 1. Preparations to be made by the teachers and students before the lesson in the Flipped Learning Model

Academician-teaching preparatory phase	Student/learner preparation phase
It determines the platforms on which the instructors will first share the simulations with their students and the time when they will be uploaded.	Together with the teachers, the students determine the platforms on which the simulations will be shared and the time they will be uploaded.
Within the framework of the Flipped learning model, the subjects on which the simulation activities will be implemented are determined.	Follows simulation and lecture presentations and worksheets before coming to class.
Simulations and presentations related to the determined subject are prepared or suitable simulations are determined.	Gains knowledge about the determined subject content. Evaluates what has been learned through worksheets.
Expert opinions about the prepared simulations and presentations are taken. The final shape is given by being revised in line with the feedback received.	Since she has knowledge about the subject, she has a positive attitude about the lesson.
Questions are prepared before and after the course simulations and presentations.	The level of motivation comes to the lesson as good.
Prepared questions are reviewed with simulations and presentations.	Safely shares the experience gained through simulations with classmates.
Course simulations and presentations, worksheets are uploaded to the specified platform.	

Table 2. Situations that teachers and students should do during the lesson in the Flipped Learning Model

Academician-teaching	Student/learner
To the lesson begins with remarkable words.	She/He comes to class prepared..
Creates groups.	Determines their groups.
Provides in-group and inter-group interaction.	It interacts within and between groups.
Listens to and contributes to the simulations, presentations and worksheets they watch.	They talk about the simulation, presentations, and worksheets they watched.
It makes students talk about simulation activities and worksheets within the framework of the Flipped learning model.	Makes experiments and applications that should be done in the lesson. And it helps your classmates to do it too.
Provides general repetition of the subject.	It repeats the topic in general.
Receives criticism about course simulations and presentations.	Criticizes the course simulations and presentations. And listens to criticism.
Gets students' ideas about the next lesson presentation and determines when these presentations will be shared.	Comments on the next simulation and presentations and learns when presentations will be shared for the next lesson.

When the literature is examined, studies conducted at various grade levels and in different courses have been found (Erdem, 2018; Flick, 2019; Frydenberg, 2013; Heo & Choi, 2014; Kahramanoğlu & Şenel, 2018; Kaya, 2018; Saunders, 2014; Weiss, 2018, Wong & Chu, 2014). When the studies were evaluated, it was determined that the teaching was positively affected in the lessons conducted with the flipped learning model. In general, it was determined that the academic achievement, motivation and readiness levels of the students increased. Aydın, and Demirer, (2017), who examined the theses and articles on the flipped learning model, found that studies in foreign language and mathematics were intensified. Studies in the field of science education

(Göğebakan Yıldız, Kıyıcı, & Altıntaş, 2016; Yılmaz, 2017) were found to be limited. In his study, Karakaş (2021), who examined 126 graduate theses made in 2014 and 2020, found that 7.9% of them were studied about undergraduate students and science teaching. At the same time, he stated that these studies remained in the qualitative research method at a rate of 11.1%. When Turan (2021) examined the studies in science education, he did not state that the studies involving the flipped learning model were conducted in various categories of science education (general chemistry lessons, physics lessons, science education lessons, etc.), but that it was a study conducted for science laboratory practices lessons. When considered in general, it can be concluded that the studies carried out in the laboratory application dimension, which cover three important disciplines such as science, biology, physics and chemistry, are limited. Experiments related to these three disciplines are intensely included in Science Teaching Laboratory Practices I and II courses taken by 3rd year undergraduate students of science teaching. Considering that there are a lot of abstract and inaccessible concepts and understanding these concepts, the use of simulation activities becomes important.

Graham (2006) states that with the flipped learning model, both online and face-to-face activities can be implemented in four different ways: activity level, course surface, program level or institutional level. With the current research, course-level activities were preferred and the effects of the model were tried to be determined for undergraduate students. Considering an educational process based on the flipped learning model, teachers and students are encouraged to learn about problem solving skills, creative thinking skills, research and inquiry skills, cooperative learning, learning by discussing, and STEM (Science-Technology-Engineering Math), which has been mentioned a lot recently. ; It can be said that the development of students will be supported by training teachers in many fields such as science, technology, engineering and mathematics applications.

In this context, it is seen that it is important to comprehend scientific knowledge through the flipped learning model based on model/simulation in science classes, and the necessity of applying this model emerges. For these reasons, the subject of the research was structured in line with the development of conceptual understanding, opinions and evaluations of prospective science teachers regarding the use of the flipped learning model. Thanks to the study, it is thought that important contributions will be made to education in the relevant field and that the gaps identified in the literature on the subject can be filled.

The research problems were determined as follows:

- Is there a significant difference between the academic achievements of the experimental and control group students of the Flipped Learning model used in teaching science subjects?
- How are the opinions of the experimental group teacher candidates about the Flipped Learning model used in teaching science subjects?

Method

This section provides detailed information on the Research design, study groups, intervention process, data collection tools, and data analysis of the study.

Research Model

In this research, a mixed research method, in which qualitative and quantitative approaches are used together, was preferred in order to examine the effects of the flipped learning model. A quasi-experimental design with control and experimental groups, which includes pretest-posttest, is one of the quantitative approaches. In the qualitative dimension of the research, semi-structured interviews were conducted with the students in order to collect the data using the case study model. Permission was obtained from the ethics committee of the relevant university for the research. The model of the research is shown in Figure 1.

Study Groups

The research was carried out in the Science Teaching Laboratory Practices I course in the science education department in the 2021-2022 academic year fall semester. The participants of the quantitative dimension of the study consisted of third-year science teacher candidates (N=48; 40 females, 8males) at a state university. These students were preferred because they were an easily accessible sample group for researchers. Participants were randomly divided into groups. The experimental group is composed of pre-service teachers whose school

number has an even last digit (20 females, 3 males), and the control group is composed of pre-service teachers whose school number has an odd last digit (20 females, 5 males). The experimental group students participated in the qualitative dimension of the study.

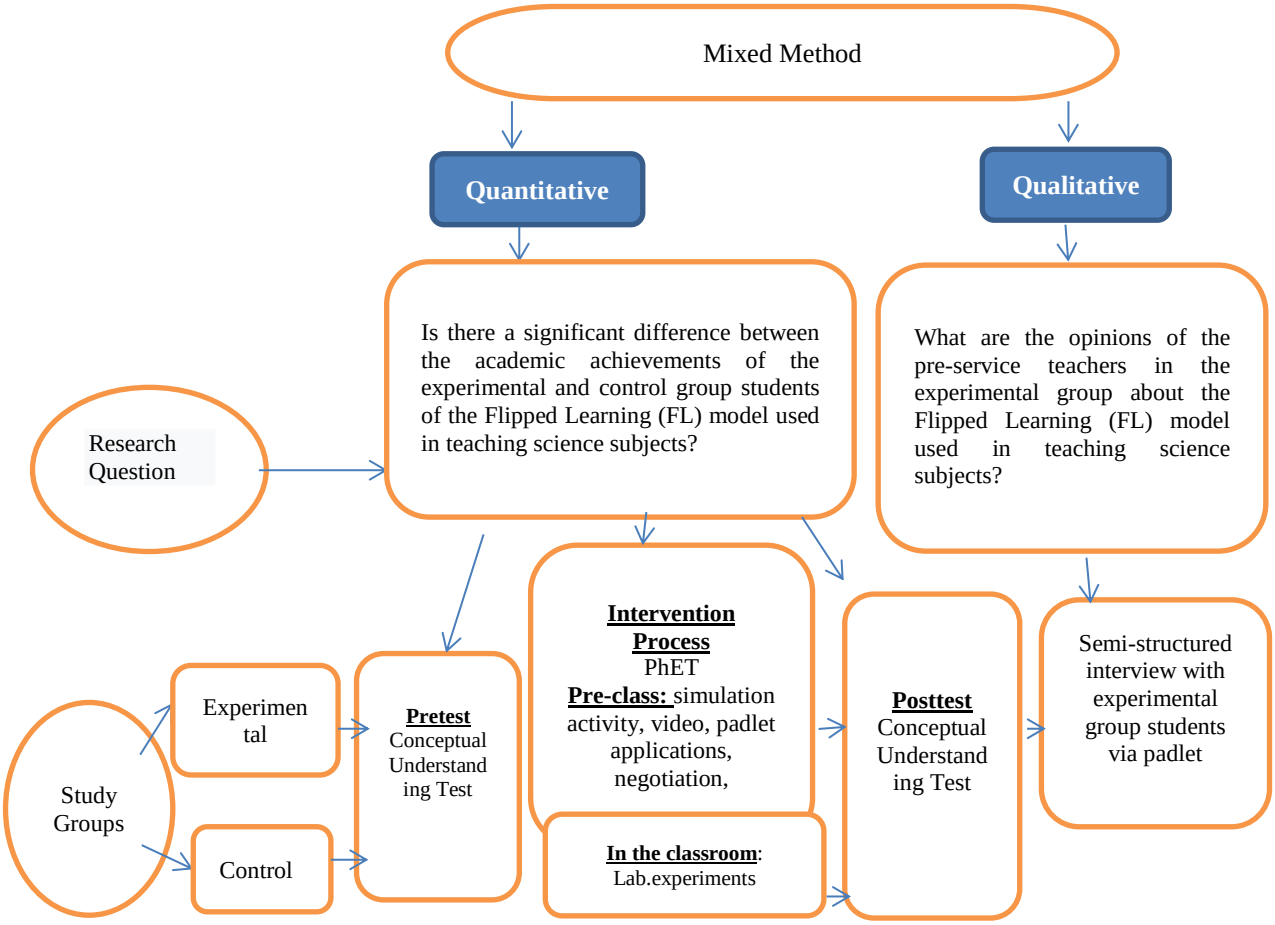


Figure 1. Diagram of the research model

Intervention Process

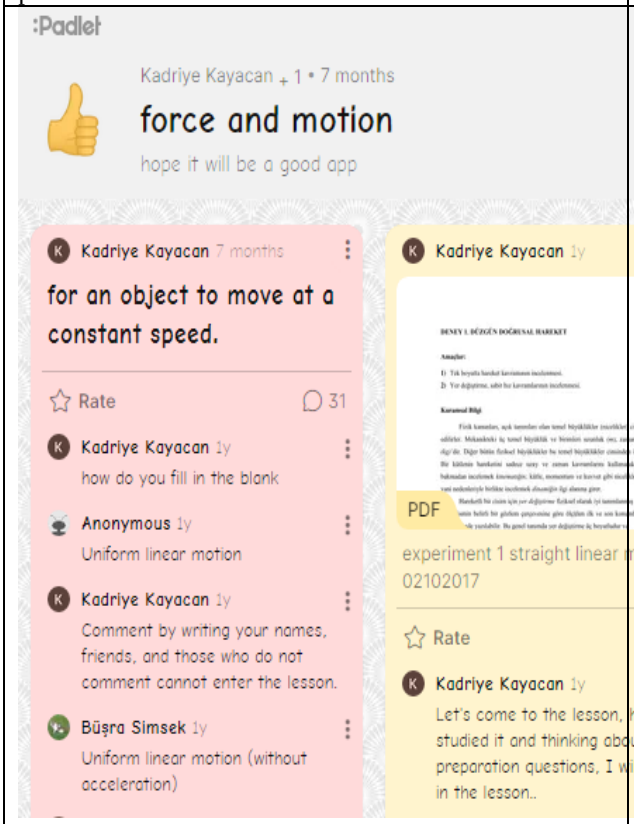
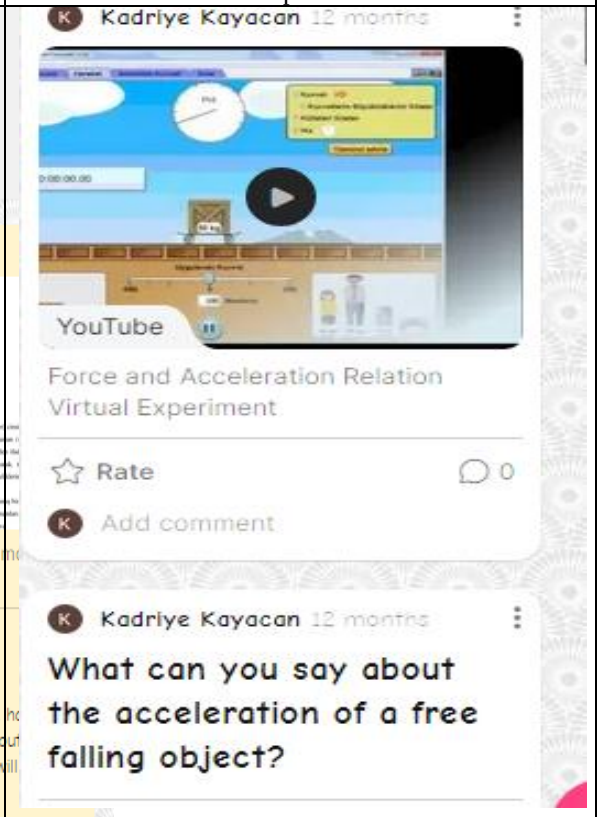
Flipped learning model was carried out in the form of students studying the subjects at home by watching the lesson videos and then doing activities and experiments on these subjects in the laboratory environment. In order to interact with the experimental group students, Padlet platform applications were used. PhET simulation laboratory programs were used for the course videos that students would follow at home. PhET is a simulation activities laboratory developed and made available to open access by the University of Colorado Boulder, founded in 2002 by Nobel laureate Carl Wieman. The topics were determined by the researchers, links to PhET simulation activities (phet.colorado.edu website), Khan Academy videos (https://www.khanacademy.org/) used, along with this, videos were prepared by the researchers for the simulations not included in the program and shared with the students. With the flipped learning model, students were provided to work in groups. Groups of about 3-4 people were formed. Before coming to the classroom environment, the students who made their preparations with shared simulations carried out the experiments with their friends in the science teaching laboratory applications course. The applications lasted for five weeks. Topics covered are listed in Table 3.

Table 3. Topics covered

Time	Topics covered
1 week	Motion, velocity and acceleration along a straight line
2 week	Velocity changes in the effect of acceleration on force and mass
3 week	Free fall motion
4 week	Momentum changes in a thrust
5 week	Inelastic collision

Experimental Group

With the flipped learning model, students were provided to work in groups. Groups of approximately 3-4 people were formed to be heterogeneous in terms of gender and achievement. The necessary simulation/model or video activities were prepared by the researchers and shared with them for the subject they determined within the scope of Science Teaching Laboratory Applications I course content. Before coming to the lesson, each group completed their learning on the subject and participated in the lesson.

a- Discussion application example on the Padlet platform	b- Question sharing example for video and discussion on the Padlet platform
	

c- Experimental samples carried out in the laboratory


Image 1. Experimental group application examples

In the classroom, they tried the theoretical knowledge they learned at home through simulations in a laboratory environment with their friends. Each group carried out experiments, presented the topic to their friends, and completed the topics in the presence of negotiations with other groups. Students followed the video and negotiation processes by registering on the online platform created by the researchers (https://padlet.com/kadriyekayacan/hynnwvzrljyb4aw6). Through this platform, it is possible to easily communicate with students and give instant feedback before the lesson. In the platform, the researchers asked the students questions about the topic of the week and the students were asked to write their thoughts (see. Image 1-a). In the experimental groups, the activities done before the lessons, watching the video/simulation, padlet applications and the negotiation phase were carried out (see. Image 1-b). When the class arrived, these questions were discussed before the lesson started, and then the experiments were carried out. During the lesson, experiments carried out in the laboratory were applied. Examples of experiments carried laboratory are given in Image 1-c.

Control Group

As in the experimental group, the students were divided into groups of 3-4 people. The students conducted an experiment in the laboratory as they understood by studying the subjects themselves with the traditional learning and they had their friends participating in the experiment. Experiments were conducted in the form of question and answer. Simple and easily accessible tools were used as test materials. Based on the observations of the first author, communication among the student groups was less, and negotiation environments did not occur as in the experimental group. Examples of Control group application examples are given in Image 2.

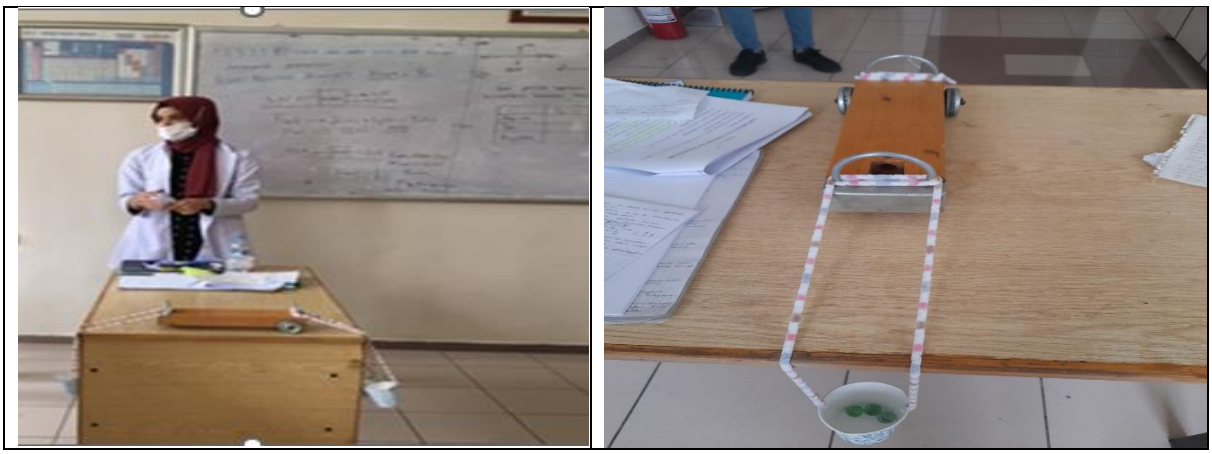


Image 2. Control group application examples

Data Collection Tools

The data were collected by conceptual understanding test and semi-structured observation forms conducted with the experimental group students. Details of data collection tools are given below.

Conceptual Understanding Tests. In the quantitative aspect of the study, a multiple-choice test consisting of 43 questions was used, which was developed by Thornton and Sokoloff in 1995 and adapted into Turkish by Kanlı and Gülçiçek in 2007, in order to evaluate the experimental and control group students' conceptual understanding of force and motion. This test is an advanced test to detect misconceptions in Newtonian physics. The reliability value of the scale (cronbach alpha) was found to be .84 by Kanlı and Gülçiçek (2007). The reliability value (cornbach alpha) found for this study is .80. The items in the test are aimed at detecting the misconceptions in the following subjects.

- Motion, Velocity and Acceleration Along a Line
- Dependence of Acceleration on Force and Mass
- Free Fall Motion
- Momentum Changes in a thrust
- Inelastic collision

The test was applied to the experimental and control groups before and after the application, and the results were analyzed with the SPSS statistical program.

Semi-Structured Interview Questions. In the qualitative aspect of the study, the interview questions were applied over the padlet platform. The semi-structured interview questions applied to the students were prepared by the researchers. The final shape was given by receiving feedback from experts in the field. In this context, the semi-structured interview questions prepared were determined as follows:

- What are the innovations brought by your online course process for you?
- What are the contributions of this process to the distribution of tasks and cooperation?
- What is the interest and motivation contribution of this process to the lesson?
- What is the contribution of this process to the learning and teaching of science subjects?
- Can you compare the online content used in this process and the face-to-face application activities in terms of their contribution to learning?
-What can be done for effective learning in the course process where online content and face-to-face application activities are used together?

Data Analysis

In the research, SPSS statistical package program was used for the analysis of quantitative data, and content analysis analysis was used for the analysis of qualitative data. For the first research question, independent t-tests were used to determine potential differences between groups. Independent t-test analyzes were conducted to determine the effect of flipped learning model on students' conceptual understanding. As the dependent variable, the achievement scores obtained by subtracting the pretest scores from the posttest scores were used and the group was accepted as the independent variable. Before performing the analysis, the assumptions of normality and homogeneity of variances were checked and met.

For the second research question, the findings obtained from the semi-structured interview questions were analyzed by content analysis method and codes and themes were created. Reliability studies in qualitative data analysis have been carried coded separately by researchers. The basic process in content analysis is to gather similar data within the framework of certain concepts and themes, and to interpret them by arranging them in a way that the reader can understand (Yıldırım & Şimşek, 2011, p. 227). In the coding phase of the data, coding was done according to the concepts extracted from the data suggested by Strauss and Corbin (1990). The analysis process was completed by following the stages of arranging the codes and themes, defining and interpreting the findings (Yıldırım & Şimşek, 2011).

Findings

In this section, the findings of the study are explained according to the research questions.

The Effect of Flipped Learning Model on Conceptual Understanding

Normality test was performed before independent t-test. Skewness and Kurtosis values were checked for normality test. It was observed that the Skewness value ranged between 1.047 and .347 and the Kurtosis value varied between .200 and .681. When Kurtosis and Skewness values are between -1.5 and +1.5, it is considered to be a normal distribution (Tabachnick & Fidell, 2013). Independent t-test results comparing the pretest scores of the experimental and control group students showed that $t(44)=-.41, p<.68$) were similar. In order to compare the conceptual understanding levels of both groups at the end of the application, the independent t-test result of the pretest-posttest achievement scores is presented in Table 4. When the results were evaluated, no difference was found between the conceptual understanding levels of the groups.

Tablo 4. Independent t-test results for the treatment and comparison groups' pretest-posttest gain scores

	Group	*n*	*M*	*SD*	*t*	*df*	*p*
Conceptual Test	Treatment	22	2,05	2,69	0,66	40	>.504
	Control	25	1,56	2,23			

Opinions on the Applications of the Flipped Learning (FL) Model

A semi-structured interview was applied to provide formative assessment and immediate feedback on the quality of pre-service teachers' learning experiences for flipped learning model applications. As a result of the interviews, three main categories were obtained. Obtained main category Scientific reasoning skills course; 1. Internal factors on the student, 2. External factors on the student, 3. Suggestions regarding online content/trainings. Findings related to each mentioned theme were explained in order by giving examples from student discourses, accompanied by tables containing descriptive statistics data.

Table 5. The code and descriptive statistics results of the FL model determined for the internal factors on the student

Main Category	Category	Subcategory Code		Code	f
Internal factors on the student		Online	Positive	Ability to repeat lessons	5
				Different classroom environment experience	3
				Pre-lesson preparation	11
				Facilitate the applications in the lesson	2
				student-centered	2
				Contribution to individual learning speed	2
				learning by understanding	2
				Ability to do homework comfortably	2
				active thinking	3
				Concrete learning	3
			Negative	It's hard to cooperate	3
				Grouping is difficult	2
				Didn't contribute	1
				Time was not efficient	2
				Interest has waned	2
				Interaction decreased	2
				Communication decreased	2
				Teaching skills are lacking	3
				Learning by doing is missing	1
				reciprocal	1
				remained at the abstract level	1
				hard to understand	3
				Suitable for theoretical knowledge	12
		Face to face		More effective/efficient face-to-face	11
				There is learning by doing	10
				more permanent	5
				sense organs are more active	3
				interactive	2
				learning oriented	1
				More concrete level	3
				easy to understand	3
				Better in apps	12
	Social skills			Collaboration increased	4
				Providing individual responsibility	2
				communication skill	2
				coordinated work	1
				Idea sharing	1
	Attitude			Curiosity and interest increased	8
				Enjoyable	1
				Striking	1
				Total	140

Internal factors on the student. It has been determined that the internal factors of flipped learning model applications on teacher candidates are in the areas of learning process, social skills and attitude. It has been determined that the effects on the learning process form a sub-category as online and face-to-face, and in this

category, especially students have positive and negative opinions about online education. The code and statistical information determined for this theme are given in Table 5.

The pre-service teachers stated that the positive aspect of the online education, which is carried out with the FL model, in the learning process, offered the opportunity to prepare and repeat the lesson the most before the lesson. The other positive aspects of the pre-service teachers in this process are that they can work in a student-centered manner, thus contributing to the individual learning speed, and expressing their thoughts that meaningful learning and concrete learning are realized through active thinking. Examples of these views are as follows:

"It helped us gain different perspectives on the concept of the classroom environment."

"The fact that we have knowledge about the subject to be covered before the lesson and that we can understand and perform face-to-face applications more easily are the innovations brought by this process"

"Knowing how the course will be in advance can contribute to the student's feeling of comfort and coming prepared"

"The connection with the lesson has never been broken, as it provides continuous active thinking."

"Permanence was ensured with beautiful animations, interest in the course increased thanks to technology."

"Making a preparation before the lesson and re-applying the subject in the lesson facilitated learning and provided permanent learning"

Among the negative aspects of the process, the most consensus is that online education is effective in giving theoretical information. Pre-service teachers expressed their opinions that it is difficult to make sense of, cooperate and work with a group because the information in online education remains at an abstract level, and that interaction and communication are reduced, and therefore learning by doing and learning by doing and the use of teaching skills are lacking. Example statements are as follows:

"It is generally a process that emphasizes individuality. Group assignments etc. Sometimes it is difficult to reach friends and do homework together. There is a system that works unilaterally."

"Collaborating in this process has been more difficult. It is more difficult than usual to communicate in the virtual environment and head towards the lessons. However, we tried to communicate effectively and distribute tasks."

"In this process, interest in lessons decreased, distraction increased."

"Online content makes me memorize. It teaches face-to-face activities."

On the other hand, the view that pre-service teachers mostly agreed about face-to-face education is that it is more efficient in practice. They stated that in face-to-face education, learning by doing is dominant because the sense organs are more active, and it is easy to make sense of it because of interactive and concrete learning. Sample expressions reflecting the views of teacher candidates are as follows:

"Because experiments are activities in science teaching, it is more appropriate to do it face-to-face. I think the student needs to see and observe. There are applications online, but I think it would be more permanent to learn by doing and experiencing in real life."

"Explaining with practice in online education is more difficult than in face-to-face education. Because only virtual laboratories can be used in online education, but in face-to-face education, students learn by doing. Therefore, the application is more effective in face-to-face education.

"No matter what, I always think that face-to-face activities and lessons are much more effective"

"Face-to-face education is more effective because experience and seeing things live and touching them become much more permanent"

"As face-to-face application activities are a situation that interacts with people, I think that its effect is more than online content"

"Online content provides visual material, face-to-face content gives examples from life."

"I think face-to-face applications are much better. Online content has also been developed sufficiently, but it would be more meaningful to test it by doing and experiencing."

Pre-service teachers expressed their thoughts that online education, which is carried out with the FL model, also contributes to the learning process in terms of social skills and attitudes. It has been determined that it contributes to social skills in terms of coordinated work, formation of cooperation, increase of communication and sharing of ideas. At the same time, they stated that they found the learning process carried out with the FL model to increase their curiosity and interest, to be fun and to be interesting. Example statements are as follows:

"I developed myself in communication and exchanging ideas because we did the experiments by taking equal responsibilities with our friends and sharing something together"

"He improved his communication skills and taught him to work in coordination."

"Whether it was group discussions where ideas were shared, discussed and expanded, or closer collaboration between individuals within the learning group, it served to increase teamwork and participation and improve understanding."

"In this process, the responsibility largely belongs to the student. It allows the student to learn at their own learning pace."

"Collaborating with the class contributed to making the lesson more fun."

"I think this process has increased our interest and motivation in the course. Because, as a result of the knowledge we gained in the lessons we saw online before and the experiments we carried out at school, our interest and curiosity in the lesson increased."

"The online content used was very attractive and beautiful. Especially at a time when we are very intertwined with technology, the use of these contents aroused our curiosity."

External factors on the student. The external factors of flipped learning model applications on pre-service teachers were found to be in the category of physical conditions. The code and statistical information determined for this main category and category are given in Table 6.

Table 6. Code and descriptive statistics results of the FL model determined for external factors on students

Main Category	Category	Code	f
External factors on the student	physical conditions	Equality of opportunity in education	2
		Learning to use technology well	16
		Saving on time	13
		Independence from place	4
		Rich content	7
		visual materials	4
		Total	46

Pre-service teachers stated that they learned well how to use technology with the FL model. Another situation in which more consensus has been achieved following this opinion is that time is saved. They stated that with online education, visual materials with rich content are presented, and they can study and repeat whenever they want with independence from the place. Example statements are as follows:

"I learned the content of technological tools and applications that can be used online and how to use them much better"

"Time saving. Being able to repeat the course whenever you want, being able to participate in the course whenever you want from anywhere. It provides a more comfortable environment."

"I discovered innovations and different applications in technology and learned how they work."

"The lesson was taught with advanced tools. 24/7 training was available. Additional expenses have been eliminated."

"We became involved with Web 2 tools and included it in our learning life."

"Online education removes the barrier of space and time. Therefore, it provides equality of opportunity and opportunity in education. Provides unlimited access to educational materials"

Recommendations for online content/trainings. Pre-service teachers offered suggestions for online content/trainings such as the FL model. The codes and statistical information determined for the recommendations are given in Table 7. The suggestions of the pre-service teachers are mostly that online and theoretical education should be used together, and that online education should be done when giving theoretical information, and face-to-face education should be done when the applications are made. Other suggestions were that the online education content should be easy and understandable, accessible to all students, providing basic training to teachers and students, and sharing information by inviting different people to the courses. Examples of the recommendations are as follows:

"Theoretical parts can be given in online education and more applications can be made in face-to-face education"

"Online content should be more efficient, useful and easy to understand. Online content and applications should be compatible with each other so that students do not have difficulty in applying and making sense of the information."

"The online content used must be directly related to the achievement described"

"It should be ensured that the online content is accessible to all students, understandable and supports face-to-face application"

"It can be beneficial to use online content while doing face-to-face training, and their integration is directly proportional to the training of teachers."

"The contents of the online courses can be enriched and made more interesting. As a result of this, I think that the implementation activities to be carried out will be more beneficial."

"It can strengthen our teacher's lectures with people who will draw attention to our lesson with external connections"

Table 7. Code and descriptive statistics results for online content/training suggestions

Main Category	Category	Code	f
Suggestions	Online content/ training	Should be used in conjunction with theory	12
		It should be in theoretical knowledge and applications should be in face-to-face education.	12
		It should be easy	5
		It should be understandable	4
		Different people should be invited	2
		It should be used to reinforce face-to-face education.	9
		It should be directly related to the topics covered.	5
		Must be accessible to all students	6
		Basic training should be given	5
		Teachers should be provided with the necessary training and equipment	4
		Total	64

As a result, the effects of this model on students are that it is suitable for pre-lesson preparation, it is suitable for theoretical knowledge, and it allows learning by doing. In addition, students frequently stated that some subjects are more effective/efficient face-to-face, that the practices in the course are good, that they increase curiosity and interest, and that they allow them to learn how to use technology well. Finally, the students' suggestion is that theoretical knowledge and learning should be distanced, and applications should be in face-to-face education.

Results and Discussion

As a result of the study, it was seen that the post-test means scores of the force and motion conceptual understanding test of the students in the experimental group, in which the lessons were conducted with the FL model, increased compared to the pre-test mean scores. However, it was observed that there was no significant difference between the force and motion conceptual understanding test post-test mean scores of the control group students, in which the lessons were conducted with the traditional laboratory method. Many of the studies on the flipped classroom model have been conducted to examine the effect of students on their learning performance. The main reason for this is that it is a new model and its results are intriguing (Chen et al, 2019). Wood, Galloway, Sinclair, and Hardy (2018) As a result of their study, they stated that there is a positive relationship between the frequency of teacher-student interactions and the development levels of students' science concepts in the lessons conducted with the FL model. Similarly Gross et al. (2015) In their study, they concluded that the FL model is a model that affects students' learning performance. Similarly, studies expressing the conclusion that this model improves students' communication, cooperation and higher-order thinking skills (Canelas, Hill, & Novicki, 2017; Olakanmi, 2017) and studies expressing that it affects students' learning perceptions, attitudes and motivations (Aşıksoy & Özdamlı, 2016; González-Gómez, Jeong, & Rodríguez, 2016; Jensen et al., 2015; Sezer, 2017). However, in this model, the results may not be suitable for generalization, since students' participation in pre-lesson learning content and their behaviours in the course are factors that affect the research results at a high level. For example, one of the reasons why there was no significant difference between the average scores of the experimental group and the control group as a result of this study may be that the students in the experimental group were not able to control their pre-lesson activities.

As a result of examining the opinions of the students in the experimental group about this model in the qualitative part of the study; the effects of the model on students (internal effects and external effects) and students' suggestions were divided into themes. In the themes created, the internal factors of the FL model on the student were divided into categories as learning process, social skills and attitude. The students stated the

positive aspects of the FL model in the learning process as follows: it offers the opportunity to prepare before the lesson, being able to repeat the lessons, experience different classroom environment, facilitating the applications in the lesson, being student-centred, contributing to the individual learning speed, providing learning by understanding, being able to do homework comfortably, opportunity, contribution to active thinking and realization of concrete learning. Shattuck (2016) In hir study, she stated that one of the positive aspects of the FL model is that students spend more time on learning activities. When the studies on the FL model in the literature are examined, it is seen that this model increases student achievement, similar to the results obtained in our study (González-Gómez et al., 2016), positively affects student perceptions (Baepler et al., 2014), provides a comprehensive understanding (Gariou-Papalexiou et al., 2017), it allows to watch and listen to the lectures over and over again (Aşıksoy and Özdamlı, 2016), increases the active learning time in the classroom (Lax et al., 2017provides more time to work on problems (Yestrebsky, 2015) there are studies that indicate the positive aspects of.

In the study, the negative aspects of the students about the model are It is difficult to cooperate, time cannot be used efficiently, interaction is low, learning by doing is limited, and it does not improve teaching skills. Similarly, Leatherman and Cleveland (2019) mentioned in their study that in this model, students do not have the opportunity to ask their teachers questions before the lesson, and there is insufficient interaction. In another study (Hibbard et al., 2016) stated that students found this model time consuming. In addition, there are studies in the literature stating that this model increases the workload of teachers (Torío, 2019) and students (Olakanmi, 2017).

At the end of the study, students; They stated that the contribution of this model to social skills is increasing cooperation, providing individual responsibility, improving communication skills, enabling coordinated work and sharing ideas. Flynn (2015) In his study, he stated that this model reduces the rate of students being in the background in the learning process. Similarly, Loveys and Riggs (2019) At the end of their study, they concluded that this model increased student participation. At the end of the study, it was concluded that this model increased the curiosity and interest of the students, and they found it entertaining and remarkable. Similar to these results, it affects students' opinions positively (Leatherman & Cleveland, 2019), increases students' motivation (He et al., 2018), positively affects student satisfaction (Bokosmaty et al., 2019), affect students' emotions positively (Jeong et al., 2016), positively affects student attitudes (Mooring et al., 2016) There have also been studies that have reached results such as. The students expressed the contributions of the study in terms of physical conditions as providing equal opportunities in education, learning to use technology well, being independent from the place, accessing rich content and using visual materials.

The students' suggestions about the model are It should be easy and understandable, different people should be invited, it should be accessible to all students, it should be used to reinforce face-to-face education, and the necessary training and equipment should be provided to teachers. As a result, we can say that students' opinions about this model are generally positive. As a matter of fact, in the meta-analysis study conducted by Turan (2021) on the FL model, it was stated that the flipped classroom model had a positive effect on student achievement in science education.

Based on the results of the study, the following suggestions can be given to teachers who carry out educational activities:
• The use of the flipped classroom model in different courses and subjects will increase the student's performance in the course, as it encourages students to prepare before the lesson, allows them to repeat the lesson, and contributes to individual learning.
• In addition, the use of abstract concepts in subjects and courses where there are a lot of abstract concepts will facilitate the concretization of abstract concepts.

Recommendations

Recommendations for those who want to do research on this subject can be listed as follows:
• In this study, the effects of the flipped classroom model for the science laboratory lesson were tried to be revealed, and its contributions to areas such as attitude, motivation, and success can be examined by using the flipped learning model, which is a new model, in different courses, units and subjects.
• Since the study group is university students, since there is no one to control the part of the model to be made at home, it can be ensured that the parts to be done at home are done under the supervision of parents by working with younger age groups.

• In order to carry out the work in a healthy way, it is useful to make sure that technological support such as internet and computer is accessible to everyone.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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The Relationship between Digital Literacy and Digital Citizenship Levels of STEM Teacher Candidates: The Mediating Role of Digital Teaching Material Development Self-Efficacy

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Abstract

In this study, it was aimed to determine the relationship between digital literacy and digital citizenship and digital teaching material development self-efficacy of the STEM teacher candidates. In the study, a correlational model was used. The population of the study consists of teacher candidates studying in different teacher training programs (Science education, Technology education, Mathematics education, Engineering education) at state universities in Turkey in the 2022-2023 academic year. The sample of the study, as for that, consists of 1050 teacher candidates who are determined by simple random sampling from the population. The study data were collected with “Digital Literacy," “Digital Citizenship," and “Digital Teaching Material Development Self-Efficacy” scales. According to the hierarchical multiple regression analysis results, it was determined that the level of digital literacy and digital material development self-efficacy significantly predicted the digital citizenship level. Besides, in the study, it was determined that digital material development self-efficacy plays a partially mediating role in the relationship between digital literacy and digital citizenship behavior. According to the study results, it was suggested that the teacher candidates’ work on increasing digital literacy levels would be beneficial to improve their digital citizenship and digital material development self-efficacies.

Introduction

It is a century in which new discussions have been made regarding the concept of citizenship with the twenty-first century, the impact of globalization, and technological transformation. One of the prominent citizenship concepts in this period is the concept of digital citizenship (Dindar et al., 2013). Lyons (2012) describes the concept of digital citizenship as a subset of citizenship, Ribble (2011) describes it as a set of appropriate and responsible behavior norms for technology use, Vizenor (2013) describes it as the process of individuals’ participation in the virtual environment through technologies within the scope of political and social activities and Miles (2011), as for that, describes it as a responsible, sensitive and rational approach to the online interaction process.

Digital citizenship was subjected to many studies recently with rapid changes and developments in information and communication technologies. Some reasons make the concept of digital citizenship such important. According to Mossberger, Tolbert, and McNeal (2008), these are: 1) The change in the social life in line with the opportunities offered by the Internet and the risks and problems brought about by this change, 2) Opportunities provided by internet access for digital technology users to participate effectively and socialize in society from anywhere, 3) The effect of online activities to strengthen democracy, 4) The need for individuals who can use digital technologies effectively and efficiently with a sense of responsibility, 5) The equality of opportunity provided by the internet in learning-teaching activities and its effect on learning-teaching activities can be listed as the main reasons.

There are different discussions in the body of literature regarding digital citizenship. Changes in sociological structure (education, research, health, literacy, family, professional development, socialization, communication, etc.) with the effects of globalization and information technologies have also changed citizenship. For example, Mossberger, Tolbert, and McNeal (2008) were evaluated the abilities that an individual should have to participate in the online society within the scope of digital citizenship. In the evaluation conducted, digital skills for digital citizenship were thrown up. Digital citizenship has nine sub-dimensions be about digital literacy, digital commerce, digital security, digital rights and responsibilities, digital health, digital ethics, digital rule (law), digital communication, and digital access. The classification of these sub-dimensions was conducted

considering the use and misuse of technologies. Although not fixed, these classifications may change in due course depending on the impact of digital technologies on social life (Ribble, 2006). In the sense of the study, digital literacy, which is a sub-dimension of digital citizenship, was discussed.

Developments in the field of digital technology rapidly gaining place both in government institutions and in all segments of society have been put forward the necessity to develop and disseminate digital literacy skills as well as traditional literacy. Digital literacy is known as one of the sub-dimensions that constitute digital citizenship. Ribble (2011) describes the concept of digital literacy as the skill of how and when digital technologies should be used in the process of individuals' training and accessing information, Kazakoff (2014) describes it as the process of individuals' participation in social and cultural activities through digital tools, Ba, Tally and Tsikalas (2002) describe it as a series of habits that students have acquired for learning, socialization, acculturation, and entertainment within the scope of computer technology use and Gilster (1997), as for that, describes it as the process of interpreting and evaluating the information presented in the digital environment with a critical perspective.

The widespread use of digital tools in the sectors such as education, health, service, which makes the concept of digital literacy a subject to be emphasized and examined, and the need to find solutions to the problems brought by the digital environment have been effective. However, it has been put forward the fact that the use of digital tools by almost all segments of the society, technology users should be trained and developed in digital literacy skills.

Effects of change and development in the age of information technologies are reflected in many areas of education such as school and teacher development, student learning, school, and environmental relations. Expectations for the competencies of teachers responsible for the change and development of education also suffer a change. Considering the effects of change/transformation in school, one of the most important resources that the teacher should provide to the school is technological developments (Hsieh, Yen & Kuan, 2014). Teachers need to demonstrate the continuity in technology systems and the transfer of existing knowledge to new technologies and situations in the digital society. In addition to this, existing and created digital tools should be used actively to reach information sources to contribute to learning, to analyze, synthesize, evaluate and use when necessary (ISTE, 2014). When considering that the current teacher candidates are generation Z individuals, they are seen by other generations as an expert in using technological tools. Applications installed on smartphones and computers and devices with internet connection leave this generation constantly connected to the network (Kotler & Armstrong, 2018). What level of digital literacy and digital citizenship skills of teacher candidates in generation Z are and how much they relate to each other or how much they affect each other was defined as a problem that is required in the study and needs to be answered.

It can be said that technologies that are constantly evolving affect digital citizenship and digital literacy as well as learning environments. At the same time, it can be told that constantly developing technology causes a change in the quality and variety of educational equipment used in learning environments. The fact that these changes created a suitable teaching environment for teachers online facilitated their own and course-based teaching materials development processes (Birişçi et al., 2018). To create an active and effective learning environment in digital teaching environments, teachers need to create digital teaching materials such as online presentations, digital games, and e-evaluation (Friesen, Fisher & Roberts, 2001).

It can be said that the ability of teacher candidates to use technological tools and equipment to be used within the scope of education and training activities has indispensable importance for educational activities in today's conditions. In addition to this, since teacher candidates' development of digital materials to aid teaching in the lesson has a significant effect on learners' interest in learning processes and their learning levels after they start practicing their teaching profession, they will need the materials they will develop in their professional lives (Bakaç & Özen, 2015). Using the materials to be developed with the use of technology to support the teaching process will contribute to ensuring that students are active in learning processes and increasing the permanence of learning (Seferoğlu & Yağcı, 2001; Yalın, 2007).

In conjunction with the development of technology by teachers, the use of technology-supported materials to create an effective classroom environment has ensued. To provide this and support the lessons, the necessity for teachers to know how to develop supplementary material eas ensued (Bakaç & Özen, 2015). One of the methods to determine the level at which teachers have material development skills is to determine at what level they feel competent in terms of these skills, namely, their self-efficacy level.

When the literature is reviewed, there is a positive relationship between the individual's persistence in trying to be successful in a job and his self-efficacy perception (Pajares, 1996; Roberts et al., 2001). Similarly, it is known that there is a relationship between teachers' self-efficacy and their effective teaching (Tschannen-Moran & Hoy, 2001; Özkan, Tekkaya & Çakıroğlu, 2002; Andersen et al., 2004). Teachers' self-efficacy in using technology is proportional to their ability to perform desired tasks at an appropriate level using web tools (Birişçi et al., 2018).

The descriptions expressed in the above paragraphs show that with the rapid development of technology, there are changes in learning environments in the sense of learner, teacher, and learning processes. This change was caused by the formation of digital citizenship; digital citizenship requires digital literacy, the formation of an opinion that it affects the use of digital materials in teaching processes in digital literacy. Based upon this thought, before starting the teaching profession, the level of digital literacy, digital citizenship, and digital material development self-efficacy of teacher candidates, how they relate to each other, and how they affect each other has been a problem of the study.

Purpose

The purpose of this study is to determine the relationship between digital literacy and digital citizenship and digital teaching material development self-efficacy of the teacher candidates. In line with the expressed purpose, answers to the following questions were sought:

1. Is there a significant relationship between digital literacy levels and digital citizenship levels of teacher candidates?
2. Is there a significant relationship between digital literacy levels and teaching material development self-efficacy levels of teacher candidates?
3. Is there a mediating role of digital teaching material development self-efficacy levels of teacher candidates in the relationship between digital literacy and digital citizenship levels?

Method

In this study, a correlational model in which relationships between multiple variables were investigated through applied scales was used. The correlational model presents an opinion about cause and effect relationships between variables (Karasar, 2012; Büyüköztürk et al., 2020).

Population and Sample

The population of the study consists of teacher candidates studying in different teacher training programs (Science education, Technology education, Mathematics education, Engineering education) at state universities in Turkey in the 2022-2023 academic year. The sample of the study, as for that, consists of 1050 STEM teacher candidates who are determined by simple random sampling from the population. Simple random sampling is the fact that a sample that is considered to have an equal chance as a result of statistical calculations in a population has a size that can represent the population and is selected by a completely random method (Yıldırım & Şimşek, 2013).

The sample of the study consisted of 1050 pre-service teachers, 72.1% of whom were female (n=757) and 27.9% (n=293) were male. 12.7% of the pre-service teachers forming the sample are 18 (n=133), 17.3% are 19 (n=182), 29% are 20 (n=304), 15.8% are 21 (n=166), 11.8% are 22 (n=124) and 4.7% are 23 (n=49). 8.8% (n=92) are 24 years old and over. 38.1% of the teacher candidates are in the first grade, 26% are in the second grade, 26.7% are in the third grade and 9.2% are in the fourth grade. 28.8% (n=302) of the prospective teachers are studying social studies teaching, 14.7% (n=154) primary school teacher, 10.3% (n=108) Turkish language teaching, 12.2% (n=128) mathematics teaching and 11% (n=115) physical education teaching. 6.4% (n=67) of the pre-service teachers study in pre-school teaching, 6% (n=63) in English teaching, 3.4% (n=36) in psychological counseling and guidance education, 3.3% (n=35) in art teaching, 2.7% (n=28) in science teaching, and 1.3% (n=14) in religious culture and moral knowledge teaching.

Table 1. Sampling data

		f	%
Gender	Female	757	72,1
	Male	293	27,9
Age	18	133	12,7
	19	182	17,3
	20	304	29,0
	21	166	15,8
	22	124	11,8
	23	49	4,7
	24 years and older	92	8,8
Class	1	400	38,1
	2	273	26,0
	3	280	26,7
	4	97	9,2
Department	Social Sciences Teaching	302	28,8
	Classroom Teaching	154	14,7
	Turkish Teaching	108	10,3
	Math Teaching	128	12,2
	Pre-School Teaching	67	6,4
	Science Teaching	28	2,7
	Religious Culture And Moral Knowledge Teaching	14	1,3
	Psychological Counseling And Guidance	36	3,4
	English Teaching	63	6,0
	Physical Education Teaching	115	11,0
	Art Teaching	35	3,3
Digital Tool	Personal Computer	138	13,1
	Tablet	45	4,3
	Smart Phones	867	82,6
Purpose Of Using Digital Platforms	Entering Social Media	396	37,7
	Listening To Music	60	5,7
	Watch Videos	209	19,9
	Conduct Research	171	16,3
	Following The Daily News Flow	97	9,2
	Other	117	11,1
Usage Time	Less Than 2 Hours	361	34,4
	Between 2 Hours And 4 Hours	60	5,7
	Between 4 Hours And 6 Hours	340	32,4
	More Than 6 Hours	289	27,5
Usage Level of Digital Platforms	Weak	61	5,8
	Medium	708	67,4
	Good	281	26,8

It was determined that 13.1% via personal computers (n=138), 4.3% via tablets (n=45), and 82.9% via smart phones (n=867) of 1050 teacher candidates in the sample group of the study benefited from digital platforms. It was determined that 37.7% for entering social media (n=396), 5.7% for listening to music (n=60), 19.9% for watch videos (n=209), 16.3% for conduct research (n=171), and 9.2% for following the daily news flow (n=97) of teacher candidates made use of digital platforms via personal computers, tablets, and smartphones.

It was determined that 34.4% spent less than 2 hours (n=361), 5.7% spent between 2 hours and 4 hours (n=60), 32.4% spent between 4 hours and 6 hours (n=340), 27.5% spent more than 6 hours (n=289) on the internet of the teacher candidates in the sample of the study. Besides, 5.8% were stated that the level of digital platforms usage was weak (n = 61), 67.4% were stated that the level of digital platforms usage at a medium level (n = 708), and 26.8% were stated that the level of digital platforms usage at a good (n = 281) level of the teacher candidates in the sample.

Data Collection Tools

The study data were collected through three scales. “Digital Literacy Scale," “Digital Citizenship Scale," and “Digital Teaching Material Development Self-Efficacy Scale” are included in the data set of the study. The scales used are five-point Likert type. The scales are scored as "(1) Strongly Disagree"; "(2) Disagree"; "(3) Neither Agree nor Disagree"; "(4) Agree"; and "(5) Strongly Agree". Information on the scales in the data set of the research is given below.

Digital Literacy Scale: It is developed by Hamutoğlu, Güngören, Uyanık, and Erdoğan (2017). Within the scope of this study, the data matrix is suitable for factor analysis since the result of the Bartlett test is significant and Kaiser-Meyer-Olkin (KMO) coefficient is “.869”. In consequence of the exploratory factor analysis made with the data set of this research, the load value among the items of the measuring tool was found between “.402 and .788”. It was observed that the measurement tool has four factors. The first factor of these four factors describes 21.746% of the total variance in the measuring tool, the second factor describes 20.029%, the third factor describes 10.004%, and the fourth factor describes 9.579%. Four factors of the digital literacy scale describe 61.358% of the total variance in the measuring tool. Cronbach’s Alpha Reliability of Co-efficient value of the scale was calculated as “.874”. In CFA conducted with the data set of the digital literacy scale, it was determined that the four-dimensional factor structure produces acceptable fit values (X2=583.792, sd=106, X2/sd=5.507, P=0.000, RMSEA=0.066, GFI=.939, IFI=.935, TLI=.917, CFI=.935).

Digital Citizenship Scale: The digital citizenship scale developed by Choi, Glassman, and Cristol (2017) was adapted into Turkish by Erdem and Koçyiğit (2019). Within the scope of this study, the data matrix is suitable for factor analysis since the result of the Bartlett test is significant and the KMO coefficient is “.852”. In consequence of the exploratory factor analysis made with the data set of this research, the load value among the items of the measuring tool was found between “.366 and .872”. It was observed that the measurement tool has five factors. The first factor of these five factors describes 19.039% of the total variance in the measuring tool, the second factor describes 12.164%, the third factor describes 10.724%, the fourth factor describes 10.310%, and the fifth factor describes 9.839%. Five factors of the digital citizenship scale describe 62.076% of the total variance in the measuring tool. Cronbach’s Alpha Reliability of Co-efficient value of the scale was calculated as “.877”. In CFA conducted with the data set of the digital citizenship scale, it was determined that the five-dimensional factor structure produces acceptable fit values (X2=983.074, sd=113, X2/sd=8.700, P=0.00, RMSEA=0.08, GFI=.90, IFI=.91, TLI=.89, CFI=.91).

Digital Teaching Material Development Self-Efficacy Scale: It was developed by Korkmaz, Arıkaya, and Altıntaş (2019). Within the scope of this study, the data matrix is suitable for factor analysis since the result of the Bartlett test is significant and Kaiser-Meyer-Olkin (KMO) coefficient is “.943”. In consequence of the exploratory factor analysis made with the data set of this research, the load value among the items of the measuring tool was found between “.503 and .744”. It was observed that the measurement tool has three factors. The first factor of these three factors describes 31.588% of the total variance in the measuring tool, the second factor describes 19.493%, and the third factor describes 11.546%. Five factors of the digital material development self-efficacy scale describe 62.627% of the total variance in the measuring tool. Cronbach’s Alpha Reliability of Co-efficient value of the scale was calculated as “.942”. In CFA conducted with the data set of the digital citizenship scale, it was determined that the five-dimensional factor structure produces acceptable fit values (X2=73.720.919, sd=631, X2/sd=11.602, P=0.00, RMSEA=0.08, GFI=.90, IFI=.95, TLI=.90, CFI=.95).

Statistical Analysis

After collecting the data of the study with three scales, outliers were cleared, skewness and kurtosis values were calculated. In consequence of the calculations, the skewness and kurtosis values are in the range of “±1.5”, it is accepted that the data meet the normal distribution criteria (Hopkins & Weeks, 1990; DeCarlo, 1997; Tabachnick & Fidell, 2013).

Data reached with three scales used for the study were analyzed in terms of validity and reliability at the first stage. Cronbach’s Alpha coefficient calculations were made to determine whether the exploratory factor analysis for the conformity of scales to construct validity (Field, 2009; Büyüköztürk, 2020) met the reliability criteria. In the study model, while examining the effect of independent variables such as perceived digital literacy and digital citizenship that predict digital teaching material development self-efficacy behavior of pre-service teachers as dependent variables, a hierarchical multiple regression analysis was conducted in which the

variables of gender, age, the teaching program and class, the tools used while benefiting from digital platforms, the purpose of benefiting, the duration of use and the level of utilization were controlled.

To describe whether the third variable mediates or has an indirect effect on the relationship between two variables, some conditions must occur (Baron & Kenny, 1986).

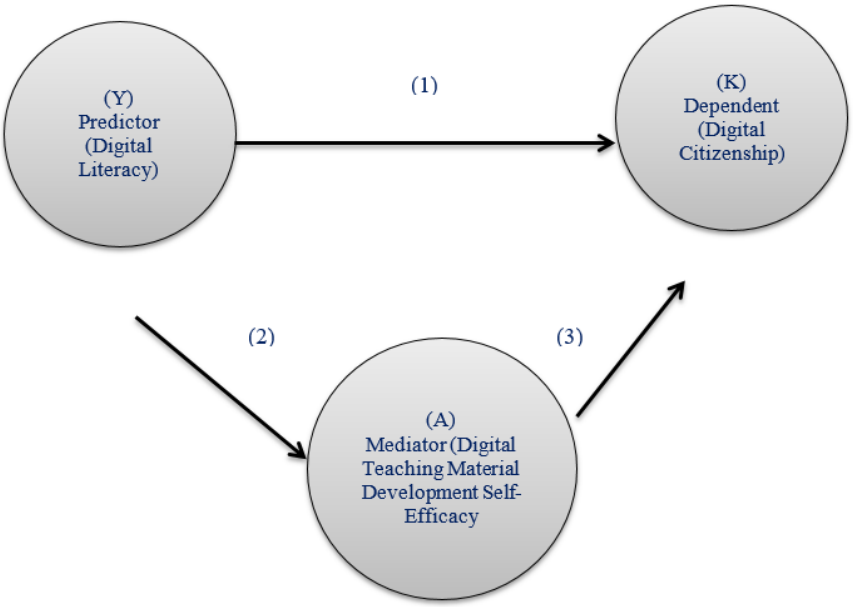

Figure 1. Mediation effect in the Baron and Kenny model

As seen in Figure 1 (Y) is Predictor, (K) is dependent/criterion, and (A) is mediator variable: (1) Digital Literacy meaningfully predicts Digital Citizenship; (2) Digital Literacy significantly predicts Digital Material Development Self-Efficacy; (3) Digital Material Development Self-Efficacy predicts Digital Citizenship by controlling the impact of Digital Literacy and (4) By controlling the effect of Digital Material Development Self-Efficacy, Digital Literacy predicts Digital Citizenship or this relationship becomes statistically insignificant. In the fourth step, if Digital Literacy predicts Digital Citizenship is meaningless, Digital Material Development Self-Efficacy is called the "complete mediator" variable, and if there is a significant decrease in Digital Literacy's prediction of Digital Citizenship, Digital Material Development Self-Efficacy is called the "partial mediator" variable (Frazier, Tix & Barron, 2004). To test the significance of mediation effects, the Sobel test, which is used extensively in the body of literature and has been found to produce high-reliability results, was preferred (Şimşek, 2007). For the use of the Sobel test, the Med-Graph-I program, developed by Jose (2003) and available on the website, was utilized.

FINDINGS

Descriptive Analysis Related to Variables and Correlation Matrix

The data regarding the arithmetic mean standard deviation, standard error values, and correlations between variables regarding digital literacy, digital citizenship, and digital material development self-efficacy of the teacher candidates studying in different teacher training programs who voluntarily participate in the study are presented in Table 2.

Table 2. The arithmetic mean standard deviation, standard error, and correlation values of the variables examined within the scope of the study

Variables	Mean	Standard Deviation	Standard Error	1	2	3
1.Digital Literacy	3.68	.527	.016	1		
2.Digital Citizenship	3.33	.597	.018	.461**	1	
3.Digital Teaching Material Development Self-Efficacy	3.46	.519	.016	.553**	.455**	1

**p<.01

According to Table 2, while teacher candidates' perceptions of digital literacy and digital material development self-efficacy are at the level of "Agree (4)", their digital citizenship levels are at the "Neither agree nor disagree" level. Considering the relationships in the correlation matrix, perceptions of digital literacy are in a moderate positive correlation (r=.553, p<.001) with perceptions of digital citizenship (r=.461, p<.001) and digital material development self-efficacy. Besides, the digital citizenship variable and the digital material development self-efficacy variable have a moderate positive correlation (r=.353, p<.001).

The Effect of Digital Literacy and Digital Teaching Material Development Self-efficacy on Digital Citizenship Behavior

Findings and results of the hierarchical multiple linear regression analysis conducted to investigate the mediating effect of digital material development self-efficacy levels on the effect of digital literacy perceived by teacher candidates on the digital citizenship level of teacher candidates are present. In the mediation test analysis conducted below, while examining the effect of digital literacy levels of teacher candidates on digital citizenship behavior, digital material development self-efficacy levels were modeled as a control variable.

Table 3. Hierarchical multiple regression analysis results on the effect of Teacher Candidates' Digital Literacy and Digital Material Development Self-Efficacy on Digital Citizenship behavior

Model		Dependent variable: Digital citizenship					
Independent variables		B	Std. Error	Beta	t	p	F
1	(Constant)	1.433	.155		9.262		42.879
	Digital Literacy	.491	.033	.434	14.703	.000	
	Gender	.069	.037	.052	1.885	.060	
	Age	-.011	.013	-.033	-.912	.362	
	Department	-.009	.005	-.050	-1.745	.081	
	Class	-.078	.022	-.132	-3.525	.000	
	internet usage time	.079	.014	.160	5.676	.000	
	vehicle*	.016	.024	.019	.683	.495	
	purpose**	-.013	.009	-.038	-1.390	.165	
	level***	.017	.034	.015	.510	.610	
2	(Constant)	.962	.159		6.032	.000	48.574
	Digital Literacy	.338	.037	.299	9.159	.000	
	Digital Teaching Material Development Self-Efficacy	.317	.037	.276	8.549	.000	
	gender	.066	.036	.050	1.862	.063	
	age	-.004	.012	-.011	-.307	.759	
	department	-.003	.005	-.014	-.509	.611	
	class	-.080	.021	-.135	-3.749	.000	
	internet usage time	.066	.013	.135	4.907	.000	
	vehicle*	.033	.023	.038	1.408	.160	
	purpose**	-.016	.009	-.048	-1.786	.074	
	level***	-.034	.033	-.030	-1.020	.308	
R^2 *change = .312*							

** Tool used to enter digital platforms;*
*** The purpose of entering digital platforms;*
**** The level of use of digital platforms.*

As seen in Table 3, in the first step, after checking the demographic variables such as gender, age, the class of education, department, for what purpose, with which tool, for how long, internet usage level and perceived digital literacy variables, in the second step, teacher candidates' Digital Material Development Self-Efficacy score was added to the model with the direct identification (enter) method. In consequence of the hierarchical multiple linear regression analysis, after Digital Material Development Self-Efficacy is added to the model, the effect of digital literacy on digital citizenship decreases from $\beta = .434$ to $\beta = .299$. The decrease in the effect of digital literacy after the Digital Material Development Self-Efficacy was added to the model, but the fact that this effect is still significant indicates that Digital Material Development Self-Efficacy is a partial mediator variable in this relationship. That is, digital literacy has an impact on digital citizenship behavior, both directly and via Digital Material Development Self-Efficacy. To apply the Sobel test for the significance of the

mediating effect found, some data in Table 3 were entered into Jose's (2003) MedGraph-I program, and Table 4 below was obtained.

Table 4. The results of the Sobel test analysis

Mediation Type	Partial
Sobel Z Value	49.422
Significance	.000
Direct effect	.161
Indirect effect	.055
Total effect	.216

As can be seen in Table 4, in the Sobel test conducted by entering some data in Table 3 into the MedGraph-I program for the significance of the mediating effect, the mediating effect of digital material development self-efficacy is significant at p<.01 level. Considering the results of the analyzes conducted to determine the effects of mediation in general, the total effect of digital literacy on digital citizenship behavior becomes β=.216, and when digital material development self-efficacy is controlled, the direct effect of digital literacy on digital citizenship behavior becomes β=.161. The difference is β=.055 as an indirect effect, resulting from the mediating effect of digital material development self-efficacy. These mediation effects and the general model can be seen in Figure 1. In the figure, the variables that predict each other are shown with a one-way arrow. The standardized beta coefficients in the regression table are indicated above the arrows.

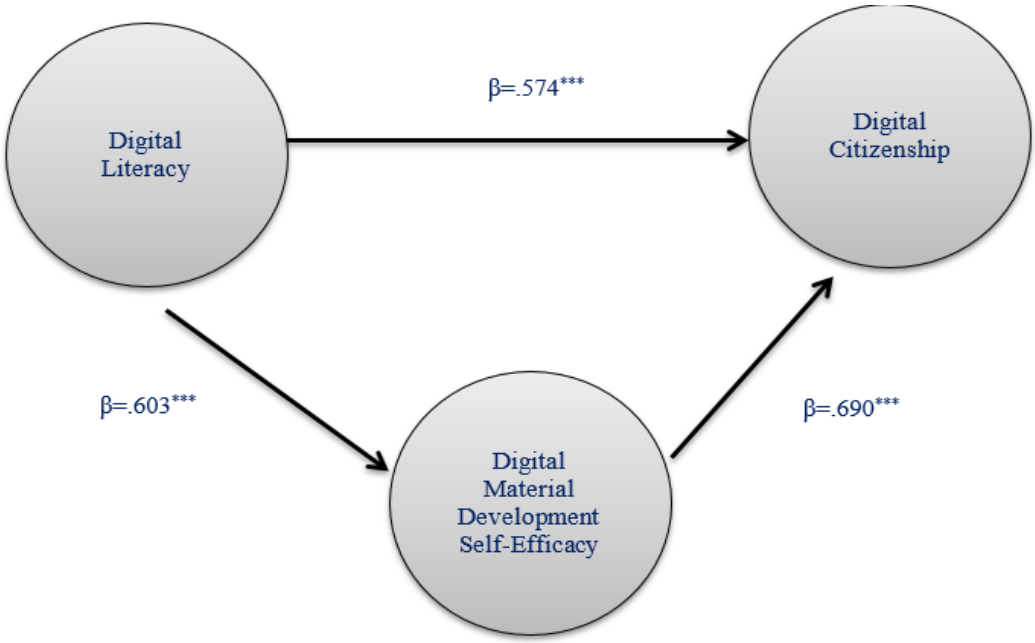

Figure 2. The mediating effect of digital material development self-efficacy level on the effect of perceived digital literacy on teacher condidates' digital citizenship behavior and standardized beta coefficients (***p<.001)

As can be seen in Figure 2, digital material development self-efficacy levels have a partial mediating effect on the prediction of perceived digital literacy on teacher candidates' digital citizenship (Z=49.422, p<.001). The high level of digital literacy of teacher candidates will increase their digital citizenship behaviors both indirectly and directly through their digital material development self-efficacy levels.

Discussion

In the study, digital literacy was examined together with digital citizenship and digital material development self-efficacy, and some important results were reached. According to the hierarchical multiple regression analysis results, it was determined that the digital literacy levels of teacher candidates increase their digital citizenship and digital material development self-efficacies. It was determined that digital material development self-efficacy plays a partial mediating role in the relationship between digital literacy and digital citizenship

behaviors. It can be said that in line with the increase in digital literacy levels of teacher candidates, digital citizenship and digital material development self-efficacy increased.

In the study conducted, findings regarding the high digital literacy levels of teacher candidates are supported by other study findings in the body of literature. Kozan (2018), Üstündağ et al. (2017) reported that the digital literacy skills of pre-service teachers studying in different teacher training programs were at a good level in their studies. Özerbaş and Kuralbayeva (2018) also found that the digital literacy levels of prospective teachers in Turkey were high in their study. This result may be since teacher candidates in Turkey represent a young population, and their integration into digital platforms is faster and easier because they are in the Z generation; as stated by Prensky (2001), students in the generation Z may be due to their innate ability to use new technologies and their ability to adapt easily to emerging technologies. Besides this result obtained, as stated in the study conducted by Menzi, Çalışkan, and Çetin (2012), it can be supported by the result that teacher candidates who use the internet more frequently in their study, which examines the technology competencies of teacher candidates in terms of various variables, see themselves more competent in the field of technology than others. In other saying, the high level of digital literacy of teacher candidates who see themselves as sufficient in technology use can be described as a natural situation.

According to "Information Society Statistics" published by Turkey Statistical Institute (TSI) in 2020, internet access in Turkey was determined as 94.9%. Web site ownership was 53.7%, and internet access in households was 90.7%. According to the results of the same research, the e-government usage rate in Turkey was 51.5%. These data showing the current digital view of Turkey are an indication that Turkey is not behind the age in digitalization. Besides, according to these data, the adaptation of Turkey to digital citizenship, which comes with digitalization, is understood from the rate of entry to e-government applications. All these data support the finding of the high levels of digital literacy and digital citizenship of teacher candidates obtained in the study.

In the study conducted, findings regarding the high digital citizenship levels of teacher candidates are supported by other study findings in the body of literature. Kocadağ (2012), Sakallı (2015), Bakır (2016), and Arslan (2016), in their study conducted, found that the digital citizenship levels of teacher candidates studying in different teacher training programs are high. Besides, the high level of digital citizenship of prospective teachers can be evaluated as that Çubukçu and Bayzan (2013) included in the definition of digital citizenship and carried out by pre-service teachers of behaviors that can criticize while using information and communication tools, are aware of the ethical consequences of online behaviors, use technology in a way that does not harm others, use the right to communicate online, show the right attitude in their sharing and cooperation, and encourage others in this direction. A similar situation is supported by the statements of Karaduman and Öztürk (2014), who define digital citizens as people who have the power to understand, write, read and share the information on the internet and use the internet effectively.

The findings of the study conducted that digital literacy increases the level of digital citizenship is supported by other study findings in the literature. Zahrani (2015) was determined that digital literacy is an extremely important factor in the perception of digital citizenship. Kaya (2020) was reported in his study conducted that there is a moderate, positive relationship between digital citizenship level and digital literacy level. Besides, in the study of Kaya (2020), the effect of digital literacy on digital citizenship was found to be positive and significant. In the study conducted, findings were obtained indicating that teacher candidates' self-efficacy levels of digital material development are high. Digital textbooks, applications, and online complementary resources (Edson & Thomas, 2016; cited in Göçen Kabaran, 2020), animations, simulations, presentations, digital texts, and videos come to mind when it comes to digital teaching material (Taşlıbeyaz & Karaman, 2015). Today, teacher candidates studying in teacher training programs are called digital natives by age. These materials, which are suitable for the nature of digital native students, can contribute to the teaching-learning environments of the 21st century. However, digital materials offer many different educational opportunities that cannot be achieved in traditional teaching forms (Kalyuga & Liu, 2015). When the expressions about the importance of digital teaching material in conceptual terms are combined with the finding that the teacher candidates' digital material development with self-efficacies are high, it can be said that the study results are sufficient for the pre-service teachers in terms of digital material development efficacies. The high level of digital literacy, digital citizenship, and digital material development self-efficacy of teacher candidates and their interrelatedness is evidence that teacher candidates studying in teacher training programs in Turkey are sufficient in terms of the three variables expressed. Besides, the relationship of study subjects examined on a digital basis is also supported by data obtained from digital platforms in Turkey (see TUIK (TSI), 2020 data).

Limitations and Recommendations

The current results of the study should be read carefully. The results of the study conducted it is limited by the opinions of teacher candidates who study in different teacher training programs at universities in different regions of Turkey. In addition to these, the limitations of the study conducted: It can be shown that (1) it was carried out with a limited sample group with teacher candidates in higher education institutions and that generalization to larger samples is limited and (2) only the perceptions of teacher candidates in state universities are determined.

Although the above-mentioned limitations in the study provide a theoretical framework for the relationship between variables that are seen as important in increasing the level of digital literacy thus, this study can contribute to deepening the knowledge on the concept of digital literacy. It was determined that the findings of the study conducted that digital literacy increases the level of digital material development self-efficacy is supported by other study findings in the body literature. More comprehensive results can be obtained, especially in the sense of digital literacy and digital citizenship, by adding different variables to research processes other than the three variables expressed. In the study, it was determined that the digital material development self-efficacy tool plays a variable role in the relationship between perceived digital literacy and digital citizenship behavior. In the future study to be held, in the relationship between digital literacy and digital citizenship behavior, economic factors affecting students' access to digital platforms, their education towards using digital platforms, or their attitudes towards digital platforms can act as mediators. Besides, according to the study results, it was suggested, that the teacher candidates' work on increasing digital literacy levels would be beneficial to improve their digital citizenship and digital material development self-efficacies. In addition to this, the study to be held can be conducted in a qualitative study on the reasons for the relationships between the concepts studied.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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Influence of a Multiphase Inquiry-Based Learning Project on Students' Science Literacy

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Abstract

Globally, fewer students are choosing careers in science. In developing countries like Bangladesh, this attrition is often attributed to limited access to laboratories, lack of qualified science teachers, and limited use of student-centered strategies (SCS). Educators are attempting to design professional development programs to empower teachers with innovative teaching methods that will eventually boost enrolment in STEM-related fields. With this end in mind, we designed a six-month-long grant-funded project that equipped five urban schools in Bangladesh with 20 science toolkits. We also provided 20 science teachers and five site coordinators with ongoing professional development to support use of these toolkits with 109 students for inquiry-based learning (IBL). Using an explanatory sequential design, we analyzed quantitative and qualitative data from three surveys. We also used transcripts from interviews with five site coordinators and four Zoom panel presentations to understand the numeric findings. While quantitative analysis with SPSS revealed that teacher-centered strategies (TCS) continue to be widespread in Bangladesh, we noted that the IBL project influenced student outcomes in several ways. The qualitative data confirmed that teachers who receive training and support over an extended period implemented SCS quite effectively. Both quantitative and qualitative findings revealed that a shift from TCS to SCS enhanced students' ability to hypothesize, experiment, and make real-life connections. In this paper, we describe statistically significant differences in the students' knowledge across curriculum type and gender. We also describe the influence of the project on student attitudes.

Introduction

Progress in science and technology is considered the main driving force for the advancement of a country (Organisation for Economic Co-operation and Development, 2012). Empirical evidence over the last few decades confirms that globally, fewer students are choosing higher education and careers in the field of science (Cooper et al., 2020). A similar trend has been observed in developing countries like Bangladesh. The Bangladesh Bureau of Educational Information and Statistics (BANBEIS) reported that students studying science at the secondary level have declined at the rate of 48 percent from 1993 to 2015 (BANBEIS, 2016). Some scholars have attributed declining numbers to culture, limited access to resources (BANBEIS, 2016), and professional development opportunities (Khanum, 2020; Talukder et al., 2021). Others attribute it to pedagogical practices; teacher-centered strategies (TCS), like the lecture method, are still popular in Bangladesh (Akhter et al., 2019; Jony, 2016). Students rarely experience engaging activities in the classroom (Akhter et al., 2019).

Learning some subjects, especially science, without active participation leaves students unmotivated and underprepared to pursue a career in STEM-related fields. A growing number of scholars in developing countries have described the benefits of using inquiry-based learning (IBL), a student-centered strategy (SCS), to attract students toward the sciences (Aulia et al., 2018; Wang & Gao, 2021; Zhao et al., 2021). With this end in mind, we designed and implemented a six-month-long, grant-funded IBL project that would equip the teachers, site coordinators, and students at five urban schools with IBL skills. Grant funding was used to provide each of the five schools with access to four science toolkits for inquiry-based learning (IBL). To facilitate effective use of these toolkits, we provided the 20 teachers (four from each school) and 5 site coordinators (one at each school) with ongoing professional development and support. Participating teachers used these toolkits and the IBL activities they designed with 109 students. Students designed posters to share their findings with students, teachers, and parents. Participating teachers shared the IBL activities they developed in a book and on 'Shikkhok

Batayon,' the largest government-owned educational content website for schools in Bangladesh. Additionally, teachers, students, and site coordinators shared their IBL experience via Zoom with educators in Bangladesh and other countries. In this article, we present a synthesis of literature which informed the design of the IBL project and a study to evaluate outcomes. We describe the context, objectives, and timeline of the IBL project. Next, we describe the four research questions and instruments used to collect data. We present the results, discuss our findings, and invite educators in developed and developing countries to replicate the project (see Machado & Nahar, 2021), with modifications.

Literature Review

In this section, we synthesize research that describes the knowledge, skills, and pedagogy science educators have focused on over the last few decades. Next, we describe how science education is organized in Bangladesh and the factors that impede innovative science teaching practices. We conclude with a description of empirical research that supports a shift from TCS to SCS like IBL.

Essential Knowledge and Skills for Secondary Science Education

There is strong agreement in the scientific community that secondary school students should have a solid foundation in the fundamentals of science, scientific inquiry, and its application in daily life. A few decades ago, the National Science Education Standards (NSES, 1996) described scientific inquiry as "diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" (p. 23). Brohi and Munshi (2021) state that the primary purpose of science teaching is to offer knowledge and information about our surroundings. To learn the fundamentals, students must engage in active processes which require capacity to make sense of phenomena and content (Matthew et al, 2019). While Murphy et al. (2021) emphasizes the importance of the inquiry process, Mezirow (1991) states that “making meaning is central to what learning is all about” (p. 11). People are more likely to accept knowledge consistent with their existing knowledge base derived from their own experiences (Kovbasyuk & Blessinger, 2013).

Teaching Strategies for Developing Scientific Literacy

Piburn and Baker (1993) attribute students' negative attitudes toward science to its abstract nature and complexity. Others suggest that teaching methods and curricula contribute to low interest and negative attitudes toward school science worldwide (Tseng et al., 2011). To address such issues, professional organizations have described a variety of pedagogical approaches suitable for secondary students (National Curriculum and Textbook Board, 1996; National Research Council, 1996). Scholars recommend that educators focus on cultivating students' scientific knowledge (Driver et al., 1994), attitudes (Pitafi & Farooq, 2012), and scientific process skills like hypothesis formulation, identification of and controlling variables, and experimentation (Ergül, 2011) with innovative science teaching strategies (Hırça, 2013).

Over the last six to eight decades, science teachers have used a variety of pedagogical approaches to enhance students' science literacy. One popular and widespread pedagogical practice is project-based learning which former science teacher Dewey described as “learning by doing” in his book "My Pedagogic Creed" which was published in 1897. ChanLin (2008) and Karaman and Celik (2008) report that learners who engage in project-based learning performed better in skill development, general ability, and knowledge compilation than those who did not. Mioduser and Betzer (2008) argue that project-based learning helps to increase students' positive learning attitudes toward technology and science (Catherine & Barry 2008). The National Research Council (NRC, 1996) developed a framework for inquiry-based learning. Dewey (1910) also recommended the inclusion of inquiry into K-12 science curriculum. Another strategy for teaching science that became popular in the 1970s is problem-based learning. Problem-based learning, which was first incorporated at the medical school of McMaster University, Canada, was used to analyze patient problems systematically, find solutions, and select the students' own learning goals (de Graaff & Kolmos, 2007). Later, the adoption of problem-based learning expanded into elementary, middle, high, universities, and professional schools (Savery, 2006; Torp & Sage, 2002). The advent of technology has resulted in many different innovative approaches that include the use of SCS. Over the last decade, science teachers have begun to use game-based learning to teach science. The term gamification, which first emerged in 2008, has gained increasing relevance since the 2010s (Deterding et al., 2011; Seaborn & Fels, 2015). Scholars have been investigating how digital games promote learning (Gee, 2007; Lynch et al., 2015; Malone, 1980; Prensky, 2005) motivation and engagement (Gee, 2007; Sheldon et al., 2011).

Recently, educational researchers have begun to study the benefits of replacing physical laboratories with virtual labs (Potkonjak et al., 2016).

Secondary Science Education System and Curriculum in Bangladesh

In many developing countries like Bangladesh students do not have access to innovative teaching strategies for a variety of reasons, including, but not limited to the educational system. Rahman et al. (2010) described the Bangladesh education system as one that consists of several coexisting streams parallel to each other. Within the secondary education system, the curriculum varies. According to Roy et al. (2020),

> The complex education system of Bangladesh …..involves more than 25 types of school providers, offering education from pre-primary to secondary levels, with ten examination boards. Based on the curriculum offered, providers can be grouped under three main streams: (a) public and private schools and madrasas that follow the National curriculum; (b) unregistered and autonomous Quomi madrasas that follow Deobandi curricula; and (c) schools that follow a British curriculum. (pp. 3-4)

Disparities exist across schools in Bangladesh in terms of cost, medium of instruction, curriculum, teaching strategies, and overall quality (Mousumi & Kusakabe, 2017; Nur, 2021). Schools that offer the British curriculum generally serve students of higher socioeconomic status (Mousumi & Kusakabe, 2017; Nur, 2021; Shahidullah, 2017). Conversely, students of lower socioeconomic status tend to enroll in schools with a National Curriculum. Mousumi and Kusakabe's (2017) mixed-method study of 149 students and 30 teachers, parents, and principals in Bangladesh revealed a widespread belief that schools that offer the British curriculum provide better quality education. Using a qualitative approach, Nahar (2021) studied five science teachers at a British curriculum school in Dhaka to examine science teaching standards. She noted that teachers at schools with better facilities and the British curriculum used more innovative science teaching techniques than their counterparts at National curriculum schools.

Barriers to Attainment of Student-Centered Learning in Bangladesh

Like teachers in other developing countries, teachers in Bangladesh may have theoretical knowledge about project-based learning, inquiry-based learning, problem-based learning, game-based learning, and virtual labs; their ability to use these approaches to develop students' scientific knowledge and skills are often impeded by factors that we discuss in this section. This includes the way secondary science education is organized in Bangladesh, the lack of resources, inadequately trained teachers, the lack of quality textbooks, and traditional teacher-centered pedagogical practices.

Lack of Resources

The Bureau of Educational Information and Statistics (BANBEIS, 2016) analysis of data collected from 100 schools and 965 students, science teachers, school heads, education officers, and guardians from across Bangladesh revealed insufficient laboratory resources, trained teachers, and poor-quality textbooks as significant challenges. BANBEIS reported that 15% of schools and 31% of Madrasahs do not have science laboratories. There is considerable disparity between urban and rural schools; only 28.5 % of rural schools have proper laboratory maintenance compared to 43.2% of urban high schools. Students in rural schools have limited access to trained teachers; proportionally more post-graduate trained teachers (44.7%) work at urban and rural government schools. Conversely, fewer rural non-government schools have qualified teachers (10.3%) as compared to their urban counterparts (60%). According to BANBEIS's survey respondents, textbooks are unclear, lack sufficient detail, do not include a glossary, and include illustrations that have errors. Additionally, the curriculum lacks instructions about how it should be implemented in rural settings where resources are even more limited.

Examinations and Rote Memorization

The assessment system at secondary schools in Bangladesh fosters the use of TCS and rote memorization over student-centered learning. Evaluation of students' learning in Bangladesh is driven primarily by the national examination system (Khan et al., 2014; Rahman et al., 2010). Exam results are very important as they are used

to determine students' promotion from one grade to another and future study options (Sarkar & Corrigan, 2014). The examinations often include a pool of items taken directly from the textbook, and tests often require answers copied straight from the textbook. This approach propels students to rely almost exclusively on the recommended textbook and rote memorization (Holbrook, 2005; Maleque et al., 2007). Teaching often reflects the washback effect (Tapan, 2010), where teachers mostly prepare students for the exams by encouraging them to practice rote learning. In Al Amin and Greenwood's (2018) mixed method study with 216 secondary school teachers of Bangladesh, 10% agreed that an effective teacher teaches only what will be important for the final examination and that over 30% acknowledged that they did not teach portions of the textbook that they considered less important for the examination. Alam et al. 's (2022) qualitative study, which included head teachers, teachers, and parents of 15 schools in Bangladesh, confirms that students and teachers are dependent on rote memorization for academic success in Bangladesh. Jony's (2016) survey of 100 secondary teachers from different schools in Bangladesh confirmed that this preoccupation with grades and results makes it difficult for students to adjust to SCS.

Limited use of Student-Centered Strategies in many Developing Countries

Scholars have reported limited use of SCS in many developing countries across the world; this may discourage students from pursuing careers in science (Doka et al., 2021, Tsegay, 2015). Schweisfurth's (2011) systematic review of 72 studies in 39 developing countries around the world revealed that:

> Classroom realities in developing country contexts evidently create challenges for LCE. The ideal-typical LCE classroom as envisaged in the doctrine of progressivists based in the rich minority world is far from the lived experience of most teachers and learners in the South… (p. 427)

Empirical and theoretical research on teachers' and students' perceptions about SCS highlight some of the benefits and challenges. Teachers' perceptions greatly influence their use of SCS. Akhter et al. s' (2019) observations and interviews with four secondary biology teachers of Dhaka city revealed that teachers lack knowledge about SCS. Jony (2016) investigated Bangladeshi secondary teachers' perception of SCS through surveys. He noted that nearly half of the sample (44.8%) strongly agreed that teachers need to prepare differently when using SCS. Over 80% of teachers feared losing control of students. They reported that students in Bangladesh are more accustomed to the traditional approach and more focused on grades and the final result. Some feared that SCS would increase students' workload and that it would be difficult for them to adjust to a new system. Schweisfurth (2011) examined teachers' perceptions from a cultural point of view and claimed they might have low expectations of individual students' ability to manage their learning if they are from marginalized communities. Several scholars described students' perceptions of SCS. Widmann and Binaya's (2013) study in Nepal highlighted students' positive responses towards the SCS; students were more likely to like what they were learning when SCS was thoughtfully embedded into instruction. Several scholars identified challenges. The 39 South African student teachers who participated in du Plessis's (2020) study described how difficult it was to maintain discipline when using SCS in large classes. Khanum's (2020) mixed-method study involving 100 undergraduate students and four teachers from Dhaka city revealed that students do not like to talk in front of the teacher; they preferred guidance over autonomy.

Inquiry-Based Learning for Acquisition of Knowledge and Attitudes

In addition to understanding disciplinary content knowledge, students need learning skills - an understanding of how knowledge is organized and acquired. By learning how to solve problems, think critically, apply information, and integrate knowledge, learners can think like experts in a discipline (du Plessis, 2020). Research, however, confirms that students do not automatically acquire these skills (Chiphiko & Shawa, 2014); teachers need to integrate innovative SCS strategies like IBL and project-based learning into the curriculum to facilitate the acquisition of content knowledge and a positive attitude toward science.

Inquiry-Based Learning: Knowledge, Attitudes, Skills

Inquiry-based learning (IBL) can be used to foster deep cognitive capabilities and develop transferable life skills, value clarification, and meaning making in all its complexity. Several professional organizations recommend the use of SCS, like IBL. The National Research Council recommended the use of IBL, which allows students to conceptualize questions and seek possible explanations to respond to their questions (NRC,

1996). The National Science Teacher Association (NSTA) described how IBL promotes scientific content knowledge in students. It goes on to add that:

> Scientific inquiry is a powerful in understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions. (NSTA, 2004, para. 3)

In addition to disciplinary knowledge, students need to develop a positive attitude towards science. The scholarly literature confirms that IBL fosters a positive attitude and a high level of student engagement. In his autoethnographic study of 49 seventh-grade students, Frezell (2018) described a close link between hands-on aspects of IBL and students' interest in science. In contrast, he also observed that some students experienced frustration when the lesson seemed to lack structure. Sangkala and Doorman's qualitative study (2019) involving 120 Indonesian high school students confirmed that IBL inculcated a positive attitude that facilitated autonomous learning, content exploration, and finding solutions. A few years later, Postma (2021) examined the effect of IBL on 349 high school students' motivation toward science. She reported a statistically significant difference in autonomous motivation in students who experienced IBL lab activities. Students who participated in the IBL lab activities with enough time, no prior preparation, and no prior assessment showed higher intrinsic motivation than those who were prepared, assessed in the past, and could not get enough time to practice IBL. In short, IBL allows students to enhance their science literacy by performing experiments and investigating phenomena (Gasterland, 2021).

Status of Inquiry-Based Learning in Developing Countries and Bangladesh

Educators in developing countries use IBL for science teaching to varying degrees. Several scholars from developing countries across Asia have reported positive outcomes of IBL on science learning (Dool et al., 2021; Duran & Dökme, 2016; Hastuti et al., 2018; Mulyeni et at., 2019). Pandey et al. (2016) and Zhao et al. (2021) reported a statistically significant effect on students' academic achievement. Abdi's (2014) eight-week experimental study with 40 Irani primary students revealed that students in the IBL group achieved higher scores than those in the control group. Similarly, Zhao et al.'s (2021) reported that 174 fifth-grade students in China had clearer concepts due to IBL. Conversely, some authors described the challenges teachers faced when using IBL in developing countries. For example, Hairida (2016), who conducted a quasi-experimental study with two seventh-grade classes in Indonesia, reported that limited resources impeded implementation of IBL. Hsiao et al.'s (2017) quantitative study with 123 fourth grade students in Taiwan highlighted students' inability to understand the findings of IBL; this could be an obstacle. Huang et al. (2021), who studied students in Beijing and Holland, reported that students need many more opportunities to practice IBL.

IBL gained popularity in Bangladesh in the 1980s. Tapan (2010) reports that the "hands-on practice" focused science curriculum which was introduced in 1982 was not implemented. The country's National Curriculum and Textbook Board (NCTB, 1996) reported that schools could not provide the resources needed to facilitate inquiry in science classrooms. Shahidullah (2017) explained that science teachers rejected IBL because the National Curriculum and Textbook Board (NCTB) of Bangladesh failed to prepare them adequately. Despite these difficulties, all subsequent science curricula included inquiry as an essential part.

Background of the IBL Project and the Related Study

Bangladeshi secondary school students' interest in pursuing education in the science field has been on the decline for decades; this has had a negative impact on the country's advancement in STEM sectors (BANBEIS, 2016). Education leaders, curriculum specialists, and policymakers in Bangladesh are committed to boosting enrollment in the sciences. Scholars have recommended professional development that equips teachers to use low-cost material to design and implement low cost SCS (Akhter et al., 2019; Hossain, 2019). We answered this call to action by designing and implementing the urban phase of a grant-funded IBL project to promote science education in three schools that offered a National curriculum and two that offered a British curriculum in Dhaka, Bangladesh. The six-month-long IBL project (October 2019 to March 2020) was designed to meet the following goals.

1. To provide ongoing professional development to 20 secondary science teachers who worked at five urban schools to equip them with the knowledge, disposition, and skills needed to design and facilitate IBL activities using locally available materials.
2. To provide 100 students with the opportunity to use the provided IBL toolkits to implement a model IBL activity (guided practice), student-led group IBL activity (independent practice), poster presentations, and IBL information sessions via Zoom.
3. To compile science-related IBL activities developed by participating teachers and make them available to the 429,777 teachers of 'Shikkhok Batayon,' the largest government-owned educational content website for schools in Bangladesh.
4. To provide teachers, school site coordinators, and students with an opportunity to share their IBL experience via Zoom with educators in Bangladesh and other countries and a book that includes IBL resources created by participating teachers.

Table 1 presents the six steps that we completed to meet the four objectives described above. The professional development training (step 1) provided teachers with an opportunity to familiarize themselves with the difference between familiar practices like teacher-led demonstrations and IBL, which requires the use of hypothesis testing, manipulation of apparatus, data collection, and analysis to arrive at conclusions. At this session, teachers were provided with details about the four IBL toolbox's each school would receive, instructions on how to create four teams per school (each with a teacher and 5-6 students), and the ways in which teachers should facilitate their teams' use of the toolkit for guided practice with the model IBL activity designed by the project director (step 2) and independent practice using the IBL activity planned by the teacher and students (step 3).

Table 1. Project overview: Urban phase

Program Overview	Timeline
Step 1: Inquiry-Based-based Learning' Training Session	14 - 20 Oct. 2019
Step 2: Use of Model IBL Project & Science Toolkits (Guided Practice)	20 - 30 Oct. 2019
Step 3: Teams Design and Implement their own IBL Activity	31 Oct.-10 Nov. 2019
Step 4: Teams Make Knowledge Public at a Poster Fair	26 Feb. 2020
Step 5: Teams and their Families Attend 'Certificate Award Ceremony'	26 Feb. 2020

We delivered the four IBL toolkits to each of the five schools a few weeks after the project began. During step 2, the 20 teachers used the toolkits and the model IBL project, designed by the project director, to test the hypothesis, manipulate the apparatus, record their observations, analyze results, and draw conclusions. After gaining a working knowledge of IBL, each team designed and implemented their own IBL projects at their respective schools (step 3). They began the process by listing several hypotheses they wanted to test with locally available inexpensive materials; of these, they picked the hypothesis they liked best. Using the model IBL and their teacher as a guide, they used the scientific method to test the hypotheses. For many students, this was the first time they conducted an experiment with locally available material using standard scientific procedures. Next, project participants made their learning public at a poster fair that was attended by 200 students, their parents, and teachers. At this catered event, teachers and students were given certificates and awards (steps 4 and 5). The project director provided ongoing individualized support by phone, school visits, and email. She also used Facebook and Facebook Messenger to provide teachers with encouragement and feedback (steps 1-5).

Upon the culmination of the project, we collected data from participants to evaluate the outcome and improve the program for the rural phase. We administered Teacher Survey B and the Student Experience Survey to evaluate teachers' and students' experiences with different aspects of the project. We also interviewed the five site coordinators (step 6). We hosted four panel presentations via Zoom to share the outcomes of the IBL project with the larger academic community. We posted links to these events on Facebook. Each panel presentation included a cross-section of project participants. On average, approximately 60 to 80 students, science teachers, school leaders, and curriculum specialists in Bangladesh and other countries joined each of the four Zoom sessions (step 6). We used the interview and Zoom session transcripts as additional data sources.

Methodology

We designed this six-month-long study to evaluate the IBL project outcomes and contribute to the limited body of professional development literature that target IBL studies in developing countries in general, and Bangladesh in particular. In this section, we describe the research design, research questions, data sources, instrumentation, and data collection procedures.

Research Design, Questions, and Data Sources

We used a mixed-method explanatory sequential QUAN-QUAL design to study the influence of a professional development program on secondary science students' IBL. The three surveys, which were administered sequentially, elicited both quantitative and qualitative data. We also used the qualitative data from the five site coordinator interviews and four Zoom session transcripts to understand the numeric findings. Table 2 presents four research questions, and the data sources used to answer each question.

Table 2. Data sources of research questions

Research Questions	Items in Survey and Protocol				
	Teacher Survey A	Teacher Survey B	Student Survey	Interview Protocol	Zoom Sessions
1. How did teachers, students, and site coordinators describe the way science is generally taught in Bangladesh?	8		8a - k	1, 2	
2. How did the IBL project influence students' scientific literacy (knowledge and attitudes)?		3	9, 11a -d	4, 5, 7	1-4
3. What challenges did students face, and how did they overcome these challenges?		5, 6	13	3	1-4
4. What influence did the IBL project have on students' motivation and desire to pursue higher studies in science?			6, 7	1, 2	1-4

Instrumentation

We drew on our shared experience of more than 22 years of K-12 teaching experience in Pakistan and Bangladesh (this includes 13 years teaching science in Bangladesh) and 16 years of research design to develop three surveys and an interview protocol. Surveys A and B were administered to teachers. Survey A elicited demographic information and teachers' preferred pedagogy (items 6, 7, and 8). Survey B included items related to the IBL project's success (items 1 and 2) and items related to challenges teachers faced (items 3 and 4).

The 13-item Students' Experience Survey included five items that elicited basic demographic information such as age, gender, and types of curricula. Items 6 and 7 elicited data to ascertain the IBL project's influence on students' future career plans related to science education. Scaled item 8 provided students with an opportunity to describe how often they engaged in different science learning activities prior to the IBL project. Items 9 to 11 garnered data on the knowledge students gained during the project. Item 13 identified the barriers students experienced and how they overcame these.

The interview protocol that we developed for site coordinators included open-ended items (items 1, 2, 3, 4, 7, 8, and 9) and closed-ended items (items 5, 6, and 10). Items 1 and 2 elicited data about general science teaching practices. The rest of the items elicited data about the successes and challenges the site coordinator observed while the project was underway.

Data Collection Procedures

We initially administered Survey A electronically using Qualtrics. Preliminary analysis of data confirmed that we needed to readminister the survey in person along with an explanation of some terms in teachers' native language, Bangla. We did this at the professional development session (step 1). We used Qualtrics to administer Survey B to teachers electronically after step 3 was completed.

Participating teachers sent the link to the Student Experience Survey to their respective students. Only 47 of the 109 students completed the survey (response rate 43.12%); the rest could not be reached due to post-exam absence, shifting location, and the impact of Covid 19 Pandemic. Given that students' perspectives are not represented sufficiently in the scholarly literature, we deemed this number acceptable, especially because the surveys included open-ended responses, which would be triangulated with qualitative data from two other sources. Upon completion of the project, we conducted in-depth semi-structured interviews with the five site coordinators via Zoom. We also used transcripts of the four recorded Zoom sessions as a data source.

Analysis and Findings

We used IBM SPSS statistics version 28 to analyze the numeric items of the survey and NVivo 12 to quantize some of the open-ended survey items. We also used NVivo for typological and interpretative analysis of the five interview transcripts and the four Zoom transcripts (Hatch, 2002). In this section, we begin with demographic information about our participants. Following this, we present analysis and findings, organized by the four research questions.

Participants

We used a purposeful sampling approach to select 109 students, 20 science teachers, and five site coordinators from three English and two Bangla medium urban schools in Dhaka city, Bangladesh (see Table 3). Due to the extenuating circumstances brought on by the pandemic, only 47 students completed the survey.

Table 3. Number of students who completed the survey across school: Organized by curriculum

Curriculum	Schools	Public/Private (approx cost per year *)	Medium of instruction	Respondents per school	Total students per curricular	%
British	A	Private ($1350-1600)	English	18	30	63.5
	B	Private ($2000-2500)	English	12		
National	C	Private ($550-700)	English	02	17	36.2
	D	Private ($320-400)	Bangla	10		
	E	Public (Free)	Bangla	05		

Note. * Information obtained through personal communication with teachers in Bangladesh

The student sample included many more females (n = 32, 68%) than males (n = 15, 32%). More than half of the respondents were 15-16 years old (n = 24, 51%), a third were 13-14 years old (n = 18, 38.3%) and a tenth were 17 -18 years (n = 5, 10.6%). Our findings reflect the perspectives of middle (n = 11, 23.4%), junior high (n = 23, 48.9%), and senior high school students (n = 13, 27.7%). The response rate varied across schools (see Table 3). Proportionately more students completed the survey at the two schools that follow the British curriculum (n = 30, 63.5%) than at the three schools that follow the National Curriculum of Bangladesh (n = 17, 36.2%).

Status of Science Teaching in Bangladesh

Research question one explored participating students' perception of science teaching practices at the five urban secondary schools in Bangladesh. We used item 8 from the Student Experience Survey, item 8 from Teacher Survey A, and the Site Coordinators' interview items 1 and 2 to answer this question.

Table 4. Response patterns to item 8: Students' perception of science teaching in Bangladesh

Students' Perception Regarding Science Teaching		Response Patterns (%)			
		1	2	3	4
TCS	We listen to teachers give lecture-style presentations	0	6.4	17	76.6
	We read our science textbooks and other resource materials	4.3	6.4	17	72.3
	We memorize science facts and principles	2.1	17	34	46.8
	We take notes during our observations	8.5	23.4	14.9	53.2
	We watch the teacher demonstrate an experiment or investigation	6.4	42.6	23.4	27.7
	We memorize the answers given by the teachers for taking exam preparation	14.9	4.3	31.9	27.7
SCS	We use scientific formulas and laws to solve problems	2.1	14.9	21.3	61.7
	We relate what we are learning in science to our daily lives	0	27.7	38.3	34.0
	We work on problems on our own	6.4	42.6	29.8	21.3
	We explain what we learned to other students and teachers	10.8	34	38.3	17.0
	We do science experiments in small groups	19.1	34	23.4	23.4
	We design or plan an experiment or investigation	25.5	36.2	23.4	14.9

Note. [a] 1 = Never, 2 = Few Lessons, 3 = About Half the Lessons; [4] = Every or Almost Every Lessons

Scaled item 8 in the Student Experience Survey elicited respondents' evaluation of SCS and TCS. The mean and standard deviation scores confirm that, on average teachers use TCS (M = 3.22, SD = 0.47) more frequently than SCS (M = 2.71, SD = 0.66). The large effect size (η^2 = .89) shows that the difference in the mean scores of SCS and TCS is not negligible; proportionally more students reported science teachers' use of TCS.

More students reported that they listened to lecture-style presentations (n = 36, 76.6%) and read textbooks and resource material for every and/or almost every lesson (n = 34, 72.3%) (see Table 4). We used a Kruskal- Wallis test to determine if there was a statistically significant difference across grade levels and type of strategy. We found a statistically significant difference in students' reported access to SCS across three different grade levels (Middle school, n = 11; Junior high, n = 23; Senior high, n = 13), X2 (2, n =47) = 6.46 p = .04. The junior-most group (Middle school) had a lower median score (Md = 12) than the other two groups. The senior-most group (Senior high) had a higher median score (Md = 20) than the group in between (Junior high), which had a medium value of 17. We did not note a statistically significant difference across the three grade levels and TCS. These findings confirm that students of all grade levels reported similar frequency of TCS; however, students of higher grades experience SCS more frequently than students in lower grades.

We used NVivo to engage in typological and interpretive analysis (Hatch, 2002) of students' open-ended responses to item 13 in the Student Experience Survey, teachers' open-ended responses to item 9 in Survey B, and Site Coordinators' responses to interview questions 1 and 2. The qualitative data corroborated the numeric results. Students reported a lack of opportunity to participate in hands-on activities due to limited resources at their school. One student said, "science apparatus handling was challenging as it was new to me" (School A, Student Experience Survey). Another added, "the IBL project was the first-ever science experiment we did on our own...of course with the help of our teacher...following all the lab rules precisely" (School B, Student Experience Survey).

Teachers' comments are consistent with student-reported data. Teachers' responses to item 7 in Survey A highlighted a strong preference for the lecture method (n = 20, 100%). They justified their choice in a variety of ways. Mr. Tapon attributed this preference to cultural norms. He said, "this has been the preferred way to teach in our country. Most students have grown up learning in school through this method. Also, this method is most effective in completing the syllabus or a topic within the allotted time duration of a class period" (School B, Survey B). Others echoed similar sentiments, "It is easy to teach all students in a short time. It is easier to discuss elaborately and easy to manage a large class" (Mr. Kabir, School A, Survey B).

Site coordinators described factors related to resource allocation that propelled teachers to use the lecture method. Mr. Rashid pointed out that class-size could range from '70 to 80 students" and the "lack of science equipment and laboratories" (Site coordinator, School D, Interview, September 23, 2020). Mr. Hunnan noted that teachers "are badly in need of training" (Site coordinator, School E, Interview, October 29, 2020). Ms. Tania faulted school authorities for the lack of SCS. She said:

> Teachers' opinions are not always essential for the authorities. This is a barrier for us. Motivated teachers want to do something for the sake of the student's interest, but we are not allowed to do it. 10 to 20% of teachers always try to do something new, and others do not. (Site coordinator, School E, Interview, September 25, 2020)

Influence of IBL Project on Students' Content Knowledge and Attitudes

The 20 teachers engaged 109 students in two IBL activities during a period of five months. Both IBL activities - the model project designed by the project director and the second one designed by teachers and student-teams included the use of the scientific process. Research question two explored the influence the IBL project had on students' content knowledge in hypothesis formulation, experimentation, and creating real-life connections and attitudes.

We used data from four different sources to answer this question: the five open-ended questions in the Student Experience Survey (Item 9, 11a-11d), open-ended questions from Teacher Survey B (item 3), site coordinators' interview data (items 4, 5, and 7), and four Zoom session transcripts. We present the results in the following four subsections: knowledge of hypothesis formulation, knowledge of experimentation, knowledge of real-world connection, and attitude toward science.

Knowledge of Hypothesis Formulation

Item 9 of the Student Experience Survey required students to formulate a hypothesis. We used NVivo to generate numeric data by classifying each response as 'correct' or 'incorrect.' Next, we used the numeric data to run a series of Chi-Square Tests of Independence to examine the association between categorical dependent variables: hypothesis formulation and categorical independent variables: gender, grade levels, and types of curricula.

1. We noted that 73.3% of the girls formulated hypotheses correctly, compared to only 26.7% of the boys. However, a Chi-Square Test of Independence revealed that gender was not significantly associated with students' formulation of hypothesis (1, $n = 47$) = 1.051, $p = .305$.
2. We observed that many more junior high school students formulated hypotheses correctly ($n = 16$, 59.3%) as compared to their middle school ($n = 6$, 22.2%) and senior high school counterparts ($n = 5$, 18.5%). However, the Chi-Square Test of Independence revealed that grade level was not significantly associated with hypothesis formulation (2, $n = 47$) = 3.34, $p = .189$.
3. We observed that many more students at schools with a British curriculum formulated hypotheses correctly ($n = 22$, 81.5%) compared to those at schools with a National curriculum ($n = 5$, 18.5). We found a statistically significant association between schools' curriculum and hypothesis formulation (2, $N = 47$) = 8.56, $p = .003$. The effect size for this finding, *Phi, was* moderate to large, 427.

Site coordinators and teachers were pleased when students showed initiative. For example, Mr. Hannan said he was happy when 'students proposed their own interests for the second phase and explored their hypothesis for IBL' (Site coordinator, School C, Zoom session 4, 26 June 2020). Similarly, Miss Rozina said, 'we were told teachers could design the IBL activity, but my students wanted to design their own project and came up with a number of hypotheses' (Teacher 1, School D, Zoom session 2, 11 May 2020).

Knowledge of Experimentation

Items 11 a and c of the Student Experience Survey required students to briefly describe how they used the scientific method with the two IBL activities. We used NVivo to quantize the qualitative data; we used a 1 for responses that were based on 'limited knowledge' and 2 for responses based on 'advanced knowledge.' Next, we used the numeric data to run a series of Chi-square Tests of Independence to examine the association between categorical dependent variables: experimentation and categorical independent variables: gender, grade levels, and types of curricula. The descriptive statistic revealed a larger number of students from British curriculum schools demonstrated advanced experimental knowledge ($n = 23$, 76.7%) than in National curriculum schools ($n = 7$, 23.3%). We noted knowledge of experimentation has a statistically significant association with school curriculum (2, $N = 47$) = 5.92, $p = .015$. The effect size for this finding, Cramer's V, was moderate .355. We did not find a significant association between experimentation and grade levels (2, $N = 47$) = .958, $p = .620$, and gender (2, $N = 47$) = 1.051, $p = .305$.

Teachers and students described the benefits of students' active engagement with scientific experiments. Miss Rabeya said, 'students get little or no scope to do science experiments of their own whereas this project gave them the opportunity to work with freedom' (School C, Survey B). Moonmoon, a Zoom session student-participant succinctly stated, 'We learned how to collect and accurately analyze data, how to handle apparatus correctly, and how to conduct experiments safely' (School C, Zoom session 2, 18 May 2020). Mr. Nazmul was impressed with the students' attitude towards lab activities. He said, 'students realized the necessity of following rules and regulations in the lab. They were capable of figuring out how to go through an investigation to complete it' (School A, Zoom Session 2, 11 May 2020).

Knowledge of Creating Real-life Connections

We used students' open-ended responses to items 11 b and d from the Student Experience Survey to determine if they were able to create real-world connections between topics taught and daily life. We used NVivo to quantize this qualitative data by assigning a 1 to responses that were "unclear or ambiguous" and 2 to responses that were "partially or fully correct." Next, we used the numeric data to run a series of Chi-square Tests of Independence to examine the association between categorical dependent variables: creating connections and categorical independent variables gender, grade levels, and types of curricula. Our data violated the assumption; to address this, we ran a Likelihood Ratio Chi-square Test of Independence. We found that type of curriculum had a

statistically significant association with creating connections with daily life (2, $N = 47$) = 6.534, $p = .010$. The effect size for this finding, *Phi*, was moderate .375. A larger number of students from British curriculum schools were able to create connections ($n = 12$, 29.3%) compared to those who followed the National curriculum ($n = 12$, 29.3%).

Students made real-world connections at different stages of the project. This is reflected in the illustrative comments drawn from three different sources.

> Model IBL has shown me that all scientific experiments and knowledge above average is significantly relevant to our surrounding environment since all objects around us obey scientific laws. For instance, I now know that it is better to have raw lemon juice than processed drinks, as it has a higher vitamin C content. (Student 11, School D, Student Experience Survey)

> Students who were confused with the topic in the lecture understood fully. They became more interested in studying physics, increased confidence, and could relate the theory with practical life. (Miss Nilima, School B, Teacher Survey B)

> Students collected information about the advantages and disadvantages of fast food and about homemade food …they found that homemade food is better…and they tried to motivate those students who usually used to eat fast food regularly. So, I think these are the successes. (Miss Tania, Site coordinator, School E, Interview, September 25, 2020)

Attitude toward Science

We analyzed 111 meaning units related to students' changes in attitude. Of these, many references came from Zoom sessions ($n = 73$), and the rest were from interview and survey data ($n = 38$). Students described how curious and enthusiastic they were during the project. During one of the Zoom sessions, Maliha, a student participant, said:

> To be very honest, I could have never imagined that I would spend my free time, my free classes, my break times in the lab at my own will without any instruction from any teacher, and that is because, I guess, we were very curious and excited about it. (School A, Zoom Session, May 18, 2020)

Teachers confirmed that the students were motivated, which in turn inspired them too. For instance, Miss Samia said, 'competition between all participating teams triggered excitement. Moreover, the students try to do better than others' (School D, Survey B). Mr. Shimanto, a site coordinator, described the attitudinal change in students, 'the project enhanced their leadership skills, they were capable of implementing their new ideas' (School C, Interview, December 18, 2020). Teachers and site coordinators also reported a noticeable difference in students' behavior. The IBL project transformed the way students interacted with teachers, used the library, and retained information. Miss Shimin said:

> Students gained a better understanding of the subject matter being taught. They were inspired to work on a particular topic that they wished to learn by asking relevant questions and doing their own research to get the answers. They were motivated to pursue education through this method. (School D, Teacher Survey B).

Students echoed similar sentiments, '... that was the first time I went into my school library for research on something; usually, I go there to gossip with my friends. We spent our free time in the laboratory and computer lab searching online' (School A, Zoom Session 3, May 18, 2020). Miss Shahida reported that students' practical lab experience enhanced content knowledge. She said, 'I observed a difference between traditional learning and IBL. IBL provides a lot of scope for learning. Students gain theoretical knowledge through experiments' (Site coordinator, School A, Zoom Session 2, May 11, 2020). In addition to positive changes, student respondents also described challenges which will be discussed in the following section.

Challenges Identified by Students

Research question three explored challenges students encountered while participating in IBL activities and how they overcame them. We used NVivo for typological and interpretive coding of responses elicited by item 13 of

the Student Experience Survey and Zoom session three, which included several student participants. We organized the 53 meaning units related to challenges into four categories. Two categories related to laboratory procedural hurdles: experimentation and observation-interpretation.

In most cases, students described challenges related to experimentation, like the illustrative comment below (n = 31, 66%):

> We had to maintain accuracy, which was a bit frustrating. As we maintained accuracy, it took a long time for us to complete the experiment because the result wasn't coming as it was supposed to. In this case, the blue-black solution took a long time to turn colorless…we had to stir and stir. (Student 10, School B, Student Experience Survey)

They also described challenges related to observation and interpretation, like the illustrative comment below (n = 10, 26.28%):

> The most challenging part, in my opinion, was the part where we had to record data in our record books. Sometimes they were not what we expected them to be, so we had to redo our experiments to find out what's wrong. And those times of data collection were the most challenging. (Student 6, School A, Student Experience Survey)

Some students described communication as a challenge which is very common in developing countries. For example, one said, 'My most challenging part is to talk or speak in English. I'm not good at English, so this is very challenging' (Student 33, School E, Student Experience Survey). Another said, 'it was to think critically' (Student 29, School D, Student Experience Survey). Some overcame problems like this by 'communicating frequently with my teachers, friends, teammates, etc.' (Student 29, School D, Student Experience Survey).

Several students described schedule management as a major challenge; this is reflected in the illustrative comment below:

> It is difficult to manage time for the IBL project after school and coaching time.
> The most challenging part of the IBL project was that the daily routine of the members of our group didn't match, so it was hard to make time for inquiry. (Student 15, School D, Zoom Session 3)

Of the 47 students, 13 reported that they reached out to their teachers for assistance. Others reported they repeatedly tried to solve problems on their own. Their attempt to do this did not go unnoticed. Mr. Rashid said:

> IBL helps overcome the mental inertia of students. They can explore in a learning session and progress at their own pace. Many students gave us a stare like, "you are asking us to do our own thinking?" Is it going to be like this from now onward? This was very interesting to observe and watch them progress. (Site coordinator, School D, Zoom Session 4, June 26, 2020)

Influence of IBL Project on Students' Desire to Pursue Higher Education in Science

Research question four explored students' motivation and desire to pursue further education in science. Analysis of survey item 6 of the Student Experience Survey revealed that many students expressed an interest in pursuing a career in science (n = 41, 87.2%). In the absence of pretest data, we cannot conclude that the IBL project influenced their decision. Nevertheless, multiple teachers described students' renewed interest in science after participating in the IBL project. For example, one of the physics teachers, Mr. Mohammad, said, 'students who were confused with the topic understood fully. They became more interested in studying Physics' (School A, Survey B). Similarly, Miss Akthari said, 'by the end of the IBL project, students became more science-oriented; this satisfied me as a teacher' (School B, Survey B).

Data Quality and Limitations

Given that the second author played a dual role as project director, we employed multiple methods to enhance the validity and reliability of quantitative data and the trustworthiness of qualitative data. A doctoral student with 20 years of teaching experience in Bangladesh validated the three surveys for clarity and readability. We re-administered Survey A in person when it became apparent that teachers had difficulty with electronic surveys

and were unfamiliar with the difference between IBL and demonstrations. Machado, in the USA, used Qualtrics to administer Survey B to teachers; she anonymized the data before sharing it with Nahar in Bangladesh. We used Google Forms to collect survey data from students. We converted item 8 of the Student Experience Survey into two subscales. The Cronbach's alpha value of each subscale is TCS (.529) and SCS (.722). Similarly, we enhanced the trustworthiness of qualitative data by transcribing the data ourselves, employing intercoder reliability, creating and using a codebook with fidelity (Hatch, 2002), and using memoing and peer debriefing during the analysis and manuscript preparation phase (Edmonson & Irby, 2008). This study can be improved by addressing the limitations. The internal consistency of some of the subscales in the Student Experience Survey can be improved by adding additional items. The low response rate of survey respondents (43.12%) due to extenuating circumstances is a major limitation of this study. This limitation can be overcome by using incentives to increase the response rate.

Discussion and Implication of Findings

There is evidence to show that teacher-centered practice can change school culture and instructional practice over time when teachers are provided with ongoing training and support (Akhter et al., 2019). The literature confirms that TCS are more prevalent in Bangladesh (Talukder et al., 2021). Scholars attribute this trend to teachers' lack of training (Akhter et al., 2019), students' exam-oriented learning style (Khanum, 2020), and lack of resources (Jony, 2016). There is limited literature to show that teachers receive training over an extended period in Bangladesh. This small, grant-funded project provided 20 teachers, 109 students, and five site coordinators with an opportunity to experience, first-hand, some of the benefits of using SCS over an extended period. Our survey and interviews data confirmed these issues continue to exist at schools that offer a British and National curriculum. Students reported that they had limited opportunities to practice SCS. Both teacher and site coordinators confirmed that teachers were limited by class size, resources, and limited support from authorities. Teachers gravitated toward the lecture method because it helped them build theoretical concepts, maintain discipline, and complete the syllabus in time. Site coordinators indicated that teachers' attitudes impeded their willingness to experiment with SCS. While a large majority of schools, both in developed and developing countries, may not be able to increase resources without government funding and/or grants, administrators can evaluate current teaching practices, develop policies that require student engagement, provide teachers with school-based professional development training, encourage teachers to use SCS and reward outstanding performance.

A wide array of research shows that students in developing countries benefit by engaging in IBL (Abdi, 2014; Wang & Gao, 2021; Zhao et al., 2021). Our findings are consistent with these studies. Our qualitative findings confirm that students appreciated the freedom to learn by exploring content from different sources; laboratory books, online search, etc., and expressed their satisfaction with achievement in content knowledge. Additionally, girls outperformed boys in hypothesis formulation even though it was not statistically significant. Given the low survey response rate due to the pandemic, it is difficult to make a clear judgment about the significance of the results. Nevertheless, the short-term outcomes confirmed that science teachers who receive training and support over an extended period could implement SCS quite effectively.

The literature is inconsistent in terms of the relationship between institutional quality and science achievement. For example, Broer et al. 's (2019) study in Hong Kong, which included high-quality and low-quality schools, showed that students have equal learning opportunities despite socioeconomic disparity. Conversely, Bodovski et al. (2020) and Mousumi and Kusakabe (2017) reported that better quality schools produce higher learning outcomes. Our findings are consistent with Bodovski et al. (2020) and Mousumi and Kusakabe's (2017) findings. We observed that students at British curriculum schools achieved higher scores than their counterparts in National curriculum schools in hypothesis formulation, experimentation, and making connections with real life. As evident from Table 3, inequalities exist. Students who attend British curriculum schools have access to many more resources because parents pay anywhere between $1,350 and $2,500 per year. These resources are used to equip laboratories and libraries. This finding suggests that inequities may exist in terms of both curriculum and instruction. Additional research, with a larger sample size, will shed light on the inequities that exist and the ways in which curricular and instruction can be modified to address this.

Consistent with Aulia et al.'s (2018) study, our respondents displayed positive attitudes towards science. Teachers and site coordinators at both British and National curriculum schools noticed positive changes in students. This included higher motivation, enthusiasm, leadership skills, confidence, and excitement. Kaçar et al.'s (2021) meta-analysis of 30 studies conducted in Turkey from 2000 to 2020 revealed that IBL enhanced the learning of secondary level students more than higher secondary students. Conversely, we found the students'

acquisition of content knowledge did not differ across grade levels. This finding is encouraging; it confirms that students in different grade levels can benefit from IBL.

Scholars identified several challenges students face while participating in IBL activities. These included difficulties conducting experiments and dealing with data (Gormally et al., 2009) and frustration in the absence of an appropriate scaffold (Levy and Petrulis, 2012). Consistent with Gormally et al.'s findings, our student respondents experienced some difficulty with laboratory experiments and data collection procedures. Consistent with Levy and Petrulis's findings, our students indicated that these obstacles were directly connected with their lack of exposure to hands-on activities in school. Our students also found it difficult to engage in critical thinking and express their opinions, a limitation that is deeply rooted in Bangladeshi culture. Many of these challenges can be reduced if teachers start to use IBL more frequently.

Gibson and Chase (2002), who surveyed summer camp students from 1992 to 1997 to study the influence of IBL activities on students' motivation to continue with science, reported that students who experience more inquiry activities, especially laboratory experiments, are more interested in choosing science careers. The majority of our survey respondents showed an interest in continuing higher studies in science by the end of the project. Given the small sample size and the lack of a pretest, the findings should be generalized with caution. Schools should consider replicating this study with larger sample size. They should also identify additional ways to encourage students to pursue a career in science.

Both quantitative and qualitative findings revealed that a shift from TCS to SCS enhanced students' ability to hypothesize, experiment, and make real-life connections. It is our hope that the 20 teachers at each of the five participating schools continue to use the science toolkits they received and locally available, inexpensive materials to design and model IBL. Innovative practice can be contagious. We also hope that teachers expand the scope of the IBL projects they design to include additional teachers and students. We also hope that administrators, both in developed and developing countries, use this study and the book chapter that provides additional detail about the professional development we provided teachers (Machado & Nahar, 2021) as illustrative examples to guide the design and implementation of similar long-term projects that foster a higher level of student engagement in science classrooms.

Scientific Ethics Declaration

This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (IRB Number: 19-221 - EXT).

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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Preservice Preschool Teacher's Phenomenological Understanding of Environment: A Projection to Education for Sustainable Development

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Abstract

The current study aims to understand the expectations of pre-service preschool teachers regarding what kind of environment we will live in in the future and the reasons behind these expectations in terms of sustainable development (SD). To this end, the current study was conducted based on a phenomenological model with the participation of 77 pre-service preschool teachers. The participating pre-service teachers were first asked to draw the future environment they expect to see. Subsequently, they were interviewed and asked to explain their drawings and why they hope to see that environment in the future. According to the study, most pre-service teachers have negative expectations about the future environment. On the other hand, there are a few positive and technology-oriented expectations. Furthermore, a significant portion of the participants explained the environmental dimension of SD. On the other hand, a small number of participants preferred to explain different pillars together by creating cause-and-effect relationships. Given the obtained findings, it is suggested that environmental education should be more widespread at every level of schooling. The political, economic, and social pillars of SD should be more extensively incorporated into the existing curriculums.

Introduction

> *"It is 2030. The world's population has now grown to 8.5 billion people. Global temperatures are now an average of 1.2 degrees Celsius higher than in 1880. Seas have already risen forty centimeters since 2016, suggesting that the models of that year that projected a rise of two meters by 2100 were likely significant underestimates. In addition, the Arctic Ocean is now consistently ice-free every summer. Moreover, several countries have lost a primary source of fresh water and freshwater storage as glaciers grow smaller and smaller each year."*

In the book *Rethinking Education on a Changing Planet,* Assadourian (2017, p.303) projected the future environment with these words. When we consider the world's current situation due to the Covid-19 outbreak, it is clear that Asssadourian's description of the future environment is quite realistic. Nature is being destroyed at an unprecedented pace in human history. While the planet is changing and natural resources are being depleted at a frightening speed, many countries have long regarded education as an essential factor in combating the global crises that environmental problems are causing now and will drive in the future. Education aims to raise individuals with the necessary knowledge, attitude, and skills required for a sustainable life by focusing education programs on sustainable development (SD), starting from early childhood education (ECE) (UNESCO, 2012).

SD is not only about what percentage of the world's natural resources are consumed: all issues, such as poverty, population growth, gender equality, justice, social life, and solidarity, are related to how and by whom natural resources are consumed. As Stern (2006) emphasized, the poorest countries in the world, which hardly consume any natural resources, will be the ones most severely affected by the consequences of climate change.

From this perspective, SD is a dynamic phenomenon that emerges and evolves in line with the world's needs. SD is defined in three pillars: environmental, sociocultural, and economical. Considering the place of development in politics, "politics" has been added to these pillars. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2002) classification, SD is established on four pillars: environmental, social, economic, and political.

As a result, SD is a concept that covers issues such as gender discrimination, human rights, and the right to education, health, safety, and intercultural communication, supporting the sustainability of animal and plant species, ecosystems, and natural resources and fighting climate change (UNESCO, 2005). In this context, Education for Sustainable Development (ESD) requires integrating and presenting social, political, and economic development concepts and environmental issues in an educational framework (Davis, 2015).

When re-evaluated in this framework, it would be more appropriate to see environmental problems not only as pollution and excessive use of natural resources but as a whole with social, political, economic, and cultural pillars. It has become almost impossible to distinguish between environmental and human problems today. Human beings not only affect their environment with their behaviors but also are affected by the environmental systems they are in (Bronfenbrenner, 2005). Lewin (1942, p.218) described this behavior as 'the environmental and psychological factors of the current situation surrounding the behavior' in his Field Theory. He defined the psychological factors mentioned here as people's perceptions, beliefs, thinking skills, etc. Shuman and Ham (1997) integrated Lewin's theory into environmental education, stating that teachers' personality, ecological philosophy, ideas, and attitudes would affect their environmental actions. Thus, perceptions about the environment's future can also be said to be essential for the relationship of humans with the environment.

At this point, asking pre-service teachers the question, "What kind of environment can humanity expect in the future?" is essential because this question can elicit their perceptions of the future environment, and these perceptions will affect their beliefs, values, and behaviors as related to education for SD. Another point to be underlined is the role of education and the teacher in shaping children's perceptions of the environment's future (Shuman & Ham, 1997). Therefore, it is essential to investigate the perceptions of teachers and pre-service teachers about the future of the environment and the factors that cause these perceptions. In this respect, the first research question to be addressed in the current study is as follows:

How do pre-service preschool teachers see "the future environment"?

At the UN Sustainable Development Summit held on September 25-27, 2015, "2030 Sustainable Development Goals (SDGs)" were adopted with the signatures of 193 countries. SDG 4 is Quality Education, which emphasizes that quality of education is related to SD. To accomplish this goal by 2030, country administrations, society, and individuals should realize their responsibilities. In this context, SDG 4 stipulates that all students should acquire the knowledge and skills necessary to promote SD by 2030 and emphasizes the role of higher education in this process. To this end, by 2030, it aims to take actions, including international cooperation, to train qualified teachers in developing and less developed countries (United Nations, 2015). Increasing the quality of teacher education for a sustainable world was previously addressed in the Bonn Declaration (UNESCO, 2009), and it was discussed that teacher-training programs should be handled reworded on ESD and that pre-service teachers should be given teacher training that emphasizes the knowledge, skills, attitudes, and values required for a sustainable future.

Higher education institutions in many parts of the world plan and implement various actions to promote sustainability, and teacher education programs should be reoriented in this sense (Shephard, 2008). As Samuelsson and Park (2017) highlighted, the underlying reason is that pre-service teachers, who are future teachers, have a vital role in promoting ESD by supporting the attitudes and behaviors of each child to contribute to a sustainable life. On the other hand, how teachers perceive SD is mainly related to the learning content they prepare for children regarding SD (Somerville & Williams, 2015). Therefore, like the world, SD should be important in Turkey's teacher-training process. Sustainability-related courses are offered in teacher-training programs, and pre-service teachers propose projects to support SD in social responsibility courses. In this connection, it is crucial to see to what extent pre-service teachers relate to SD when describing the environment of the future; therefore, the second research question of the current study is:

Which of the four pillars (environmental, social, economic, and political) of SD explains the reasons behind the scenarios developed by pre-service teachers on the issue of "the future environment"?

Method

Research Model

This phenomenological study aims to understand the pre-service preschool teachers' opinions about "the future environment." In addition, it also seeks to understand the reasons behind the pre-service teacher's views about

"the future environment" and under which of the four pillars of SD (political, environmental, economic, and social) they can be handled. In the study, "future" and "environment" will be used as the central phenomena. Phenomenological research is done to understand a person's or people's experiences related to any phenomenon (Creswell, 2013). Van Manen (1990) states that the primary purpose of phenomenological research is to make a universal definition based on individual experience. Husserl (1931), who formed the basis of phenomenological research, emphasizes that the essential criterion for understanding ideas is to be free from prejudices. From this viewpoint emerged the concept of transcendental phenomenology. Moustakas (1994) emphasizes that perceiving everything about the phenomenon as something new encountered for the first time is the basic understanding of transcendental phenomenology. The current study assumes pre-service preschool teachers are free from prejudices because they have been dealing with environmental issues for 20 years. Therefore, the present study was conducted based on transcendental phenomenology.

Setting and Ethics

The current study was conducted on the pre-service preschool teachers attending the Department of Pre-school Teaching in the Education Faculties of Kastamonu University and Mersin University. The setting of the study is these two universities, and classes of the education faculties of these two universities were used. The researchers work in these departments as tenured faculty members. Thus, there is already teacher-student interaction between the researchers and the participants. The participants were given the necessary information to take our researcher role to the fore. The current study was conducted on a volunteer basis, so the participants were told that they would not be graded for the activities they would be involved in and that the study would not bring any extra responsibility to them. Before initiating the study, the faculty administrators were informed, and the data were collected so as not to interrupt the regular classes of the participants.

Study Group

The research study comprises pre-service teachers attending the Department of Pre-school Teaching in the Education Faculties of Kastamonu University and Mersin University, taking the elective general culture course of Sustainable Development and Education in their second year. As Turkish is the second language of one of the participants, they departed from the study voluntarily since he/she could not discuss the questions in detail. This student was of Syrian origin and was in Turkey with the status of a temporary refugee. He/she gave the following written explanation "*I want the war to be over and to go to my country,"* and even this short statement is relevant to the current study. Therefore, this student was excluded from the study, and thus it was conducted on 76 preschool pre-service teachers. The course Sustainable Development and Education is an elective course that the students select at their discretion. Therefore, the homogenous sampling technique was used to form the study group. This technique is widely used in qualitative research because it reduces the differences between participants, offers the ease of focusing on the phenomenon, and facilitates the analysis process (Miles & Huberman, 1994); therefore, it was preferred for the current study. Though this reduction of differences is a limitation, when the socio-cultural status and facilities of the cities where these two universities are located and their place in the achievement ranking are considered, this limitation can be partially overlooked.

Data Collection

The current study's data was collected from the participating pre-service teachers through their drawings about the phenomenon of the "future environment" and the interviews conducted based on the drawings they had produced. In the data collection process, firstly, a meeting was held with the participation of all the participants, where it was explained to them that they would draw paintings and be interviewed for a scientific study. Those who did not want to participate in the study were asked to inform the researcher. The students who agreed to participate were told they could leave the study whenever they wanted.

A ready-made document was prepared for the participants to produce their drawings on. This document consisted of two parts: the first part was for drawing, and the second or indicating all the codes involved in the drawings and for the interviewer to take notes. All the participants produced their drawings in one session at the same time. Some measures were taken to prevent the participants from being affected by each other in the class. Each participant was personally instructed on what to do. The participants used whichever drawing technique they wanted to make their drawings. The large majority of them used colored pencils. They drew for about 30 minutes. After the completion of the drawings, the codes in the drawings were determined.

Another source of data was the interviews conducted with the participants individually. To keep external factors under control, the participants were invited to the researchers' rooms for interviews. This was a place with suitable conditions for the discussions. In addition, the researchers were already familiar with the students as they had conducted some educational and instructional activities at school together. This way, the possible emergence of factors that could spoil the interview process, such as anxiety or fear of being alone with a stranger, could be controlled.

During the data collection process, participants were asked: What environment do you think people will live in in the future? Then they were requested to draw their answers. Accordingly, interviews were held with the participants. The interviews were related to the drawings. Although different questions were asked to the participants according to the flow of the dialogue, some questions were asked to each participant. These questions are posed: What are the reasons for creating such a future in your drawing in this way? What is the role of humans in having such a future? Due to the nature of the research model, no interviews were conducted in a structured form. Therefore, each participant is assumed to know and experience the related phenomenon.

Data Analysis

The data collected in the current study were analyzed in the framework of transcendental phenomenology. In this respect, a textural and a structural description of the data were performed. According to Creswell (2013), textural description is done to understand what the participant experiences about the phenomenon, and structural characterization is done to understand what the participant experiences regarding the situation and content. Through the drawings, it was hoped to determine the structures (code) that remained in the participants' minds about the concept of the future environment. To put it more precisely, drawing creates textual description by enabling us to understand what they are experiencing about the phenomenon of the future environment and the construction of the phenomenon in their mental structures due to this experience. During the analysis, the style and tone of drawings were determined to realize the content, whether positive or negative, etc. The place of the drawings' is also crucial in establishing a spatial relationship with the participant's perception of the future environment. While the style of the drawings points to the participant's way of expression and makes a small contribution to the primary purpose of the research, the tone and place are also critical in understanding the mental structure of the participants' views about the phenomenon.

Table 1. The findings obtained from the participants' drawings

Categories	Frequency (f)	Percentage (%)
Drawing Style		
Symbolic	30	39.5
Depictive	44	57.9
Both	2	2.6
Drawing Tone		
Positive	4	5.3
Negative	51	67.1
Technological	18	23.7
Dual	3	3.9
Where		
Nature	6	7.9
Urban	35	46.1
Rural	2	2.1
World	12	15.8
N/A	21	227.6
Sustainable Development Pillars		
Social	4	5.3
Political	3	3.9
Economic	5	6.6
Environmental	53	69.7
Social and political	2	2.6
Social and environmental	1	1.3
Political and environmental	1	1.3
Economic and environmental	6	7.9

Interview scripts were used for structural description. With the data obtained from the interviews, it was attempted to reveal how the participants see and experience the relevant phenomenon in terms of the conditions and situations they are in now about the future environment. Furthermore, it was attempted through textual and structural descriptions to understand how the future is visualized in the participants' minds and how they understand and internalize the phenomenon. All these procedures were performed using the method developed by Colaizzi (1978). By this analysis technique, basic sentences in the interview texts were identified, specific meanings were developed from these, and themes created the light of these meanings. In the findings section, the data given with the sub-title of Sustainable Development Pillars, as revealed in Table 1, emerged from the interview analysis. In addition to the abovementioned purpose, the interviews were also used to support the findings obtained from the drawings.

The data obtained from the interview texts consist of two themes. Firstly, the drawing and participants' views about the future environment were focused on. In this theme, the tone of the drawing, positive, negative, technological, and environmental classifications of the future environment were performed. The second theme attempted to understand why and how the participants believed the future environment would be as shown in their drawings and how this was by their experiences and expectations. The reasons given by the participants were located in one of the four basic pillars of SD (Davis, 2015): political, environmental, economic, and social.

Reliability

One of the most critical problems of qualitative research is the reliability of the results derived from the data. There are a variety of ways to ensure this. The triangulation technique based on the researcher-centered post-positivist paradigm was used in the current study. With triangulation, researchers combine multiple and different sources and interpret them with evidence to support the findings (Creswell, 2013). Moreover, according to Creswell and Miller (2000), triangulation is a popular technique, and by this method, it is possible to collect data in different ways and allow in-depth data analysis.

In the current study, the data were collected based on both visual and interview techniques. To ensure triangulation, a specialist in the field of ESD was appointed as an external observer during the analysis. After the researchers finished their analysis, the external observer's opinions about the process were asked, and the external observer analyzed the findings. The agreement between the researchers' and the external observer's themes was calculated as 0.91 by summing the Kappa Fit Index. In this way, it was concluded that the external observer and researchers achieved reliability.

Findings

The current study's findings were obtained from the drawings and documents of the interviews conducted with the participants. First, the drawings were analyzed, and the conclusions obtained were collated. Then, the results of the interviews were discussed.

Figure 1. A sample drawing using the dual method of the future environment
drawing style: depictive, drawing tone: dual, place of drawing: nature

Findings Obtained from the Drawings

The drawing style shows the depictive style preferred by the participants in their drawings. More than half of the participants (*f*= 44, 57.9%) were found to have drawn their drawings in the depictive style. While 30 (39.5%) participants preferred to use symbolic elements in their drawings, only two (2.6%) used both techniques (Details can be seen in Table 1, in Annex).

The drawing tone indicates the participants' opinions about what kind of place the future environment will be compared to today's environment. The most remarkable finding here is that most participants (f = 51, 67.1%) drew the future environment in a more unfavorable condition than it is today. In contrast, only four participants (5.3%) drew the future environment more favorably than today. Furthermore, the number of participants drawing the future environment in a more technological structure than today is considerable (*f*= 18, 23.7%). All participants who produced these drawings depicted buildings piercing the sky, flying cars, rockets, or interplanetary journeys in the future. From the data in these drawings, it is impossible to determine whether such an environment will be better or worse than today. In addition, three participants (3.9%) used dual scenarios in their drawings. All three indicated that today is a turning point for humanity, and if it continues, the future environment will worsen. However, still, if one manages to solve the problems through information and technology, there will be a much better environment in the future.

Figure 2. A sample drawing with a positive perspective on the future environment
drawing style: symbolic, drawing tone: positive, place of drawing: world

Figure 3. A sample drawing with a negative perspective of the future environment
drawing style: symbolic, drawing tone: negative, place of drawing: world

The place drawn indicates where the events in the participants' drawings happen. As researchers, we care about this finding in terms of understanding where the demographic structure, while in the background of the

participants' minds and directly affecting SD, will be in the future. From the perspective of SD, it is seen that in there are cities in nearly half of the drawings (f = 35, 46.1%), the number of participants who drew their drawings in the context of nature (f = 6, 7.9%) and the countryside (f = 2, 2.6%) is quite limited. Therefore, it is impossible to understand where the drawings of 21 participants (27.6%) are set. The remaining 12 (15.8%) participants indicated the world as the place.

One or more of the four pillars of SD can be explained by the situations emerging in the drawings. Although the findings obtained from the interviews are important to understand the distribution here better, the distribution in the drawings is also important in revealing a general understanding of the study group. First, how many pillars are included in a drawing matters to us as researchers. In this sense, the findings from the study group are quite limited. The arguments or thoughts used by 65 participants while explaining how the future environment will be related to just one of the pillars of SD. The remaining 9 (11.6%) participants discussed the effect of two pillars. A large proportion of the drawings explained with a single sub-dimension (f = 53, 81.5%) stated that the future environment would b shaped by the reasons found in the environmental sub-dimension. The others are shown in Table 1.

The more important finding of the current study is to explain the reasons for the formation of the future environment by establishing connections between more than one sub-dimension. The information obtained here is limited. The participants could associate at most two pillars or indicate this in their drawings by establishing a cause-effect relationship. These participants constitute a small part of the study group (*f*= 9, 11.8%).

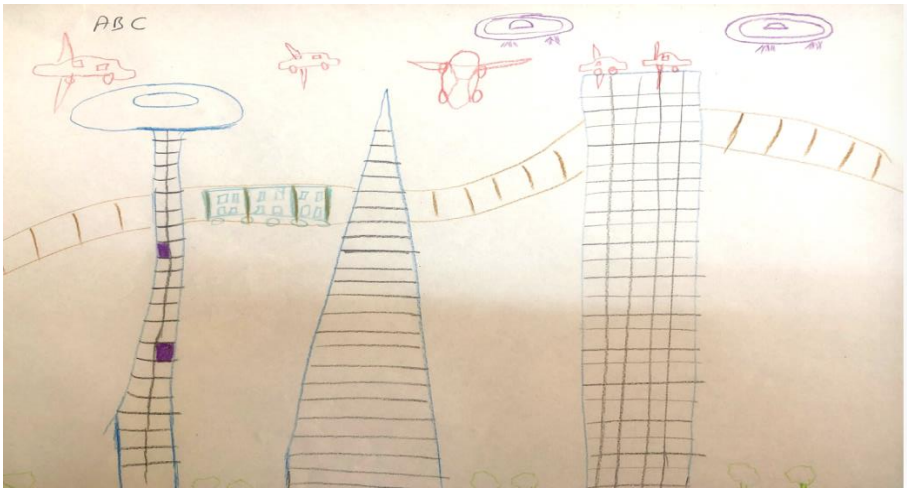

Figure 4. A Sample Drawing with the Technological Perspective of the Future Environment
Drawing Style: Depictive, Drawing Tone: Technological, Place of Drawing: Urban

Findings Obtained from the Interviews

Explanations Made with a Single Reason

The data obtained from the interviews showed how the views of the future environment in the participants' drawings were shaped. In addition, it became clearer through which pillars of SD these views could be explained. A minimal number of participants (f = 4, 5.3%) explained the social sub-dimension of SD. The social dimension of SD focuses on peace, equality, and human rights. All participants commented negatively about the environment based on war and post-war human rights victims. P41 expressed their opinion: *"A tank and a guy are shooting a rocket in my drawing. What drives me to this drawing is the obliviousness and selfishness of people. People who have problems even with mutual communication and cannot tolerate each other offer war as an option at the end of the day. This understanding will destroy us. Therefore, I do not think a better environment awaits us in the future."* Another participant (P56) emphasized the theme: *"I think that there will be a bad environment in the future due to people devoted to worldly materials and seeing their country as superior to other countries. The most important reason for this to happen is that I think people care about the values of the groups they feel they belong to and ignore the values of other groups and people. Nations or groups within nations are not seen to be equal. This is a serious problem."*

Another sub-dimension of SD is politics. The politicians, practices, decisions, and decision-making processes

are important focal points within the sub-heading of politics. A limited number of participants (f = 3, 3.9%) provided opinions that could be included in this sub-dimension. P30 expressed his/her views about the sub-dimension of politics *"(...) After all, everything is sadly in the hands of a few politicians. They affect the rights of our citizens with the decisions they make. The point where these policies will take us is obvious: the collapse of peoples, policies which failed to inequality, racism, and sectarianism. This will destroy the whole world."* P1 explained his/her opinions based on the decision-making process of politicians and the quality of the decisions made: "*Every decision made by politicians pushes us to become more polarized. They try to turn people into enemies as if they were doing it intentionally. There is fierce competition, and this will bring our end. The implemented policies seem to force us to work harder and to be more content with less. In such conditions, I do not expect a good future."*

The other sub-dimension on which the participants expressed limited opinions (*f*=5, 6.6%) is the economy. The opinions expressed about this sub-dimension consisted of professions and sources of income, with particular emphasis on the low-income and unfair distribution of income. K64 emphasized the inequality in income distribution *"I do not think that income growth can keep up with this rapid consumption growth. People are constantly looking for ways of earning more. The rich are becoming richer. This makes them unreachable. Moreover, this makes people feel frustrated."* P3 also emphasized the inequality in income distribution *"People try to live according to their income, but people who qualify as really poor have callous living conditions. So I think they will somehow disrupt this system. People need to distribute money more fairly."* K58 expressed his/her opinions: *"The most important reason for the worlds becoming a worse place in the future is that people lose their current values and substitute money for them. Everything is money now. Our only aim in life is to earn money. Therefore, selfishness has reached its peak. We thought everything was enough for us, but it did not work. It was not shared as we had thought."*

More than two-thirds of the participants (f = 53, 69.7%) expressed opinions within the scope of the environmental sub-dimension. Among these are their negative and positive expectations about the future environment. Only four participants expressed an expectation of a future environment better than it is now. The remaining 49 participants, on the other hand, expressed negative opinions. The participants expressed positive opinions in general and thought that people would realize the facts after a certain point with the help of technology. In this regard, P4 said his/her opinions: *"People play the leading role in forming this world. I think we have realized we were doing it wrong. We have the technology. I believe that it will correct this."* P28 expressed his/her opinions: *"I think people are now aware of the facts. We will save the world and our environment. Electric cars have become widespread. We have alternative energy sources. People are more conscious about conserving natural resources. A better future will come true thanks to technology and scientists."*

On the other hand, the common point emphasized by all the participants having positive opinions about the future environment within the context of the environmental sub-dimension is the pressure on using natural resources. In this regard, P44 expressed his/her opinion: *I do not know exactly what will happen in the future. However, we are at the highest point of natural resource consumption. I hope it will remain there. However, we have lost our direction within this production and consumption chain. Even if we notice the depletion of natural resources, we manage it somehow with the perception that we have time anyway. We do not think about future generations but do not even think about our generation."*

Explanations Made Over Multiple Reasons

The pillars of SD are processes that interact with each other. Our expectation was the establishment of cause-and-effect relationships involving more than one sub-dimension. However, only a small proportion of the participants (*f*=9, 11.9%) expressed multiple reasons. Six of these nine participants established connections between the economic and environmental pillars. P2: *"We have established more factories to produce and consume more. Factories have consumed natural areas and resources for their raw materials. Now we have factories, but we have destroyed nature. It will be worse in the future."* P12: *"The current state explains everything. A life focused on money and consumption is being designed for us. We have taken everything that works for us, as much as we want, and we are about to finish nature just as we need it for our consumption."* Two participants established connections between the social and political pillars and thus shaped their expectations of the future environment accordingly. In this regard, K48 stated: *"This question reminded me of the book titled* Fahrenheit 451. *I think everything is clearly stated there. The politicians we have chosen will first suppress us with the decisions they make; the policies they offer us will make us enemies, then humanity will experience a deep social collapse."* Moreover, P33 stated: *"Worse environmental conditions are waiting for us*

in the future. First of all, social relations among people have been destroyed. States have done their best to make this happen. I think the states caused the collapse of social life. States do not implement correct policies. They act in their interests."

One of the remaining three participants established connections between the social and environmental pillars. In this regard, P16 stated: *"We humans are socially polarized. We do not care about each other's views. We are selfish. This selfishness makes it harder for us to understand nature, let alone understand each other. Since we do not understand nature, we will rapidly destroy it for our purposes."* P24, on the other hand, stated his/her opinions about the relationship between the social and economic reasons as follows: *"(…) because now we are living for our interests. Everyone is focused on his/her interests. We put control into the hands of the people wearing suits and sitting in comfortable seats. We watch how they get us stuck and expand their positions in their banks, nature, environment, animals, water, etc. Nobody cares about them anymore. Economies will collapse, and destruction will start."* Finally, P69 expressed his/her opinions about the relationship between the political and environmental pillars: *"Advances in science will affect our policies. Flying cars etc., everything will be produced for the rich. States will be under the control of the rich. We will consume the natural resources of the world more rapidly. Wars will break out for natural resources, and we will face a worse future."*

Discussion

When the styles of depiction that the pre-service teachers preferred in their drawing styles were examined, it was seen that the participants drew the future environment in a more negative situation than it is today. The pre-service teachers also included many technology-related elements while describing the future environment. According to pre-service teachers, the deteriorating environmental conditions will be solved by developing technology to create a better environment than today. The reason behind these negative viewpoints of the pre-service teachers is undoubtedly the rapid increase in the number of people struggling with hunger, war, and epidemic disease in a world where natural resources are rapidly depleted. At this point, pre-service teachers should realize their significant role as teachers of the future. In the changing and barren planet, how the environment will be in the future is shaped mainly by environmental education. Achieving this transformation in education is the most critical responsibility of pre-service teachers, who qualify in environmental education and sustainability issues during their teacher training. It should not be forgotten that the transformation process lies in education. Perhaps, as Orr (1990) stated, the fact that all education is environmental education can change the negative picture foreseen for the future.

It is seen that the participants mainly indicated 'cities' as the places where the events occur, and there were very few participants drawing 'nature' and 'rural' locations. Instead, some participants saw the world as the place where the events take place. Most pre-service teachers were born and raised in cities; even their higher education years are spent in universities in big cities. In this context, it is understandable why they mainly drew cities. However, this finding reminded us of an important point that should be emphasized. Significant Life Experiences is a theoretical framework developed by Tanner (1980) and Chawla (1998) and then mentioned by many researchers in their studies (Sward, 1999; Gough, 1999; Hsu, 2009). According to Significant Life Experiences, past natural experiences affect the human-environment relationship in adult life. The bonds established with nature by a child turn into environmentally friendly behaviors that require caring for nature and natural resources in adulthood. Children, who will be the future adults, must establish ties with nature, starting during childhood, so that they will care about the environment of the future. Therefore, pre-service teachers need to have action plans for both themselves to connect with nature and for their future pupils.

When the drawings were evaluated in terms of SD, it turned out that the drawings only touched upon the environmental dimension of SD. Similarly, in the interviews, the vast majority of the pre-service teachers mentioned the environmental dimension of SD. Research conducted in different countries, using other research methods and techniques, with teachers and pre-service teachers showed that SD is often associated with environmental issues. The studies conducted by Kagawa (2007) with university students in England, by Summers, Corney, and Childs (2004) with pre-service science and geography teachers, and by Choi et al. (2010) with pre-service elementary school teachers in Korea it has been found that pre-service teachers associated the concepts of SD with environmental issues. When the history of SD is examined, the World Conservation Strategy Report (1980) suggested that if development were sustainable, the ecosystems could be protected. In addition, this report proposed the economic and social causes and consequences of the environmental problems. It is emphasized that to get better results from environmental education, it is necessary to consider the environmental education process in economic, social-cultural, and political contexts (IUCN, 1980). In their reports, Fien (1993) and Huckle (1993) stated that SD emerged from environmental education and the

"education for environment" approach, which forms the basis for "ESD," emphasizing the effects of social, economic, and political pillars on the human-environment relationship. When the participants' relating of SD to the environmental dimension is re-evaluated in the light of these reports, it seems that it is necessary to expand the scope of the environmental education courses in the process of teacher training and to integrate socio-cultural and economic pillars into the practices of ESD in the early childhood period.

Apart from the majority relating SD to the environmental dimension, very few participants explained the social dimension of SD, focusing on peace, equality, and human rights. Instead, participants made pessimistic predictions environment based on wars and post-war human rights violations. SD is based on creating a balance between environmental, economic, and social areas of development. The social dimension of SD is not as prominent as the other pillars, but it needs to be investigated further (Boström, 2012). In addition, Gough & Scoot (2008) emphasized that the relationship between environmental and social pillars of sustainability should be investigated more. Based on this gap in the literature, Murphy (2012) conducted a theoretical study describing the social dimension of SD and the relationship between the environmental and social pillars. After this study, he characterized the social dimension of SD with the concepts of "public awareness," "equity," "participation," and "social cohesion." While describing the future environment, the pre-service teachers who participated in the current study mentioned the victims of war, people whose rights were violated, and those who did not have similar conditions. The victims of war are much more affected by the state the world has come to due to pollution, climate change, and depleted natural resources. As Boström (2012) stated, bringing the relationship between the social dimension of the SD and its environmental dimension into the agenda is more important for national and international SD projects. At this point, directing pre-service teachers to social responsibility projects that would enable them to discover the relationship between the social and environmental pillars of SD is seen as a proposal to be presented within the framework of the current study's findings.

As many resources emphasize, SD consists of social, economic, and environmental pillars. UNESCO (2002) highlighted the political dimension and mentioned democracy and decision-making processes. Similarly, the policy sub-dimension of SD focusing on democracy, management, and decision-making processes was associated with the environment of the future by a small number of participants. While the current study participants explained the environment of the future through the decisions made by politicians, they emphasized that the decisions made during the political processes were decisive. In their study with young people from Malta, Mifsud (2010) found that they have similar thoughts about the effects of political structures on the world's future. The critical point to be highlighted here and perhaps the question to be asked, as Orr emphasized in the foreword to EarthEd (State of the World): Rethinking Education on a Changing Planet (Assadourian, 2017), is "Are these decision-makers aware of the side effects of fast climate change on agriculture, biological diversity, and coastal regions; economic problems created by climate change and the effects of climate change on many issues ranging from drought to famine, diseases to wars and deaths and the necessity of putting these issues into the center of public management?" Based on the pre-service teachers' descriptions of the future environment and the questions asked by Orr, we can make the following suggestion: Pre-service teachers can be encouraged to develop policies about what should be done for a more sustainable environment and a more sustainable world by taking initiatives in the associations to be established within the administrative bodies of universities, and suitable conditions can be provided for them to do so by university administrations.

Just as with the social and political pillars, the economic dimension of SD was addressed by a limited number of participants in the current study. Pre-service teachers emphasized the economic dimension by presenting arguments about the low income and inequality of income distribution in the future environment. When the economic dimension of SD is associated with the environment, concepts such as local production and consumption, energy saving, and environmentally friendly production emerge (Siraj-Blatchford et al., 2016). In his article, which explores the economic dimension of SD, Ahmed (2010) has addressed the economic dimension within the framework of ending poverty and emphasized that through education and lifelong learning, a robust system of values can be created that encourages economic development. The economic dimension of SD should be explained to pre-service teacher candidates, just like the other relatively less mentioned pillars, and they should be taught how to teach them in ECE. Developing countries like Turkey are where the economic dimension should be better understood and developed. Pre-service teachers should realize this, make sense of the economic dimension, and integrate it into their curriculum when they become teachers.

Finally, when all the current study findings are evaluated together, the most critical finding emerges from pre-service teachers' explanations about the causes of their formation of the future environment. Pre-service teachers established the connections between more than one sub-dimension of SD in their drawings and interviews. When the interviews about the future environment are evaluated, it is seen that the participants

explained both single and multiple reasons. While these reasons provide a more straightforward interpretation of the drawings, it can be seen that the pre-service teachers' opinions about the future environment are explained with different pillars of SD. When the pre-service teachers' views were evaluated, it was found that they established cause-and-effect relationships between the pillars of SD while explaining the future environment. It is understood that the participants related environmental-economic, social-political, social-environmental, political-economic, and political-environmental pillars to each other.

SD is a holistic concept of intertwined, harmonious pillars (UNESCO, 2005). In other words, SD practices cannot be carried out without considering any social, economic, political, and environmental pillars. When the 2030 SD goals are analyzed, it is seen that each of the goals that must be achieved in all pillars of SD is interrelated and inseparable. In this context, it was to be expected that the pre-service teachers included these relationships in their descriptions of the future environment. The Brundtland Report (WCED, 1987) emphasized that it is necessary to deepen the links between the pillars of SD. Similarly, addressing development with a holistic and relational approach in the education process for SD will enable individuals to consider the social and economic pillars of their environmental actions (Rudsberg & Öhman, 2010). In addition, the holistic approach to the education process for SD allows individuals to learn concepts related to SD more easily (Gough, 2002; Herremans & Reid, 2002). Therefore, when the findings of the current study are evaluated in this context, it can be suggested that while pre-service teachers are planning and implementing an educational process for SD, they should activate the network of relations occurring in their minds; that is, they should shape their applications, considering the cause-effect relationships they have created while explaining the future environment.

Educational Implications

The findings obtained in the current study have revealed not only the pre-service preschool teachers' views of the future environment but also their views about the world's future. Although the environmental dimension came to the fore, the pre-service teachers also mentioned the economic, political, and social pillars of SD. They explained their perceptions about the world's future with a holistic approach. Pre-service teachers' perceptions related to how they will carry out the ESD in ECE when they become in-service teachers. The early years are crucial to promoting SD. Research in recent years has shown that children can express ideas about environmental and social problems even at a very young age (Kahriman-Öztürk et al., 2012; Grodzinska–Jurczak, et. al., 2006).

Furthermore, children are the ones who will face future problems created by the economic and social conditions that have been deteriorating for a long time. For this reason, future citizens should be involved in ESD starting from preschool. In this process, the most significant responsibility lies on the shoulders of the teacher. In developed countries, preschool teachers integrate sustainability into curriculums and daily activities. In this way, preschool children obtain concrete opportunities to understand sustainability better daily (Davis, 2009; Siraj-Blatchford et al., 2016). The relevant teacher training to pre-service preschool teachers regarding ESD will enable them to integrate SD into ECE. Thus, more children worldwide will be more hopeful about their future environment.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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Promoting Preschool Pre-service Teachers' Understanding of Food Additives Using the Debate Method

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Abstract

The aim of this research is to investigate the development of preschool education pre-service teachers' (PST) understanding and evaluation of a socio-scientific topic, namely food additives by using debate as a teaching technique. Qualitative research was designed in a case study model with purposeful sampling in which sixty PST attended Mother and Child Nutrition course. We used qualitative data instruments including pre- and post-reflective forms (RF), assignment papers and video recordings. Data were analyzed using open coding and cross coding. The results indicated that PST's opinions about food additives may change with the use of debate and scientific articles. The findings also showed that it can be possible to improve their understanding of scientific knowledge about food additives, sources of information, evaluation of sources of information with the help of well-designed debate applications. The evaluation of the components of evidence, sources of evidence, arguments, and expert judgment as well as inclusion of these components in teacher education programs are recommended for further research.

Introduction

Scientific literacy has been on the agenda of science education for decades and seven aspects have been defined within the scope of scientific literacy including foundational literacies, content knowledge, understanding of scientific practices, epistemic knowledge, identifying and judging scientific expertise, cultural understanding of science, and dispositions and habits of mind (National Research Council [NRC], 2011, p.32). Scientific literacy is described as the "ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" (Organization for Economic Co-operation and Development [OECD], 2013, p. 7). A scientifically literate individual can explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically (OECD, 2013). Furthermore, OECD (2011) stressed the importance of helping students acquire the skills of critical thinking, decision-making, communication, and collaboration included in 21st century skills. In a nutshell, to create scientifically literate individuals who are socially responsible and have a democratic worldview, educators should encourage learners to solve problems by evaluating them critically in a discourse environment. Upahi, Gbadamosi and Bonifaci (2017) suggested making deliberate efforts to relate objectives and contents of curriculum to explain the natural world and how scientific and technological enterprise relates societal issues and problems. To fulfil this requirement, this study examined the influence of debate, which is a teaching technique that enables the acquisition of skills, on PST's understanding and evaluation of a socio-scientific topic, namely food additives.

Health literacy, technology literacy, financial literacy, digital literacy, and other domain literacies closely interconnect and overlap with scientific literacy. Consumers' knowledge and awareness of food is crucial in this sense. However, nutrition is one of the topics that have been rarely studied in science education (Zeidler & Nichols, 2009). Therefore, we aimed to investigate PST's understanding and evaluation of this issue as they create future citizens. Food additives, such as sweeteners and food coloring are often considered by consumers as unnatural, unhealthy, or even hazardous for public health. However, these perceptions are mostly influenced by consumers' knowledge of regulation, their trust in regulators, and their preference for natural products (Bearth, Cousin & Siegrist, 2014). Fake news has been a growing concern for some industrial sectors including food industry. Disinformation and misinformation about food and agriculture spread rapidly in online platforms and jeopardize not only industrial sectors, but also scientific experts, research institutions, research institutions and the whole society (Demestichas, Remoundou, & Adamopoulou, 2020).

PST should have sufficient knowledge about nutrition to help children develop healthy eating habits, good health and prevent malnutrition and disorders. However, PST have generally a lack of knowledge about nutrition (Øvrebø, 2017). From this perspective, we selected food additives as the context of this study to promote PST's both understanding and evaluation of a socio-scientific issue, namely food additives.

Theoretical Framework

Food Additives as a Socio-scientific Issue

At the beginning of the 21st century the definition of socio-scientific issue (SSI) has been established and was considered in science education programs mainly to develop the scientific literacy of students in different grade levels by relating their knowledge to social problems. SSI are defined as issues that are "based on scientific concepts or problems, controversial in nature, discussed in public areas and mostly subjected to political and ethical effects" (Sadler & Zeidler, 2005, p. 113). Studies on SSI implementations in the classroom reported results of increased understanding of science subjects (Barker & Millar, 1996; Dori et al., 2003; Klosterman & Sadler, 2010; Sadler, Barab & Scott, 2007;Yager, 2006), promotion of decision-making processes (Sadler & Zeidler, 2005; Topcu, 2010), improved evidence-based thinking (Wu &Tsaib, 2007) and critical thinking skills (Altuntas, Yılmaz & Turan, 2017) of students in various grades ranging from middle school to undergraduate levels by practices presented with various perspectives.

SSIs are science-related and social issues that are interdisciplinary in nature and inherently include socio-ethical dilemmas (Kolstø, 2001, Ratcliffe & Grace, 2003, Sadler & Zeidler, 2004). Food additives is also a SSI that includes socio-ethical dilemmas and has been accompanied by disinformation and misinformation among public. Contemporary scientific literacy requires individuals' competency to critically evaluate and debate about SSIs (Tsai, 2018). Considering preschool teachers' influence on children in very early ages, it is especially important to foster their scientific literacy by focusing on their understanding and evaluation of a controversial issue about food, namely food additives.

Although there has been much research about SSI, there isn't enough practice of SSI in classroom settings and lecture plans nor enough sources of SSI activities in the classrooms for teachers (Kara, 2012; Lee, Abd-El-Khalick & Choi, 2006; Peel, Zangori, Friedrichsen, Hayes, & Sadler**,** 2019; Sadler, Foulk & Friedrichsen, 2017). Kılınc et al. (2014) argued that contrary to other topics, teaching SSI requires evaluating evidence, coping with uncertainties, defending arguments, and increasing moral and ethical sensitivity. From this point of view, researchers suggest employing argumentation and debate in classroom (e.g. Sadler, 2018); Torres & Cristancho, 2018; Zeidler and Nichols, 2009). Santos (2014) examined debate for global warming as an SSI and suggested the usage of debate for socio-scientific practices. However, there are not enough studies specifically focusing on PST's understanding and evaluation of a topic about food. The influence of debate on PST's understanding and evaluation is also rarely found. Therefore, in this research we applied debate as a teaching technique to provide a deeper understanding by enhancing meaningful learning, applying analysis and evaluation skills of the student, motivating them to hold logical, clear, and error-free discussions (Omelicheva & Avdeyeva, 2008) instead of presenting students information directly. Other teaching methods and techniques included laboratory practices based on inquiry, dilemma cards, concept cartoons, problem scenarios etc. Debate,as a teaching technique based on the literature, requires the discussion of ideas and evidence-based argumentations to make meaning of the topic to be taught and encourages the students to critically evaluate the source of knowledge.

Debate as Teaching Technique

Debate is a teaching technique applied in the form of discussion between the two groups of people who have opposite opinions to defend their own thoughts in front of an audience (Freeley & Steinberg, 2013, Taspinar, 2012). It is considered as an active learning (Bonwell & Eison; 1991) where students take the responsibility for their own learning in which they determine their duties (Bell, 1996). It is based on Socratic dialogue in which students research and analyze a subject or a problem deeply by critically evaluating information based on evidence in an argumentative discourse environment, (Bozer &Kurnaz, 2016; Paul & Elder, 1998; Saban, 2013). It is a teaching technique that provides student's opportunities to share their opinions on the subject, enhance their practice of analysis, evidence-based argumentation and promotes evaluation skills (Omelicheva & Avdeyeva, 2008). In this context, debate includes research and argumentation processes to support or refute an

idea based on scientific evidence, which in turn contributes to students' improvement of critical thinking and their scientific literacy.

Debate applications in class have many benefits for students including promotion of critical thinking, empathy, and communication skills (Hall, 2011; Kennedy, 2009, Shamsudin, Othman, Jahedi & Aralas, 2017), improvement of the ability of persuading others and communication skills (Oros, 2007), development of the ability to work collaboratively (Gervey, 2009), increase in the learning of content knowledge (Vo & Morris, 2006), and enhancement of representation and defense of ideas by discussing with others (Bellon, 2000) as well as elimination of bias and increase in motivation (Kedraka & Kourkoutas, 2018; Schroeder & Ebert, 1983). Critical thinking was indicated as the main output of debate by many academicians for many years but the benefits of debate for students can be divided into four themes.

a-cognitive domain (critical thinking and understanding subject) (Candela, Michael, & Mitchell, 2003; Garrett, Schoener, & Hood, 1996; Oros, 2007)
b-skills (collaborative working, communication (listening, speaking), effective usage of language) (Darby, 2007; Kennedy, 2009; Omelicheva, 2007)
c-attitudes (motivation to lecture and other social and political problems) (Hanna et al., 2014; Kennedy, 2009; Omelicheva & Avdeyeva, 2008).
d- democratic citizens (reducing prejudices and discrimination being scientifically literate) (Jager,2013; Omelicheva, 2007).

Besides the advantages of debate, some researchers focused on the limitation of its implementation. For instance, whether the students agree and disagree or have no idea about the discussed issue, their opinions or ideas may be oriented to their assigned positions after the debate instead of having their own opinions (Lily, 2012). Other disadvantages have been listed, such as misleading students and strengthening their existing views as well as causing conflict, tension, alienation, and anxiety within students (Omelicheva, 2007). Students need advanced research skills like scanning, skimming and critical reading to help them select relevant, useful, and trustworthy sources of information to defend their arguments as well as improving their listening and writing skills (Zare & Othman; 2013). Roy and Macchiette (2005) and Oros (2007) highlighted the importance of assessment and the feedback processes for the successful application of the debate technique. Based on this background, one can infer that critical reading by questioning the trustworthiness of the sources as well as a feedback process is necessary during implementation of debate.

Najafi, Motaghi, Nasrabadi and Heshi (2016) imply that students need to be taught how to think freely and positively, and there is need to increase their self-confidence. Goodwin's (2013) students criticized debate applications while they enjoyed it in that listening to the debates was passive and uninformative. Generally, most argued views about debate interventions are that all of the students are not active, it is difficult in a crowded classroom, it leads students to competitiveness students cannot produce their own ideas, and instructors have problems with classroom management and planning of debate applications, as well as requirement of post-debate feedback and integration of curriculum into debate applications. Therefore, Oros (2007) advises indicating details of a structured classroom debate model in which clear evaluation criteria, appropriate debate questions, management of groups, a well-planned debate format, the practice and evaluation of the debate by way of written and spoken assessment and student self-evaluation with suggestions was outlined with examples. In this research, debate was used as a teaching technique in a structured way including 60 PST's written and oral discussions.

The Purpose of the Study

The aim of this study was to see the improvement of scientific literacy skills of PST by understanding and evaluation of a socio-scientific topic, food additives, by using debate as a teaching technique.

Research Problems

1-Does the debate improve PST's understanding of the contents of the socio-scientific topic, food additives?
2-Do the sources of information that PST use change after the debate?
3-How do PST evaluate the trustworthiness of the sources they use about food additives before and after the debate?
4-Do PST'a opinions of usage of food additives change after the debate?

Significance of the Study

It is essential to promote PST's understanding of nutrition since they have impact on their students' good eating habits and health. It is also significant to create scientific literate preschool teachers who critically evaluate information about food and health in general. To achieve this goal, the study presented here aimed to improve their understanding and evaluation of a socio-scientific topic, namely food additives. The topic of food additives is selected as a context for this study to eliminate the impact of disinformation and misinformation about this topic on PST's. The debate method was chosen with the aim of improving their understanding and evaluation of this topic since it provides students with opportunities to support their argumentation with evidence and it improves their evaluation skills. The results of this study will be a well structed debate in science education and it will bring new light to designing preschool teacher education programs and further research investigating PST's understanding and evaluation of SSIs.

Method

Research Design

The study was designed as a case study using qualitative data. Yin (2009) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (p.18). The current study uses the case study research to examine PST's understanding and evaluation of food additives. Food additives as an example of SSI were used for real life context to understand the effects of debate on PST's understanding and evaluation of food additives. According to Yin (2014) what differentiates case study research from experimental research is that the case study is investigated in context, examined in its "real world setting" (p.16). This research is an explanatory case study consisting of more than one outcome and examples of casual relationships (Fisher & Ziviani, 2004). In the present study, in which debate as a teaching technique may change PST's understanding and evaluation of food additives, we examined the multiple outcomes of the case and tried to understand and emphasize the complexity and uniqueness of that case (Stake, 1995). Besides, the other feature of explanatory case study is that the usage of multiple sources of qualitative data may bring a deep understanding of a case and provides intrinsic knowledge and details regarding a problem or issues of interest to a researcher (Stake, 1995). In this study, we used reflective form (RF) as pre- and post-reflective forms, assignment papers as homework for the entire sample group and video recordings during the debate activity to answer the research questions. We organized the intervention based on the steps that Oros determined for debate (2007). We examined PST's understanding and evaluation of food additives and the sources they used about this topic. The first author was the instructor of this course. She is an experienced instructor who was familiar with the characteristics of the participants.

Participants

The research sample group represented in table 1 consisted of 60 PST attending a preschool teacher education program who enrolled in a Mother and Child Nutrition course during the fall semester of 2018-2019 academic year in a private university in Turkey and all of the participants were female. Before this course, they only attended anatomy and physiology course related with scientific concepts and most of them graduated from vocational schools that had a limited number of science courses only in 9^{th} grade. They entered the preschool education program by answering literacy and mathematic questions in the university entrance exam. Therefore, purposeful sampling was preferred for the senior level of PST's who were suitable for the research purpose because SSI units related with nutrition are included in the curriculum of this course. In addition, the opportunity of the sample group to communicate experiences and opinions in an articulate, expressive, and reflective manner and willingness to participate purposeful sampling was contributed (Bernard, 2002; Spradley, 1979). The only limitations of the sample group were their gender and their department (Palinkas, Horwitz, Green, Wisdom & Hoagwood, 2015). The participants signed a consent form for the use of data and video recordings in the research.

Table 1. The characteristics of pre-school education pre-service teachers'(PST)

Number of PST	Gender	Grade	Course (application of research)
60	All are female	Senior	Mother and child nutrition

Data Sources

In terms of transferability, Merriam (1998) indicated that the findings of a qualitative study should be applied to other or broader areas. Debate is a teaching technique used in many areas of education and this study tried to show the effective usage of it in science education reduces the negative assumptions of crowded classrooms. The aim of systematically gathering qualitative data was to discover a theory on completion of the research (Glaser & Strauss, 1967). Therefore, we gathered data from various sources including the reflective forms (RF) and assignment papers and video recordings obtained during the debate activity. The researchers of this study analyzed the data independently.

Reflective Test

The RF was applied before and after the debate interventions as a pre- and post-reflective form. The questions in RF were created by researchers to understand the influence of debate intervention. A professor from the Nutrition Department of Health Science Faculty checked the reflective test questions and assignment papers to ensure the validity of the questions. The researchers of this study constructed categories based on the participants' writings, then coded their explanations in approximately one month depending on these categories independently. First, they discussed the categories and after reaching a consensus they began to code the participants' writings. The initial agreement between researchers in coding was 80%. The researchers discussed these conflicts until they reached complete agreement on these codes. The questions in these forms were as follows:

- How can you define food additives?
- Do you think that you are consuming food additives? Provide some examples.
- What are the effects of food additives on human health?
- Which sources do you use to collect information about food additives?
- Do you think your sources of information are scientifically trustworthy or not?

Assignment Papers

Aiming to engage all the students in the debate and inform them about the content, 4 assignment papers were given to meet the requirements of the evaluation criteria that Oros suggested (2017). We distributed four articles to all participants, two of which explained the benefits and the other two mentioned the negative effects of food additives and asked them to read and to answer the questions related to each article. The articles and texts were regulated by omitting unknown concepts and they were shortened for the purpose of comprehension. The researchers of this study again created categories based on the participants' writings, then coded their explanations depending on these categories independently. They coded the participants' writings independently after discussing and deciding on the categories. The initial agreement between their coding was 80% and finally they reached complete consensus on the codes after discussing these concerns.

The questions of the assignments are listed below.

- What did you learn about food additives from the texts? Give a brief information.
- Is there any information in the text that food additives are beneficial or harmful?
- Do you agree with the information in the text? Why/Why not?

Video Recordings

Video recordings began to be used after the development of technology, for data collection, assessment, and distance educations. Gulek (1999) indicated that videos provide teachers an opportunity to critically review their teaching methods and students to observe their own actions due to its capability to reveal insights into the classroom from a different perspective (p.8). In this research during the debate application in the class, video recordings were used to identify and to obtain detailed outcomes of research questions and different outcomes rather than research questions to argue debate as a teaching technique. The video recordings made during the debate activity were used as a data source to understand the scientific knowledge about food additives, change of habits, evaluation and trustworthiness of the sources used by the participants.

Data Collection Process

In this research, six different units which were food additives, functional foods, childhood nutrition, and supplements during pregnancy, genetically modified foods, and diet programs were used to see the effects of debate applications on 60 PST. But in this working paper only the results of the debate about food additives were used. Before the debate application, we distributed four articles two of which explained the negative effects of food additives and the other two explained the necessity and benefits of their usage. When they were reading the articles, they should answer the questions on an assignment paper as homework to allow all the participants to engage in debate and to reduce the limitation of debate based by Goldwin (2013) in which other than debate group lay groups discussed the given information with their group mates and drew a conclusion in their assignment. Also, the pre-reflective form related to food additives, mentioned above, was applied to all sample groups before the debate application. The debate group's members were assigned randomly by drawing names from the whole study group. Five students were assigned to the role of defending the argument that 'foods containing food additives shouldn't be used in nutrition', and the other five of them were responsible for arguing that 'foods containing food additives can be used in nutrition'. The groups had two weeks for preparation and for answering the assignment papers, which were collected at the beginning of debate application from all the PRSET. The format of the debate could change however, the important thing was to ensure that the argumentation process in the class served discussion of bias within the claims (Bonwell & Eison; 1997). We therefore gave structured guidelines, that was given below, before the debate to guide their research and to underline the contents of the debate. We also gave the rubric which was used for the evaluation of the debate groups concerning 60 participants.

Debate Structured Guidelines

Divide the assignments between your teammates and take the following into consideration:
1. Define food additives and their history (when and how they were found, produced, developed)
2. Why is the given topic important for society?
3. What did the society do to prevent the production or to restrict the usage of food additives?
4. What are the positive or negative effects of the given subject regarding human health, psychology, ethics, and moral values?
5. Indicate your references when you provide evidence to support your claims. You can use given articles or texts.
6. You can use many different techniques like videos of your research, experiments, drama, your questionnaire results etc.

Also, the debate steps were mentioned for the participants who didn't take place in any debate activity. The steps generally were structured from Oros (2017) but adapted for 4-5 students in each debate group. The debate activity was completed in two course hours, approximately 90 minutes.

Debate steps:

1a- Team One presents the supporting arguments—10 minutes
. The argument (s) is introduced.
. Evidence is submitted to support the argument.
1b- Team Two presents the opposing arguments—10 minutes.
. The argument is introduced.
. Evidence is submitted to support the argument.
. No direct response is given to Team One.
2a- Team One reintroduces the supporting arguments—5 minutes.
. Secondary arguments are introduced.
. More evidence is submitted.
. The opposing team's evidence and arguments are rebutted.
2b- Team Two reintroduces the opposing arguments—5 minutes.
. Secondary arguments are introduced.
. More evidence is submitted.
. The supporting team's evidence and arguments are rebutted.
3a- Team One rebuttal—5 minutes
. Respond directly to opposing team's arguments.
. Sum up key points of your team's position.

3b- Team Two rebuttal—5 minutes

. Respond directly to opposing team's arguments.

. Sum up key points of your team's position.

4a- b: team one and two will respond the three questions of the instructor, jury member and their friends with evidence.

In the debate, in addition to using the exact first three steps of Oros (2007), the fourth step was added. Finally, the average score of the jury, consisting of a researcher and four other students, was calculated and the score and the reasons for the score of each group were explained. The rubric was composed of three main parts: research, presentation, and group work. The rules of the debate and the results of the evaluation of the rubric forms were also announced. Each group member got the same grade.

Data Analysis

According to Marshall & Rossman (2011), credibility, transferability and dependability are the main issues to determine the trustworthiness of a qualitative study. To ensure the trustworthiness of this study data was analyzed using open coding and cross coding by two researchers depending on the research questions. All data groups were managed using the Miles and Huberman reliability formula (1994) formula:

Reliability = amount of agreements / number of agreements + disagreements

The initial percentage agreement of the researchers was 80%. The researchers discussed their conflicts until they reach 100% agreement to assure the reliability of the results. Depending on the analysis of reflective tests, assignment papers and video recordings during the debate period in class, all codes were grouped under the four themes in the light of the research questions. The themes were: the understanding of scientific knowledge about food additives, source of information, evaluation of sources of information and change in PST' opinion about consumption of food additives. Codes and sub-codes were given in the table 2 below. The results of RF test and assignment papers were given separately and data from video recordings were used to explain each theme results in detail.

Table 2. Themes, codes and used data sources in research analysis.

Themes	Codes	Sub-codes	Used data sources
Understanding of scientific knowledge about food additives	Scientific knowledge	Definition of food additives (Durability –examples of foods, shelf-life color, odor, taste & appearance	Pre-RF test Post –RF test Assignment papers Video recordings
	Effect on health	Harmful, not harmful, diseases	Pre-RF test Post –RF test Assignment papers Video recordings
Source of information	Types of sources		Pre-RF test Post –RF test Video recordings
Trustworthiness of information	Not trustworthy	- explaining why the sources are not trustworthy	
	Trustworthy	- explaining why the sources are trustworthy	Pre-RF test Post –RF test Assignment papers Video recordings
Change in their opinion about consumption of food additives	Harmful	-Why harmful with or without evidence	Pre-RF test Post –RF test Assignment papers Video recordings
	Not harmful	-Why not harmful with or without evidence	Pre-RF test Post –RF test Assignment papers Video recordings

Results

This study analyzed PST's understanding of a socio-scientific topic, food additives and their evaluations of sources of information about this topic before and after the debate in the classroom. To make this analysis we inspected their pre- and post-RF as well as their assignment papers and video recordings. Subsequent sections include the findings of PST's understanding of scientific knowledge about food additives, change in their habit, evaluation of the sources of information they used for this topic and finally, the criteria used to decide the trustworthiness of the sources of information provided in the texts they read.

Understanding of Scientific Knowledge about Food Additives

In this section we present the results of PST's responses in RFs and assignments. First, we present their definitions of food additives, whether they consume these additives and how these additives affect human health in RFs. Table 3 illustrates the results obtained after analyzing the answers of the participants to the first, second and third question of the pre-and post- RF.

Table 3. Frequency of the reference to scientific knowledge

Scientific knowledge (%)					Effect on health (%)				
	Durability	Shelf-life	Color, odor, taste & appearance	Personal consumption	Harmful	Not harmful	Not harmful within pre-determined limits	Both benefits and dangers	No idea
Pre-	25.71	20	42.86	100	94.29	0	0	0	5.71
Post-	31.43	42.86	51.43	100	42.86	2.86	37.14	31.43	0

As shown in Table 3, nearly half of the PST's knew that food additives are the substances added to food to preserve its flavor or improve its odor, taste, appearance, and other properties. Some of them also knew that these substances increase the endurance durability and shelf-life of food. Besides this, all of them thought that they consume food that contains additives before and after the debate. Statements such as one participant wrote, "They are not organic" or another participant, "They are used for the purpose of decreasing costs" are not mentioned in the post-RF. Another explanation in pre-RF was as follows: "They are added to cause the least harm to people." This explanation can be interpreted as the participant's thought that additives are already harmful, but they are added in determined limits. Except for her no other participants made this type of explanation. However, after the debate a considerable number of participants thought that food additives are not harmful in pre-determined limits. It is interesting to note that nearly all the PST believed that these additives are harmful and listed several risks including allergies, digestive problems, obesity, cancer, etc. in their pre-reflections. Two of the participants had no idea about food additives before the debate, while only one participant argued that they are harmless after the debate.

In the assignment papers the answers to the question "What did you learn about food additives from the texts and are the food additives harmful or beneficial?" were used to analyze scientific learning about food additives. Depending on the results an attempt to analyze some of the learned concepts about food additives was made. Different then their pre-RF test new disorders were determined like hyperactivity within 8 % ratio and digestive system problems with 6% and the ratio of allergies in answers increased to 14%. They defined food additives as being unnatural with 9% in pre-test but instead of that they preferred to use *'they have both benefits and dangers', 'no harm in predetermined limits / amounts'*. Even though they used the words; readymade foods, candy, juices, chocolate, take-away foods, ketchup-mayonnaise, and tomato sauces in their pre-RF test. In their assignment papers, the names of new foods like soup and meat products were obtained.

In video recordings taken during the debate application disorders caused by food additives come to prominence such as allergic reactions, hyperactivity, cancer, skin disorders, and insomnia, asthma, gastrointestinal problems. Therefore, when we compared pre-test results and video recordings, the number and the names of disorders caused by food additives were increased. Furthermore, the examples of food additives given during the debate activity changed; examples such as soup, chips, jam, cake, salami, sausage, and gum are given instead of candy, fruit juice, and ketchup-mayonnaise and tomato sauces. PST's descriptions and explanations about food

additives in their assignments and video recordings also revealed their understanding and evaluations of food additives.

All the PST's were able to describe and explain the information presented in the text. The other discussion about the harmful effect of food additives. Their biased perception about the dangers of food additives seems to have changed and they began to argue this topic using more evidence-based ideas after the debate. Although the number of participants who were against using food additives reduced after the debate, nearly half of the participants still thought that these substances were harmful and should not be used. This result supports Sadler and Zeidler's (2005) findings that understanding content knowledge is related to the quality of informal reasoning with regards to SSIs. We argue here that the understanding of content knowledge depends not only on individuals' informal reasoning but also on the sources that they used to obtain information about food additives. Therefore, we analyzed participants' responses to the fourth and fifth questions in RFs and examined whether the sources they use may have an impact on their content knowledge. The subsequent section presents the findings of these questions.

Sources of Information

The fourth question of pre- and post-RF asked participants which sources they utilized. The answers to this question indicated the sources they used to get information on this topic. Before and after debating food additives in the classroom, PST listed the following sources of information used to obtain information about food additives and the frequency of each source is given in the table 4 below.

Table 4. Comparison of source of information between pre-RF and post-RF tests

Sources of Information	Pre- RF %	Post-RF %
Experts in the field	0	14.29
The websites of foundations and universities	0	11.43
TV/newspapers/media	42.86	31.43
Internet	40	17.14
Social media	11.43	0
Books/textbooks	20	14.29
Lecture	8.57	54.29
Journals	8.57	5.71
Articles	2.86	65.71
Peers and people around	17.14	5.71
Various readings	2.86	0
Ingredients written on the package	2.86	0
No source	2.86	0

Table 5. Frequency of the reference to trustworthy sources in RFs

Trustworthy (54.29% in pre-RF, 82,9% in post-RF)								
	News (%)	Academic/ scientific articles (%)	Experts/ professors (%)	Based on evidence / research /data (%)	Based on arguments and counterarguments in the debate (%)	Instructor and friends (%)	Foundations (%)	Various sources (%)
Pre-	2.86	2.86	14.29	0	0	0	0	5.71
Post-	0	8.57	14.29	48.57	2.86	8.57	8.57	2.86

The sources listed above indicate that PST mostly depended on TV, newspapers, or other media, including social media sources to get information about foods additives before debating on this topic in the classroom. Ingredients written on the package and social media seem to be sources of information before the debate, while one participant wrote that she used none of the sources listed above to collect information about food additives. Another significant result is that only three participants stated that they got information about food additives

throughout the lecture while most of the participants did not mention it as a source of information before the debate. After reading related texts and debating on this topic, nearly half of the participants said that they acquired information about this topic in the classroom and from the texts they read. There were also some participants who mentioned expert opinion in post-RF, while none of them mentioned expert judgment in pre-RF.

Evaluation of Sources of Information

The fourth question in the RF asked whether they think these sources are trustworthy and the fourth question of the A asked them whether they think the information presented in the texts are trustworthy. The fifth question in the A asked which source(s) about food additives is/are most trustworthy. The answers that PST gave to these questions in their pre- and post-RF revealed their evaluations of sources of information. Table 5 indicates the frequency of the PST who thought that the sources of information they generally apply are trustworthy and Table 6 shows the frequency of the PST who thought that the sources of information they applied are not trustworthy in RFs. The frequency of the reason they asserted when deciding the trustworthiness of these sources is also presented in these tables.

Table 6. Frequency of reference to untrustworthy sources in RFs

Not trustworthy (14% in pre-RF, 9% in post-RF)					
	Fake news (%)	Not experts/ professors (%)	Contradicting information (%)	Knowledge is tentative (%)	Not scientific (%)
Pre-	0	2.86	0	2.86	2.86
Post-	2.86	0	2.86	2.86	0

As illustrated in Table 5 and 6, PST are more likely to trust the sources of information they get about food additives. The participants who trust their sources also tend to offer more reasons for why they trust them.The findings revealed that PST mostly trust expert judgements before and after debate. Readings on food additives and debating on them seems to have been effective in enabling PST to appreciate evidence and research data. Only one of them mentioned the significance of argument and counterargument during the debate in post-RF. This result may be promising for letting at least one PST to discuss argument and counterargument.

The participants who thought that their sources were not trustworthy listed only five reasons in total. It is important to note that different participants listed all these reasons. Even those who mentioned the tentativeness in pre- and post-RF were different participants. This tentativeness argument seems problematic here. We provided PST texts which addressing both the benefits and harms of the food additives, and this situation seem to have led them to conclude that knowledge is tentative instead of searching the scientific view.

After examining the results of their assignment papers (Table 7) dealing with the trustworthiness of sources like scientific research, foundations and information provided by an instructor, similar results were obtained. But in the assignment paper they mentioned the trustworthiness of research that was done in a laboratory by a scientist or professor and, they explained why they found their teacher to be a trustworthy source.

Table 7. The frequency of sources which were found trustworthy by PST

n= 42	%	Sources	Examples
8	19	Foundations	Ministry of Health, Ministry of Agriculture, World Health Organization (WHO), Food agriculture organization (FAO)
19	45	Expert	Doctors, food engineers, engineers
27	64,5	Scientific research and article	The results of experiments conducted in a laboratory by a scientist and professor.
5	12	Media	TV, social media, media
4	9,5	Internet	Web pages including results of scientific research.
5	12	Books	Course books, scientific books
3	7,1	Course instructor	Our teacher mentioned new research.

Beside PST's positions about using food additives, we also examined the trustworthiness evaluations of each article and sources in general. Table 8 illustrates the frequency of the PST who evaluated trustworthiness of the given texts.

Table 8. The frequency of the PST who evaluated trustworthiness of the given articles.

Not trustworthy	%	Students' examples sentences
Explanation without providing any evidence.	4	"Because I believe that it is not trustworthy."
Emphasis on evidence	16	"The text doesn't provide enough evidence for the given information" "This information does not depend on research findings."
Emphasis on the author	8	"The author of this text is unknown."
Questioning the internet	8	"This text is retrieved from the internet. We cannot trust any source found on the internet."
Emphasis on research	8	"Further research is needed in order to claim that food additives are harmful. The information presented here is not satisfactory." "There is not enough information to draw a conclusion on this subject."
Trustworthy		**Students' examples sentences**
Explanation without providing any evidence.	16	"I think this text is trustworthy. I learned a lot." "Yes, it is trustworthy because it is very instructive." "If it weren't trustworthy, it would not have been published."
Emphasis on evidence	72	"This text provides evidence for the information it gives." "The information given here depends on research data."
Emphasis on expertise	24	"The given information is based on experts' findings." "Experts in this field drew these conclusions."
Emphasis on references	12	"There is a reference section, and it is possible to access these sources." "The references seem sufficient to me."
Emphasis on foundations	4	"Worldwide organizations such as World Health Organization (WHO), Food and Agriculture Organization (FAO), Joint FAO/WHO Expert Committee on Food Additives (JECFA), etc. are referred to in the text."

Again, there are PST who do not provide any evidence for their judgment that the texts are trustworthy or not. However, the discussions of evidence, references, and expertise especially while arguing the trustworthiness of the text seems promising. However, it is not clear what PSTs mean by the term 'evidence.' Furthermore, the number of PST who mentioned the need to include references seems quite low. Another interesting point is that the notion of expertise seems misleading here, especially considering that two participants who mentioned the name of a public figure whose explanations are based on non-scientific evidence. These PST might have seen her on TV and other types of media channels and just because she is a cardiologist, they assume her advice on the topic of food is correct. In other words, her expertise is not on food. The analyses of the trustworthiness of information in general revealed nine criteria. These criteria and their frequency were given in Table 9.

Table 9. The criteria used to evaluate trustworthiness of the given articles by the PST

Criteria used to evaluate trustworthiness of the given articles	%
Experts in the field	64
Scientific articles	56
Research, experiments, scientific studies	52
Foundations and organizations	28
Books	24
Media	16
Course instructor	8
Websites that make scientific explanations	4
Libraries	4

It is promising to have PST include expertise commonly in these criteria as well as scientific articles. They also seem to have appreciated the significance of research, experiments, and scientific articles. They again mentioned foundations and organizations and books as trustworthy sources of information. Among the trustworthy sources of information they mentioned, the participants listed the word "expert". In their assignment papers the participants explained who qualifies as an expert according to them. He/she is a doctor, food engineer or an engineer. In other words, they back up the research results with evidence and explain the results of laboratory experiments.

Also, during the debate process (from the analysis of video recording), they tried to prove their assertions by using a given article, the articles they used for research or reports of World Health Organization [WHO], Ministry of Health, and the results of medical research studies and they indicated the source of the references as "*this information was taken from many articles, news reports and research studies, ……. was explained many years ago by Paracelsus, …… Dr Selman Turker affirmed that the consumption of a legally permitted amount of food additives is not harmful, at the same time in this research the allergic reaction on children who eat……..increase*.

Table 10. The frequency of PST's positions on the usage of food additives

Categories	%	Students' sentences
Harmful		
Explanation without providing any evidence	48	"It makes sense to me." "Because I believe that they are harmful." "I don't believe that they are harmless even in pre-determined limits." "This text gives us sufficient information about their dangers''
Emphasis on evidence	16	"The texts/readings provide enough evidence of the danger."
Emphasis on the responsibility of consumers	8	"The consumers need to read the list of ingredients written on the food label." "The consumers should search and get information about what they eat."
Pointing out prohibited additives	8	"Prohibited substances shouldn't be added to food."
Trust in natural substances	8	"Food additives are harmful because they are not natural."
Emphasis on research	8	"Further research is needed in order to say that they are beneficial because knowledge may change over time." "One day the experts say that a substance is beneficial, then another day they find out that it is harmful. Unless findings of lots of research provides evidence that they are not harmful they shouldn't be used as food additives."
Distrust of the inspection system	12	"I don't trust the food inspection system." "Sometimes human health is ignored by just taking shelf-life into consideration."
Overdose	12	"These substances may be harmful above pre-determined doses."
Beneficial		
Explanation without providing any evidence.	4	"I know that they are beneficial. They protect food."
Emphasis on evidence	24	"This text mentions the hazards of these substances by providing evidence." "There is not enough evidence of the danger."
Persuasion	24	"I was against the use of food additives, but I am convinced of the need of using them after reading this text." "I learned from the text that there are also natural substances that are used as food additives."
Limit of usage	20	"There is no harm in using food additives in pre-determined limits." "The amount of these additives shouldn't exceed the particular limits."
Emphasis on foundations	4	"Worldwide organizations such as World Health Organization (WHO), Food and Agriculture Organization (FAO), Joint FAO/WHO Expert Committee on Food Additives (JECFA), etc. support these findings."

Change in their Opinion about Consumption of Food Additives

Fifty-five PST out of 60 reflected on the readings that we assigned to them. We examined their explanations in two parts. In the first part we created themes for those who were opponent and proponent of using food additives and in the second part we investigated their trustworthiness evaluations of each text they were assigned to read. Table 10 shows the frequency of PST who questioned whether food additives were harmful or

beneficial after reading the texts about these substances. It is interesting to note that the number of PST who explain that they are against using these substances without providing evidence is by far higher than the number of those who propose to use them without making any evidence-based explanations. One can infer from this result that the participants who concluded that food additives are beneficial decided their positions based on evidence, while those who concluded they are harmful based their opinion mostly on their intuitions and beliefs. Very few of the participants emphasized that consumers need to be well-informed about food additives and again very few of them pointed out that there are substances prohibited to use as food additives. Emphasis on the need of a high amount of research seems to be promising, but this seems to have led participants think that we cannot trust these substances because in the future the experts may oppose what they say now. Although the number of PST who don't trust the food inspection system is very low, this result may predict their position on the usage of food additives.

Distrust of natural additives is another interesting point of view. Twenty-four percent of PST seem to have a change of mind after reading related texts and learning that there are also natural substances that are used as food additives; however, some of them still seem to believe that food additives are harmful because they are not natural even after they have read the same texts. The emphasis on foundations to support using food additives and the limit of using them are also promising. These results show that PST rely on various criteria to decide whether it is appropriate to use additives or not. Therefore, as Zare & Othman (2013) explained, PST need advance research skills to select relevant, useful, and trustworthy sources of information to defend their arguments.

According to the video recording, the group who proved that food additives are harmful used their own collected data. They asked people in a market whether food additives are harmful or not and presented their answers in a video during their debates. The majority of the respondents said "*food additives are harmful*" but they cannot explain why they are harmful. The other group refuted the argument like this.

> "*We didn't choose this debate topic and at the beginning we believed that food additives are harmful and we afraid of its proof. But when we researched, read given articles, reports, other research papers, our ideas started to change, we learned that when we consume a limited amount of food additives, they are not harmful. ……we are not saying they are harmful or not, we just explained their risks and beneficial properties in the light of research results, you can read and decide according to the best of your knowledge or ideas." "The consumption of food additives in a limited amount is not harmful.*"

These sentences were repeated many times during the debate by the group with opposing viewpoints. The most important result of the debate is this sentence. *"Due to this debate we learned that we believe whatever we hear, in fact we should seek information from various sources and then we should decide whether they are beneficial or harmful and also we should teach this to at least 15 people around us."* In the above example a PST tried to explain the characteristics of scientifically literate people.

Discussion and Conclusion

In this research, we tried to practice with PST improving properties of scientifically literate people with debate technique by using food additives being the SSI. Therefore, we checked their knowledge about food additives, the types of information sources they used and the criteria they utilized in choosing these sources and the change in their opinions about the consumption of food additives. Based on the results, debate and course readings seem to have had a positive impact on PST's scientific knowledge about SSI concepts. It is hard to change a learner's opinion on a subject even if they are provided with evidence that contradicts their opinion. Topcu, Sadler and Yilmaz-Tuzun (2010) noted that Turkish pre-service teachers benefit from their own learning experiences that support their own informal learning practices. The findings of this study support this discovery by providing insights into PST's reflections about understanding and evaluation of food additives before implementing the debate. However, when we pointed out related scientific sources including results based on scientific evidence to help them prepare for the debate it seemed to have a positive impact on both the learning contents of SSI issue and it helped to change their idea about the usage of food additives like Gervey (2009) and Lilly (2012). The results of this study revealed that reading articles and researching further sources about food additives in preparation for the debate facilitated active learning during the classroom activities (Barker & Millar, 1996; Dori et al., 2003; Klosterman & Sadler, 2010; Sadler, Barab & Scott, 2007; Yager, 2006); thus, understanding of content knowledge increased throughout the debate activity. The articles given to the whole class, introducing the rules of the debate, the usage of an assessment rubric and other students and researchers asking questions to the debate participants, were effective tools to improve argumention during the debate (Goodwin ,2013). In

addition to Roy and Macchiette (2005) and Oros (2007) suggestion of assessment, selecting critical reading articles for all students and detailing research rules to debate groups is effective as stated by Zare & Othman (2013).

Apart from the given articles, the debate groups used many other sources to support their ideas, in other words whichever group had more scientific evidence to refute the opposing ideas seem to have influenced the whole sample group to change their positions about the usage of food additives. In their post-test most of them explained their ideas about usage of food additives as *"suitable for consumption in a limited amount that is scientifically determined."* Therefore, the quality of the research done by the debate groups and their evidence-based argumentation abilities contributed to the decisions of the whole group. The group which had ample resources consisting of scientifically evidence-based conclusions had a chance to alter the ideas of most of the participants. In short, reading articles and debating in the classroom seem to have increased PST's understanding and evaluation of food additives. Therefore, it can be inferred that PST appreciated the importance of evidence on the decisions of society in SSI problems.

To improve PST's appreciation of research and evidence, it is necessary to integrate the discussions of what constitutes evidence and the relationship between evidence and argument seem crucial because PST use the term 'evidence' in their RFs and assignments in an ambiguous way. We can say that the evidence-based reading articles presenting opposing opinions helped PST to make informed decisions. Therefore, the guidance provided by the instructor with the sources of related research articles or given articles to PST is very important for understanding which sources are scientifically evidence-based and which are not. The PST acquired the ability to select evidence-based sources during preparation for the debate (NRC, 2001; OECD, 2013) to read and to search through practice. When questioned about the trustworthiness of their sources, they explained that they learned SSCI units from their teacher. Later on, in their post-test, they mentioned the reason for relying on their teacher as a trustworthy source of information as follows: "when our teacher is mentioning SSCI units she is using some research data". It is evident from this result that this participant seems to have appreciated the credibility of evidence.

The results of the current study also showed that PST misinterpreted the expertise. They need to be informed about the meaning of field expertise and under which circumstances and depending on which criteria it needs to be applied to make decisions based on expertise. For example, does an expert who we used to see in the media very often make his/her explanations based on research findings or his/her own opinions? PST need to be able to distinguish between evidence-based explanations and opinion-based evidence even when considering an expert. Deliberate efforts in teacher education programs should be made to facilitate such kind of distinction. PST also seem to have overestimated the media.

To facilitate argumentation and debate, SSIs should be integrated more often in teacher education programs. Fake news and evidence-based news need to be included during discussions of these issues. As Omlicheva (2017) explained the contribution of debate improves student's attitudes towards political problems. The students who formed the debate groups in this research suggested producing organic food, restricting the use of insecticide and plant hormones to be able to eat unadulterated food. However, the participants outside the debate group denoted the inaccuracy of the country's agricultural policies and economical power of population to buy organic foods. Here, apart from the debate on SSI, there are two important outcomes. One is the increase in PST's scientific knowledge and the other is their awareness about agricultural policies and the relation between agriculture and economy. This result demonstrates that they interconnected an SSI with other fields, and it also helped the students to make research and be informed on the topic, and show interest in these fields (politics, agriculture, economy). Therefore, as Erduran & Jimenez-Aleixandre (2007) stated, debate helps students become knowledgeable and future intellectual citizens, who can construct evidence-based arguments and make decisions based on evidence. In short, encouraging PST to make research, instructor guidance, and competition through debate improved the understanding the topic and communication skills of the participants.

Recommendations

The following implementations are recommended for further research on PST's understanding and evaluation of SSIs based on the findings of this study:

- Implications of debate specifically focusing on the discussions of what counts as evidence and the connection between the evidence and argument.

- Implications of debate specifically focusing on the discussions of expertise and profession by pointing out the significance of expert judgment and its impact on the disinformation and misinformation on SSIs.
- Implications of debate specifically focusing on the evaluation of the credibility of media and other sources of information on SSIs.
- Preschool teacher education programs should encourage PST to design and implement discussions in early childhood activities.

Scientific Ethics Declaration

In this article the rules of scientific research and publication ethics specified in the Higher Education Institute (YOK) Scientific Research and Ethics Regulation were followed.

The author declares that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author.

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Examination of Health Literacy Levels of Pre-Service Teachers

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Abstract

Low level of health literacy causes a decrease in quality of life and social inequalities. Adequate health literacy levels of pre-service teachers will not only reduce the risk of disease, but also will contribute to development of a healthy lifestyle for societies. In the study, it is aimed to determine the health literacy levels of pre-service teachers, and to reveal how it changes in terms of various socio-demographic characteristics. The study group of the research consists of 482 pre-service teachers studying at the education faculties of state universities. The 'Turkey Health Literacy Scale-32' was used to determine the health literacy levels of the participants. In the analysis of the data parametric tests were used, since there were no outliers, and the normality assumptions were met. The results show that two-thirds (68%) of the research group have inadequate and limited health literacy. When health literacy index scores examined in terms of the variables discussed in the study, it is understood that the level of health literacy remains at a limited level. It is thought that making arrangements to improve health literacy in the curriculum of teacher training programs will directly contribute to a healthier life for both individuals and societies

Introduction

Along with the current pandemic, which affects the whole world, diseases and health protection issues have taken their place at the forefront as an important agenda item for all individuals. Epidemics related to infectious diseases, which have been experienced many times throughout the world's history, have resulted in significant loss of life, however, many chronic diseases such as cancers, cardiovascular diseases, diabetes, chronic obstructive pulmonary disease, and high blood pressure have become common in the recent past. Within this period, understanding and applying health-related information has become an inevitable necessity for the health of both individuals and societies. Individuals can lead a healthy life only if they can access, understand, and apply basic information about health (Nutbeam, 2000), in other words, if they are health literate. The World Health Organization has defined the concept of health literacy as "the ability of an individual to access, understand and use health information for the protection and maintenance of health" (World Health Organization [WHO], 1998). Health literacy is accepted as an indicator of health status, quality of life and community well-being (Suwono et al, 2023), and a low level of health literacy causes a decrease in quality of life and social inequalities. The World Health Organization reports that improving health literacy is an important tool in reducing health inequalities.

Health literacy has critical importance in developing the capacity of individuals to reach health-related information and to use this information effectively (Nutbeam, 2000). Achieving the desired level of awareness about health literacy leads to positive changes both individually and socially. On the other hand, an inadequate level of health literacy creates some risks and causes limitations in evaluating health-related information. Studies reveal that the evidence for the negative effects of inadequate health literacy is increasing (Yılmazel & Çetinkaya, 2016). These; inadequacy in understanding the individual's health status, inability to adhere to medical recommendations, the inadequacy of self-care, increased health care costs and increased mortality rates (Freedman et al., 2009). There are many studies showing that there is a positive relationship between health literacy and healthy lifestyle behaviors, and the results show that the level of health literacy has significant effects on healthy lifestyles. Again, many studies have proven the relationship between limited health literacy and being unhealthy (U.S. Department of Health and Human Services, 2010). Interventions to improve the level of health literacy due to its primary role in improving health and preventing diseases have an important place in both individual and social areas.

Health literacy, which contributes to the development of skills related to health protection, is seen as a competence that can be gained through educational practices (Paakkari & Okan, 2019). Stating that the main way to develop health literacy is formally organized and structured health education, Nutbeam (2019)

emphasizes the necessity of cooperation between the health and education sectors for the goal of improving health literacy (Nutbeam, 2000). It is recommended by the World Health Organization that health literacy education should be started in early childhood and the concept of health promotion in school education should be emphasized to improve health literacy awareness (Yılmazel & Çetinkaya, 2016).

In the report published as a result of the "First International Conference on Health Promotion" held in Ottawa in 1986, it is stated that it is not possible to achieve health promotion studies only with the efforts of the health sector, and other sectors should also take responsibility in this regard (Bilir, 2014; Dost & Üner, 2020). At this point, education workers are one of the occupational groups that can play an important role in improving the health literacy of individuals. It is stated that health literacy functions as a bridge between the fields of education and health (Paakkari & Okan, 2019) and education workers have a unifying role. Improving health literacy among school-age children from diverse backgrounds can prevent the emergence of health inequalities (Paakkari & Paakkari, 2012). Inadequate health literacy leads to problems related to risky behaviors in children and adolescents; these behaviors exacerbate problems such as stress, depression, anxiety, and poor self-perception with the effect of social-environmental conditions, and children and adolescents face serious health problems. Schools have difficulties in meeting these needs of students with insufficient health literacy and important health needs. For this reason, not only health professionals but also teachers should be prepared for the health problems that students experience (Peterson et al., 2001). Teachers need to consider the physical, mental, social, and emotional health of children as well as their academic development (Yager, 2011). At this point, along with the preparation of teachers for their professional responsibilities, it is seen as an important requirement that they have sufficient knowledge and skills on health issues, which have social, developmental, and biological dimensions, in the pre-service period.

Health literacy has been the subject of many large-scale research projects and policy agendas of countries due to its individual and social importance. Empirical findings from research highlight the importance of health literacy for coping with more common health problems recently. In this direction, it is seen that the number of scientific research on health literacy has increased exponentially. Great interest in health literacy at the national and international level has been reflected in the policy strategies of countries and has resulted in promoting health literacy in their health-related goals. Health literacy has been included in strategic plans among the action plans developed and implemented in various countries. In some countries, health literacy has become a part of education policies and the teaching of health literacy has been included in school curricula starting from early life.

Rationale of the Research

Despite the efforts of people to reach scientific information in the health problems faced due to the current Covid-19 pandemic, it has been seen that they often do not question the accuracy of the information and cannot make an effective evaluation. The health problems experienced for these reasons have revealed the importance of health literacy in a striking way. The need to improve individuals' ability to access, understand, use, and evaluate health information has become much more visible within this process. At this point, it should be considered as an important requirement that students be educated as health-literate individuals and that teachers have sufficient knowledge about health issues. It is stated that there is a need for pre-service and in-service professional teacher training that can help teachers understand the principles of primary prevention, key concepts for the implementation of effective primary health care and health promotion programs (Peterson et al, 2001). In the pre-vocational education period, determining the health literacy levels of pre-service teachers and the affecting factors can provide important data to eliminate the deficiencies in this subject.

Health literacy is considered a tool to be used in reducing the inequality faced by society in health (Bakan & Yıldız, 2019). It is expected that teachers, who are thought to be effective in the dissemination of health literacy in society, should be well-equipped in this regard. It can be stated that teachers are at the forefront in acquiring students' basic health knowledge and self-care skills that are effective in protecting health. Studies have shown that children who have frequent health problems encounter situations such as absenteeism, grade repetition, problematic behaviors in the classroom, attention problems, and low success in standard tests (Martin & Chen, 2014: 346). For this reason, health literate teachers will also alleviate inequalities in the field of education with their contributions to their students in this regard.

For these reasons, pre-service teachers were chosen as the study group in the study. Supporting the personal development as well as academic and professional development of pre-service teachers during the pre-service education period is one of the requirements of not only individual but also social progress. Adequate health

literacy levels of pre-service teachers will not only reduce the risk of disease for themselves and the individuals they will raise in the future, but also will contribute to their development of a healthy lifestyle (Baker, 2006). A low level of health literacy will cause them to experience limitations in protecting and maintaining health (Çopurlar & Kartal, 2016). It is obvious that research on health literacy is mostly carried out by researchers in the field of health, but due to the social value and multidimensional nature of the subject (Marimwe & Dowse, 2017), it should be handled by different field researchers. In this direction, it is aimed that the results of the research will make new contributions to the relevant literature from different perspectives.

Purpose of the Research

Examining the health literacy levels of pre-service teachers underpin this research. In this direction, it is aimed to determine the health literacy levels of pre-service teachers, and to reveal how it changes in terms of various socio-demographic characteristics. Within the scope of this purpose, general health literacy levels of pre-service teachers were also investigated in terms of 'health care', 'disease prevention and health promotion', and their levels of accessing, understanding, evaluating, and using health-related information. The research questions addressed in this direction are as follows:

1. What is the health literacy level of pre-service teachers?
2. What is the health literacy distribution of pre-service teachers according to their department and grade level?
3. Do pre-service teachers' scores on health literacy components differ according to gender?
4. Do pre-service teachers' scores on health literacy components differ depending on whether they have a chronic illness in themselves or the family?

Method

Research Model

This research was carried out in the survey model, since it aims to reveal the existing situation by examining the health literacy levels of pre-service teachers studying at the university. Since survey studies are concerned with describing the characteristics of a large population and how it is distributed among the individuals in the sample (Fraenkel & Wallen, 2006), the distribution of health literacy levels of pre-service teachers was investigated with a survey model in this study.

Study Group

The study group of the research consists of pre-service teachers studying at education faculties of state universities. Convenience sampling approach was adopted in the determination of the study group. In this way, the data of a total of 482 participants who voluntarily consented to participate in the research were used. The distribution of the study group in terms of the variables discussed in the study is shown in Table 1.

Table 1. Distribution of descriptive characteristics of the study group

	N	%		N	%
Gender			*Department*		
Male	109	23	German Education	4	1
Female	373	77	Computer and Instruc. Tech Edu.	2	<1
Presence of chronic disease			Philosophy Education	1	<1
Exit	41	9	Science Education	57	12
Non-exit	441	91	English Education	5	1
Presence of chronic disease in Family			Mathematics Education	38	8
Exist	197	41	Music Education	2	<1
Non-exist	285	59	Preschool Education	126	26
Grade			Special Education	21	4
1. year	171	35	Guidance and Psychological Counselling	33	7
2. year	133	28	Art Education	5	1
3. yeas	108	22	Classroom Education	135	28
4. year	70	15	Social Studies Education	26	5
Total	482	100	Turkish Education	27	6

When Table 1 is examined, it is seen that the study group of the research consists of 77% female students. The ages of the participants in the study group ranged from 18 to 42, with an average age of 21. Participants aged between 18 and 25 make up 96% of the entire group. The participants consisted of pre-service teachers studying in 14 different departments of Education Faculties in different state universities, and participants from all grade levels took part in the research. The presence of chronic diseases in the families of the pre-service teachers in the study group is distributed in close ratio. The rate of those with chronic diseases in the family was determined as 41%. The rate of having a chronic disease among the participants is 9%.

Data Collection

In the study, 'Turkey Health Literacy Scale-32 (THLS-32)' was used to determine the health literacy levels of pre-service teachers. In addition, the personal information form created by the researchers was used to examine the demographic characteristics of the students. The "Turkey Health Literacy Scale-32" was developed in 2016 by a research team consisting of the Ministry of Health, (General Directorate of Health Promotion, Department of Health Promotion) and Adnan Menderes University, Faculty of Medicine, Department of Public Health (Okyay & Abacıgil, 2016). While developing THLS-32, the conceptual framework developed for the European Health Literacy Survey was taken as reference, and it was revised by adapting Turkey's social characteristics, the health level of the society and the structure of the health system (Sağlık Bakanlığı (Ministry of Health), 2018). THLS-32 consists of a 2x4-matrix structure with 32 statements and is a 5-point Likert type scale. Accordingly, the matrix consists of eight components: two dimensions (health care; disease prevention and health promotion) and four processes (accessing health-related information; understanding health-related information; evaluating health-related information; using/application of health-related information). In the evaluation of the scale, indices were standardized to be between 0 and 50, with a score of (0-25): inadequate health literacy; (>25-33) score: problematic – limited health literacy; (>33-42) score: adequate health literacy, (>42-50) score: excellent health literacy. The reliability of the scale was examined with internal consistency (Cronbach's Alpha) and the general internal consistency coefficient; It has been reported as 0.927 (Okyay & Abacıgil, 2016). In this study, the findings related to the reliability of the THLS-32 scale are presented in Table 2.

Table 2. THLS-32 reliability results

Estimate	McDonald's ω	Cronbach's α	N	Mean	Std. Dev.	Min.	Max
Point estimate	0.914	0.913	482	89.892	14.827	39.000	128.000
95% CI lowerbound	0.900	0.901					
95% CI upperbound	0.925	0.923					

It was determined that the THLS-32 scale used in the study had sufficient internal consistency and structural reliability for the research sample (Revelle & Zinbarg, 2009; Yurdugül, 2006). Research data were collected online in a single session using MS Office Forms. The study was carried out with the consent of the Aksaray University Human Research Ethics Committee and voluntary consent of the participants, and institutional or personal information was not collected.

Data Analysis

The data obtained to seek answers to the research questions were prepared for analysis. First, outlier analysis was performed on the data set. In this context, boxplot graphics were examined with the SPSS 22.0 program, the determined outliers were also examined from the forms, and it was decided to use 482 participant data by removing 26 of 508 data. The normality assumption was examined with kurtosis and skewness values and examined with Kolmogorov-Smirnov test before each analysis. In addition, normality assumptions were tested by examining the histogram and Q-Q plots. Parametric tests were used in the analysis of the research questions since there were no outliers and the normality assumptions were met ($p>0.05$). In the analysis of the data, firstly, percentage and frequency values were used to determine the distributions according to demographic information and health literacy levels. The significance of the differences between the health literacy scores according to the factors within the scope of the research questions was tested by analysis of variance.

Results

Descriptive Results on Health Literacy Levels of Pre-service Teachers

Distribution and descriptive statistics of pre-service teachers' scores obtained with the THLS-32 scale according to health literacy indices were determined. In Table 3, the number, and percentages of participants according to four different levels of health literacy indices calculated for the matrix components of the THLS-32 scale are presented.

Table 3. Distribution of pre-service teachers' health literacy levels

	Health Literacy Level							
	Excellent		Adequate		Limited		Inadequate	
	n	%	n	%	n	%	n	%
General	34	7	120	25	211	44	117	24
Health Care	42	9	159	33	166	34	115	24
Accessing Health-Related Information	76	16	257	53	67	14	82	17
Understanding Health-Related Information	51	11	248	51	58	12	125	26
Evaluating Health-Related Information	16	3	124	26	79	16	263	55
Using Health-Related Information	89	18	250	52	66	14	77	16
Disease Prevention and Health Promotion	34	7	124	26	170	35	154	32
Accessing Health-Related Information	47	10	229	48	79	16	127	26
Understanding Health-Related Information	52	11	217	45	102	21	111	23
Evaluating Health-Related Information	31	6	163	34	72	15	216	45
Using Health-Related Information	25	5	132	27	67	14	258	54

According to the health literacy indices calculated within the framework of THLS-32 general scores, it is seen that pre-service teachers have limited levels of health literacy at a rate of 44% and inadequate levels of health literacy at a rate of 24%. The rate of those whose health literacy levels are adequate and excellent is 32%. It is observed that these rates are similar for the sub-dimensions of 'health care' and 'disease prevention and health promotion'. Based on the THLS-32 scores of the pre-service teachers in the research group, the highest rate of inadequate health literacy is 55%, with the process of 'evaluating health-related information' in the 'health care' dimension.

The 'using health-related information' process in the dimension of 'disease prevention and health promotion' with a rate of 54% follows this. In the same dimension, the 'evaluating health-related information' component is 45%. These findings show the prominent dimensions of health literacy that pre-service teachers are inadequate. The proportion of pre-service teachers who are inadequate in the remaining dimensions of THLS-32 is below 32 %. The mean and standard deviation scores of the pre-service teachers for the THLS-32 matrix components are given in Table 4.

Table 4. Descriptive statistics of pre-service teachers' health literacy scores

	Mean	Standard Deviation	N	Health Literacy Level
General	30,15	7,72	482	Limited
Health Care	29,64	12,17	482	Limited
Accessing Health-Related Information	34,40	9,01	482	Adequate
Understanding Health-Related Information	32,06	9,51	482	Limited
Evaluating Health-Related Information	24,79	10,78	482	Inadequate
Using Health-Related Information	34,98	9,25	482	Adequate
Disease Prevention and Health Promotion	28,75	9,31	482	Limited
Accessing Health-Related Information	30,74	11,01	482	Limited
Understanding Health-Related Information	31,36	10,10	482	Limited
Evaluating Health-Related Information	27,24	11,24	482	Limited
Using Health-Related Information	25,65	11,28	482	Limited

When Table 4 is examined, it is seen that the average scores vary between 24.79 and 34.98. It is seen that the index mean scores for the health literacy matrix components are rather limited. While the level of health literacy is inadequate in the 'health care' dimension in the 'evaluating of health-related information' process, it is seen that it is adequate in the 'accessing health-related information' and 'using health-related information' processes. It is seen that the mean of the 'disease prevention and health promotion' dimension and its sub-components vary between 25.65 and 31.36, that is, the pre-service teachers have a limited level of health literacy for this dimension.

Examining the Health Literacy Levels of Pre-service Teachers According to Various Variables

Health Literacy of Pre-service Teachers by Department

The general health literacy levels of the pre-service teachers in the study were examined according to the department they studied, and their distribution is presented in Table 5.

Table 5. Distribution of health literacy of pre-service teachers according to the department

Department	Mean	Standard Deviation	N	Health Literacy Level
Science Education	29,22	7,82	57	Limited
Mathematics Education	27,25	7,16	38	Limited
Preschool Education	30,32	6,44	126	Limited
Special Education	26,54	8,84	21	Limited
Guidance and Psychological Counselling	32,56	7,11	33	Limited
Classroom Education	30,48	7,68	135	Limited
Social Studies Education	32,09	10,25	26	Limited
Turkish Education	30,96	6,56	27	Limited
others	31,36	11,45	19	Limited
Total	30,15	7,72	482	Limited

In Table 5, it is seen that the general health literacy mean scores of the pre-service teachers vary between 26.54 and 32.56 according to the departments they study. These results show that pre-service teachers have a limited level of health literacy, regardless of the department they study. When the difference between the health literacy scores of the pre-service teachers according to the departments was analyzed by one-way analysis of variance, it was seen that the difference was statistically significant *($F_{(8;473)}=2.484$; $p=0.012$).* The post hoc test regarding the source of these differences was made with Tukey and Tamhane tests according to the results of the Levene test, and there were differences in favor of some departments in various sub-dimensions and processes. For example, in the 'health care' sub-dimension, there was a significant difference between mathematics teaching and preschool and classroom teaching departments in favor of preschool and classroom teaching departments *($p<0.05$).* However, when the effect size values of the differences are examined, it is understood that they do not have a significant effect. As a result, it has been determined that general health literacy is at a limited level in all departments.

Health Literacy of Pre-service Teachers by Grade Level

General health literacy levels of pre-service teachers were examined according to their grade level and their distribution is presented in Table 6.

Table 6. Distribution of general health literacy of pre-service teachers by grade level

Grade	Mean	Standard Deviation	N	Health Literacy Level
1	29,37	5,75	171	Limited
2	30,85	7,86	133	Limited
3	30,98	9,23	108	Limited
4	29,46	8,95	70	Limited
Total	30,15	7,72	482	Limited

As can be seen in Table 6, the average health literacy scores of pre-service teachers according to their grade levels vary between 29.37 and 30.98. These results show that pre-service teachers at all grade levels have limited health literacy. When the difference between the health literacy scores of pre-service teachers according to grade levels was analyzed with one-way analysis of variance, it was seen that the difference was not statistically significant *($F_{(3;478)}=1.556$; $p=0.199$).*

Health Literacy of Pre-service Teachers by Gender

General health literacy levels of pre-service teachers were examined according to gender, and the results are presented in Table 7.

Table 7. General health literacy levels of pre-service teachers by gender

Gender	Mean	Standard Deviation	N	Health Literacy Level
Female	30,34	7,71	373	Limited
Male	29,50	7,78	109	Limited
Total	30,15	7,72	482	Limited

When the values related to general health literacy by gender are examined, it is seen in Table 7 that female students have a higher mean score than male students. When the statistical significance of the difference between the mean general health literacy scores of female and male students was examined by one-way analysis of variance, it was seen that the difference was not significant *($F_{(1;481)}=1.016$; $p=0.314$).* In addition to this result, it was determined that the health literacy levels of both female and male students were limited.

Health Literacy of Pre-service Teachers by Chronic Disease Status

The index scores of all the components of health literacy of the pre-service teachers were calculated according to whether they had any chronic disease, and the statistical significance of the differences between them was examined. The results are shown in Table 8.

When the values in Table 8 are examined, it is seen that pre-service teachers with chronic diseases have a higher mean score than pre-service teachers without chronic disease in all processes. When the differences were examined whether they were statistically significant or not, it was seen that the difference was significant in favor of pre-service teachers with chronic diseases in the process of 'evaluating of health-related information' in the 'health care' dimension *($F_{(1;\ 480)}=3,864$ $p=0.050$).*

Table 8. Health literacy levels of pre-service teachers according to their chronic disease

	Exist			Non-exist		
	Mean	N	Std. Deviation	Mean	N	Std. Deviation
General	31,95	41	8,23	29,99	441	7,66
Health Care	29,70	41	12,78	29,63	441	12,12
Accessing Health-Related Information	35,98	41	9,44	34,25	441	8,97
Understanding Health-Related Information	34,04	41	9,12	31,88	441	9,54
Evaluating Health-Related Information*	27,95	41	10,91	24,50	441	10,73
Using Health-Related Information	36,08	41	9,62	34,87	441	9,22
Disease Prevention and Health Promotion	30,39	41	9,91	28,60	441	9,25
Accessing Health-Related Information	32,42	41	12,52	30,58	441	10,87
Understanding Health-Related Information	32,72	41	10,02	31,24	441	10,11
Evaluating Health-Related Information	29,57	41	11,37	27,02	441	11,21
Using Health-Related Information	26,83	41	11,34	25,54	441	11,28

*:p<0.050

Table 9. Health literacy levels of pre-service teachers according to their family history of chronic disease

	Exist			Non-exist		
	Mean	N	Std. Deviation	Mean	N	Std. Deviation
General	30,86	197	8,05	29,66	285	7,46
Health Care	29,47	197	11,88	29,75	285	12,38
Accessing Health-Related Information	34,88	197	9,54	34,06	285	8,63
Understanding Health-Related Information	32,93	197	9,93	31,46	285	9,19
Evaluating Health-Related Information	25,06	197	11,17	24,61	285	10,51
Using Health-Related Information	35,68	197	10,05	34,49	285	8,65
Disease Prevention and Health Promotion	29,58	197	9,11	28,17	285	9,42
Accessing Health-Related Information*	32,09	197	10,02	29,81	285	11,58
Understanding Health-Related Information*	32,72	197	9,67	30,42	285	10,30
Evaluating Health-Related Information	27,75	197	11,13	26,89	285	11,32
Using Health-Related Information	25,78	197	11,25	25,56	285	11,31

*:p<0.050

Health Literacy of Pre-service Teachers According to the Status of Chronic Disease in the Family

The index scores were calculated according to the THLS-32 general and sub-dimensions of health literacy according to the presence of chronic disease in the family of the pre-service teachers and the statistical significance of the differences between them were examined. The results are presented in Table 9. When the health literacy scores of the pre-service teachers were examined according to the presence of chronic disease in their families, in the dimension of 'disease prevention and health promotion', 'accessing health-related information' *($F_{(1; 480)}=5.013, p=0.026$)* and 'understanding health-related information' *($F_{(1; 480)}=6.083, p=0.014$),* the differences were found to be significant in favor of those with a family history of chronic disease.

Conclusion, Discussion and Recommendations

In the study examining the health literacy levels of pre-service teachers, 482 pre-service teachers studying in 14 different departments of education faculties took part and it was determined that the general health literacy of pre-service teachers was mostly at a limited level (44%). While only 7% of pre-service teachers have an excellent level of health literacy, 25% have an adequate level of health literacy, and 24% have an inadequate level of health literacy. These results show that only one third (32%) of the research group has adequate and excellent health literacy, while two thirds (68%) have inadequate and limited health literacy. Similarly, the values obtained from the 'Health Literacy Survey in Turkey' conducted with the adult group over the age of 18 in 2014; inadequate health literacy 24.5%; limited health literacy 40.1%; adequate health literacy 27.8%; excellent health literacy was reported as 7.6% (Durusu Tanrıöver et al., 2014). In the report titled "Investigation of Health Literacy and Related Factors in Turkey" published by the Ministry of Health in 2018, individuals with limited and inadequate general health literacy levels were found to be 69%, and individuals with adequate and excellent levels were found to be quite similar at 31% (Sağlık Bakanlığı (Ministry of Health), 2018). As a result of the 'European Health Literacy Project' carried out in 8 member countries of the European Union, the rate of excellent health literacy was 17%, adequate level 36%, limited level 35%, and inadequate level 12% (HLS-EU Consortium, 2012). As a result of a study measuring the health literacy of American adults, the health literacy levels of individuals in the 19-24 age group were: 11% adequate; 58% moderate; 21% basic; It is stated as 10% subbase (Kutner et al., 2006). The proportion of individuals with sufficient health literacy levels in Australia is 40%, and 28% in China (ACSQHC, 2015; Shi et al., 2020). Accordingly, it is understood that the results obtained in the study are in parallel with the results of large-scale health literacy research conducted in Turkey, and the distribution according to health literacy levels differs from European countries, Australia, and America. It is thought that these differences arise from the differences between the development levels of the countries, the health policies they follow, the health services they offer and the education programs they conduct. However, health literacy is not at the desired level in the USA, Australia, and European countries, and accordingly, countries are looking for solutions to improve health literacy and they have created national action plans (ACSQHC, 2015; US Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2010).

When evaluated health literacy in terms of index scores, the average of the general index scores in this study was determined as 30.15. According to this result, it is possible to state that the health literacy levels of pre-service teachers are limited (Okyay & Abacıgil, 2016, p.36). As a result of the “Turkey Health Literacy Survey”, Turkey's general health literacy index was found to be 30.4 (Durusu Tanrıöver et al., 2014). In the 'Reliability and Validity Study of Turkish Health Literacy Scales', another report published by the Ministry of Health in 2016, the general index score average of individuals aged 15-24 was 32.0; The average of individuals with a university or higher education level is stated as 32.6 (Okyay & Abacıgil, 2016). In the 'European Health Literacy Project' report, the average general health literacy index scores were reported as 33.8 (HLS-EU Consortium, 2012). According to these values, the results obtained in the research show that the health literacy of pre-service teachers reflects the average of Turkey but is below the average of European countries.

When the pre-service teachers' index scores of the health literacy sub-dimensions and processes were evaluated, the mean scores of the pre-service teachers in the processes of 'accessing health-related information' and 'using health-related information' in the 'health care' sub-dimension were 34.40; 34.98 (>33) was determined. Accordingly, it is understood that pre-service teachers have a sufficient level of health literacy in these two processes. In the same dimension, since the index score average is 24.79 (<25) in the 'evaluating health-related information' process, it can be stated that the pre-service teachers are inadequate in this process. In all other processes related to health literacy, pre-service teachers were found to have a limited level of health literacy. Similarly, it has been reported by the Ministry of Health in 2016, the highest scores in the 'health care' dimension in the 'accessing health-related information' (31.1) and 'using health-related information' (33.5)

processes, the lowest scores in the 'evaluating health-related information' (26.2) processes (Okyay & Abacıgil, 2016, p.56). As a result of a study conducted in the Netherlands, it was reported that the highest average score among health literacy dimensions was observed during the process of understanding health-related information, and the lowest average score was observed in the applying health-related information (van der Heide et al., 2013). As a result of another study examining the health literacy of teacher candidates, it was seen that higher scores were obtained in the dimensions of accessing health information and understanding health information, while the lowest average scores were reported in the dimensions of evaluating health information and applying health information (Ahmadi & Montazeri, 2019). In this research the process of 'accessing health-related information' in the 'health care' dimension, in which pre-service teachers have adequate health literacy, includes skills such as searching and finding information about disease symptoms and treatment which three different categories defined by Nutbeam (2000) correspond to functional health literacy, which is the basic level of health literacy. The process of 'using health-related information' of 'health care' dimension, in which pre-service teachers' health literacy is at an adequate level; It requires behaviors such as making an appointment with a health institution by phone or the internet, calling an ambulance when necessary, using medications as recommended by health professionals, and it also overlaps with basic/functional health literacy in Nutbeam's classification. The process in which pre-service teachers' health literacy levels were found to be inadequate was 'evaluating health-related information' in the 'health care' dimension. The skills required in this process are high-level and have been defined as a level that Nutbeam classifies as critical health literacy and requires critical analysis of information by using advanced cognitive and social skills together (Nutbeam, 2000; 2015). As a result, it can be concluded that pre-service teachers have limited health literacy in most of the processes, the health literacy processes that they are adequate include basic level knowledge and skills, and the process in which they are inadequate includes high-level skills. These results show that pre-service teachers have basic knowledge and skills, though limited, about health literacy, they have deficiencies in advanced high-level cognitive and social skills, and they need to be strengthened in these subjects.

When the health literacy levels of the pre-service teachers were examined according to their departments and grade levels, it was seen that they were at a limited level in all departments and all grade levels. In the comparisons made based on department and grade level, it was understood that there were no significant differences, and this result was significant when the health-related courses in the teaching programs were considered. When the curricula of the teaching programs are examined, only the pre-school teaching department has 'child health and first aid', which is a compulsory course at the 1st grade level. Health-related topics in the content of this course are within the framework of child health, physical development of children, pediatric diseases and vaccines and are not related to the necessary acquisitions related to health literacy. When the teacher training programs in our country are examined, it is seen that 'nutrition and health' course is included as a general culture elective course in their curriculum, and the subject of healthy life is included in the content of this course (YÖK (Council of Higher Education), 2018). This course can be chosen at the 2nd, 3rd, or 4th grade levels. However, the subject content of the course does not cover the knowledge and skills related to health literacy. As a natural consequence of the lack of teaching about accessing, understanding, and using health-related information in teacher-training programs, the health literacy of pre-service teachers is limited regardless of department and grade level. As a result of another study on the health literacy of pre-service teachers, it was determined that there was no difference between health literacy levels according to the branch (Demirtaş, 2019). Considering the health literacy levels of pre-service teachers by gender, a limited level of health literacy was observed in both female and male students. It was understood that female students had a higher mean score than male students, however, there was no statistically significant difference between their health literacy levels. As a result of a study examining the health literacy of nursing students, no statistically significant difference was found between male and female students (Uysal & Yıldız, 2021). In a specialization thesis study involving medical faculty students, it was determined that the health literacy levels of female and male students were mostly at an adequate and excellent level, however, there was no significant difference when health literacy was compared according to gender (Tatar, 2020). Similarly, as a result of a study conducted throughout Turkey, no difference was found in terms of gender (Okyay & Abacıgil, 2016, p. 58). In the Turkey Health Survey report published in 2014, health literacy levels were also found to be limited without changing according to gender (Durusu Tanrıöver et al., 2014). In the 2018 report, it was stated that the difference in health literacy levels between women and men was found to be significant in favor of men (Sağlık Bakanlığı (Ministry of Health), 2018). As a result of the European Health Literacy Survey, a weak effect of gender on general health literacy was mentioned and it was stated that this effect originated from the Netherlands and Ireland. It was also shown that the correlation between gender and general health literacy was insignificant for Austria, Bulgaria, Greece, and Spain (HLS-EU Consortium, 2012). As a result of a study in which 85 studies conducted in the USA were systematically reviewed, it was reported that the level of health literacy was not related to gender (Paasche-Orlow et al., 2005). Although different levels of health literacy findings were reached depending on the characteristics of the study groups in the related studies, it was determined that health literacy did not change

depending on gender as a general result. Gender is a variable that is affected by social, cultural and geographical features and can be an effective variable depending on the scope and purpose of the research. However, due to the content and dimensions of health literacy, gender only has a biological meaning in this study and is not expected to have any effect in this sense.

In the study, an answer was sought to the question of whether the health literacy levels of pre-service teachers change depending on the presence of chronic disease in themselves or their families. If there is a chronic disease, it has been observed that there is a difference in health literacy. A similar result was also revealed in the study conducted by Bakan and Yıldız (2019). The authors determined that the mean THLS-32 score of individuals with relatives with poor health status was statistically significantly higher. However, there are also studies in which there is no difference in the health literacy of having a chronic disease or having a chronic disease in a relative (Muslu et al, 2017; Okuyan, 2019). As a result of this research, the health literacy of pre-service teachers who stated that they have a chronic disease was found to be higher in all processes related to health literacy than those who do not have a chronic disease. However, the process for which statistical significance was determined is the 'evaluating health-related information' process in the 'health care' dimension. The processes in which the difference was determined in favor of pre-service teachers with chronic diseases in their families are 'accessing health-related information' and 'understanding health-related information' in the 'disease prevention and health promotion' dimension. In a master's thesis study (Guven, 2017), in which the factors affecting health literacy are investigated, it is stated that there is a difference in health literacy in the presence of people with chronic diseases in themselves or the household. As a result of a study conducted in China, it has been reported that having one or more chronic diseases is associated with better knowledge of diseases, and that the health literacy of individuals improves after chronic illness (Liu et al., 2020). The results show that exposure to a health problem has an impact on the health literacy of individuals. As the reason for this situation, it is considered as a factor that people who are faced with a health problem have encountered situations that require the use of skills such as accessing, understanding, using, and evaluating health-related information.

When the results of the research are evaluated in general; the health literacy of pre-service teachers is not affected by their demographic characteristics and educational status, but it changes depending on whether they have a health-related problem. Here is an inference that can be reached; subjective experiences related to the health problem are effective on the level of health literacy. However, the goal of improving health literacy includes not only reducing the negative consequences of health problems but also preventing health-related problems. For this reason, it is expected that the level of health literacy will be high without experiencing any health problems.

Health literacy levels are found to be relatively high in studies conducted with people from health fields such as medicine and nursing, and it is seen that they are adequate. However, it is concluded that the level of health literacy is limited or inadequate in survey research targeting the general population. This shows that the high level of health literacy of individuals working or studying in the field of health is not sufficient to achieve the expected level in the social field. The necessity of the support of the education sector, which is the most important field in reaching all levels of society, comes to the fore at this point. The education system has been recognized as a central arena for improving children's health literacy (Paakkari & Paakkari, 2019). In addition, Nutbeam (2000) states that health literacy can be developed and improved with a well-organized health education. The necessity of health literacy education in schools is frequently emphasized by researchers, and in this direction, it is necessary to train teachers as professionals with a high level of health literacy. It is thought that making arrangements to improve health literacy in the curriculum of teacher training programs will directly contribute to a healthier life for both individuals and societies.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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