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Prof. Dr. Hulya GUR

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PREFACE

This book provides a detailed and up-to-date overview of works in education, science and mathematics education. This book is informative for especially educators, reseachers, academics, postgraduate students, preservive teachers, teachers and school leaders own development. It gives suggestions to educators, reseachers, academics, postgraduate students, preservive teachers, teachers, school leadersand policy makers and so on...

The book presents educational articles on various aspects, all of them centred on the area of Area of Education and Pandemia. The book consists of eleven chapters and 173+-page work.Thus, first paper – "*Opinions of the High School Students Regarding the Flipped Classroom Practice…*". The next work is "*The Content Analysis of Studies on Individual Differences in Education In Turkey From 2000 to 2020*". After that, the paper entitled *"Effectiveness of Remote Training with Covid-19 Pandemic Source*", Another study "*Investigatıon Of Awareness of Parents in the Pandemic Process and the Perspectives Related to Science and Education In This Process",* and other namely: "*Multiple Intelligence Theory and Effective Learning in Visual Arts Education"* , "*The Relationship Between the Views of The Preservice Mathematics Teachers on Proof and Their Multiple Intelligence…",* "*The Significance of Science Centers in Science Education…*", "*The Effect of Positivist And Post-Positivist Paradigms on The Change of Validity Conceptualization*", "*A Psychological Perspective on Organizational Loneliness…*" and "*Studies on Cognitive Load Theory in Turkey: A Literature Survey".*

December, 2020

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CHAPTER I

OPINIONS OF THE HIGH SCHOOL STUDENTS REGARDING THE FLIPPED CLASSROOM PRACTICE

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INTRODUCTION

The effects of technology which is rapidly becoming widespread and is developing today can also be seen in the field of education as it has affected many areas. With these effects, it has become inevitable for technology to enter the classroom environment. In addition, the learner has been taken to the center with the development of various learning approaches (Bolat, 2016). The only aim of education has become to equip the learner with multiple skills and talents such as learning collaboration, problem solving, creative and critical thinking, as well as accessing information (Gerstein, 2014). In the 21st century, teacher-centered classes as the information source have been replaced by innovative classes which are in cooperation with teacher-student (Singh, 2014). In this context, it has become a necessity to design learning-teaching environments and learning is aimed to be effective and permanent by the learning environments with educational technologies. When we look at the studies carried out in the field of educational technologies, it can be seen that different tools have been used in terms of technology in the practices performed in the classroom and various learning approaches have started to be used (Aydın, 2016; Bell, 2015; Farah, 2014; Yestrebsky, 2015).

Blended learning, which is one of these approaches, has emerged by blending the effective aspects of distance education and face-to-face education (Garrison & Kanuka, 2004) uses the advantage of these two learning environments (Unsal, 2007). In other words, it is the blending of the face-to-face education in the classroom environment and the education which students conducts with different online environments and tools outside the classroom and shape its place, time and speed according to their needs (Staker & Horn 2012). Thus, the learner benefits from the strengths of face-to-face education and technology-supported learning environment. In online environments, teaching can be performed asynchronously with materials such as video, audio recording, text or practices such as forum discussions or it can be carried out simultaneously with practices such as audio/video conferencing, instant messaging or distance learning

environments (Hew & Cheung, 2014). Blended learning increases the communication between teacher and student as classroom time is used more efficiently and actively and costs can be reduced (Stein & Graham, 2014).

Blended Learning Types:

Different classifications were made for the blended learning model. Rossett and Frazee (2006) discussed blended learning in three groups while Staker and Horn (2012) discussed it in four groups. The classification of Staker and Horn (2012) is presented in figure 1.

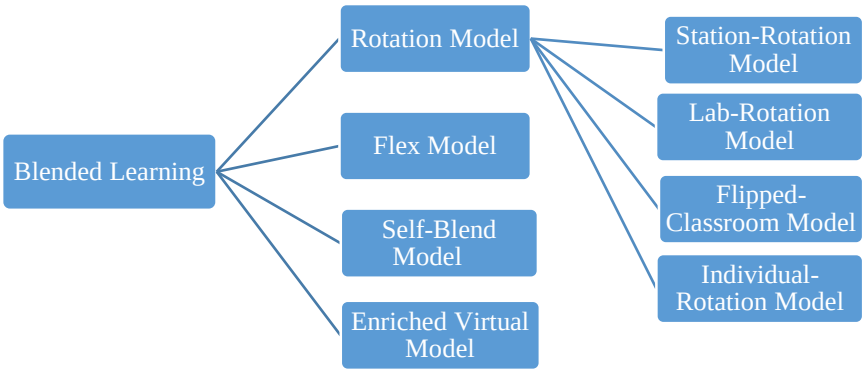

Figure 1. Blended Learning Types

In the rotation model, which is among the blended learning types, learner rotates between various learning environments according to the directions of the teacher (Staker & Horn, 2012). In this environment, which consists of different learning environments, at least one of the environments must be an online learning environment. Other learning environments can be project assignments, face-to-face learning or group work. Flipped-classroom model, which is one of the subheadings of the rotation model, is model that blends the advantages of technology-enriched online environments and face-to-face education.

Flipped classroom model

The flipped classroom model, unlike the traditional education, is a model that offers students the opportunity to learn theoretical knowledge outside of school on their own and apply it in the school (Zownorega, 2013). It is a learning-teaching model that provides teachers with the opportunity to make one-to-one communication with the students and meet their needs (Seaman & Gaines 2013). Another view is that the education system supports individual learning by providing the students with the information they want without time and space restrictions (Talbert, 2012).

The flipped classroom model was first used by the economics professors of the University of Miami, in the fields of law, psychology, philosophy, sociology and business due to the excessive reading homework (Lage, Platt, & Treglia, 2000). As Jonathan Bergman and Aaron Sams, who taught at Woodland High School, produced software to record their lecture presentations in 2007 and used it in the field of education by simultaneously recording lessons for students who could not attend the classes and publishing in the online environment, this situation attracted the attention of other teachers.

This practice has become widespread in a short period of time with over 3000 users when the academic staff of the University of Northern Colorado devoted their time in the classroom environment to practices and common work spaces and presented the course content through online and uploaded videos (Bergmann & Sams, 2012). According to Talbert (2012), the traditional method used in the past was not the best for students to learn and he stated that the students had to fulfil the responsibilities and duties given to them outside the classroom when they needed teacher assistance. Depending on this practice, the flipped classroom system takes students to the centre and provides a more effective education environment by activating the student in contrast to the traditional education system (Talbert, 2012). According to Toto and Nguyen (2009), flipped classroom system provides the learners with the opportunity to create their own knowledge and apply the theoretical knowledge that they have learned as it provides the opportunity to carry out a classroom discussion. In addition, when the flipped classroom system is reinforced with digital environment, the learners are given the opportunity to access information at any time and place while they receive education in remarkable and collaborative learning environments.

When digital environments are used considering the pedagogical features of the students, it provides a more effective education opportunity by increasing the level of efficiency compared to the traditional education system since it develops and customizes learning-education (Seaman & Gaines, 2013). It is important to integrate contemporary technology into the learning-teaching process as it contributes to the learning process with its positive aspects such as individual study, access to information resources, eliminating individual differences, the concept of time and space in learning and active communication with group members. In this context, there is an increase in teachers who use educational technologies and apply especially the flipped classroom model in their lessons today. Therefore, it is important to obtain the opinions of students regarding the flipped classroom model whose lessons are taught by applying this model. Determining the opinions of students about the flipped classroom application can guide the teachers who will apply this model. In this way,

it can contribute positively to students' achievements. With this study, it was aimed to determine the opinions of high school students about the flipped classroom practice. For this purpose, answers to the following questions were sought.

- What are the opinions regarding flipped classroom practice?
- What are the opinions regarding the effectiveness of the flipped classroom practice?
- What are the positive and negative aspects of the flipped classroom practice?
- What are the problems encountered in flipped classroom practice?
- What is the difference of flipped classroom practice compared to traditional classroom?
- What are the effects of the flipped classroom practice on learning?

METHOD

Research Design

In this research, which aims to determine the opinions of students about the flipped classroom practice, sequential transformative design which is one of the mixed model methods was used. The mixed model method is an approach that includes using quantitative and qualitative methods together. Using this model allows research questions to be understood more effectively than using both methods separately (Creswell & Clark, 2007). The mixed model method is divided into two as simultaneous and sequential design. Sequential designs are divided into sequential explanatory design, sequential exploratory design and sequential transformative design. In sequential transformative design, the collected qualitative data are analysed and supported after the quantitative data are analysed or vice versa (Creswell, 2003). In the quantitative part, the post-test single-group pre-experimental design, which is one of the quantitative research methods, was used. In post-test single-group pre-experimental design, independent variables are applied after applying to a group that is randomly selected (Metin, 2014). The qualitative research part was carried out by the descriptive analysis method. In descriptive analysis, the researchers can provide the readers with obtained findings as interpreted or summarised by giving direct quotations in order to reflect the views of the people they interviewed in the research (Yıldırım & Şimşek, 2016; Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2010).

Research Group

The study group of the research includes 78 students who are receiving education in the 11th grade of a female Vocational and Technical Anatolian High School located in Siirt province in the department of information technologies during the spring term of 2019-2020 academic year. In the study, simple random sampling method was used which is one of the probabilistic sampling methods since the differences in the input behaviours of the participants were not important in the selection of the study group in terms of the procedures applied in the process. In simple random sampling method, the probability of all units forming the research population to enter the sampling is equal (Büyüköztürk et al., 2010). Interviews were conducted with 16 volunteer students who participated in the post-test.

Data Collection Tools

As a quantitative data collection tool in the research, "Questionnaire for determining the opinions of students regarding flipped classrooms" developed by Akgün and Atıcı (2017) was used as data collection tool. The questionnaire, which was developed in line with the expert opinions by reviewing the literature, consists of 15 questions. The following procedures were applied in the interpretation of these questionnaire items coded as 5-point Likert type;

- For never ($1.00 \leq \overline{X} \leq 1.79$),
- For rarely ($1.80 \leq \overline{X} \leq 2.59$),
- For sometimes ($2.60 \leq \overline{X} \leq 3.39$),
- For often ($3.40 \leq \overline{X} \leq 4.19$),
- For always ($4.20 \leq \overline{X} \leq 5.00$)

As a qualitative data collection tool, semi-structured interview form was used. The form was presented to an expert working in the field of Turkish education and three experts working in the field of Computer Education and Instructional Technologies for their opinions in order to ensure the reliability and validity of the form, which consists of 10 questions. As a result of the suggestions of the experts, five questions were included in the semi-structured interview form. Both voice recorder and note taking method were used in the interviews.

Data analysis

Research data were collected from 78 female students who are receiving education in the 11th grade of a Vocational and Technical Anatolian High School located in Siirt province in the department of information technologies during the spring term of 2019-2020 academic

year on a volunteer basis. Data of the questionnaire applied to determine opinions of the students about the flipped classroom were analysed using the statistical package program (SPSS). In the analysis of the data of the questionnaire applied to determine opinions of the students about the flipped classroom, the average, percentage and frequency were examined. The analysis of the questionnaire for determining the opinions of students regarding flipped classrooms was carried out as item by item. In order to write the data of semi-structured interview form, Word was used which is a word processing program. These data were analysed using descriptive analysis method. In this analysis method, direct quotations reflecting the statements of the participants were given and interpreted. The students participating in the study were named as S1, S2.

Implementation Process

Before starting the implementation process for the units of database course given in 11th grade of the high school, a program was prepared to determine the requirements of content of each unit and weekly course materials and course videos were prepared by the researcher in accordance with this program within the scope of the research. The implementation process was carried out by the school teacher for a total of nine weeks. Educational platform (YouTube, Edmodo, Kahoot) environments were designed by the researcher to share the content prepared according to the course subject every week. An introduction was made regarding the use of educational platform environments designed before the implementation process and membership entries for the educational environments were provided to the students. Within the application process, the videos which were prepared previously related to the subject were uploaded to our YouTube channel and presented to the students to watch asynchronously and they were provided with access to the course materials shared in Edmodo. Students needed to watch the videos prepared about the lesson before coming to the lesson. Whether they watched the videos or not were tested through quizzes conducted with Kahoot. In addition, students were asked to make comments on the content through the YouTube channel. In the classroom environment, a discussion activity was held about the videos that they watched. At the end of the course, process evaluation was made according to the results of quizzes conducted with Kahoot. In the implementation process, smart board, computer, mobile phone, tablet and internet connection technologies were used. In addition, pilot study was conducted with undergraduate students for 3 weeks before the educational platform environments started to work and precautions were taken for possible difficulties. Information about the implementation process is presented in table 1.

Table 1. Information about the Implementation Process

<table>
<tr><th>Before the implementation</th><th>Contents of the implementation</th><th>After the implementation</th></tr>
<tr><td>Program preparation according to the content</td><td>Examination of the course content of the database course (purpose and scope). (Week 1)</td><td>Implementation of the data collection tools</td></tr>
<tr><td>Preparing course materials and lecture videos</td><td>Examination of the basic law of National Education and discussion in terms of information technology education. (Week 2)</td><td rowspan="8">Conducting interviews</td></tr>
<tr><td>Determination of the technologies used (Computer, Mobile phone, Tablet)</td><td>Examination of information technology teaching from modules. (Week 3)</td></tr>
<tr><td>Creating educational platform (YouTube, Edmodo, Kahoot) environments</td><td>Examining the general objectives of information technology teaching. (Week 4)</td></tr>
<tr><td>Enabling students to become members of the "Kahoot", "Edmodo" and "YouTube" course groups</td><td>Being able to use data processing language queries. (Week 5)
- Use of functions.
- Copying a row from another table
-Being able to use data processing language queries. (Week 6)</td></tr>
<tr><td>Preparing data collection tools</td><td>-Updating the data in the table.
-Deleting data from tables
Writing queries of the user. (Week 7)</td></tr>
<tr><td rowspan="3">Expert opinions on data collection tools</td><td>- Database management functions.
- Creating user profiles (Create User)</td></tr>
<tr><td>Writing queries of the user. (Week 8)
-Changes in user rights</td></tr>
<tr><td>Writing queries of the user. (Week 9)
-Deleting the user profiles</td></tr>
</table>

FINDINGS

This section includes the findings reached as a result of the analysis of the research. Findings related to the analysis of quantitative data are presented first and then findings related to the analysis of qualitative data

are presented. Opinions of students regarding flipped classroom practice are presented in table 2.

Table 2. Opinions of students regarding flipped classroom practice

Items	**Never**		**Rarely**		**Sometimes**		**Often**		**Always**		**Average**
	N	%	N	%	N	%	N	%	N	%	$\bar{X}$
1. Item	9	11.5	18	23.1	30	38.5	9	11.5	12	15.4	2,96
2. Item	3	3.8	9	11.5	6	7.7	15	19.2	45	57.7	4,15
3. Item	3	3.8	3	3.8	6	7.7	6	7.7	60	76.9	4,50
4. Item	3	3.8	6	7.7	12	15.4	21	26.9	36	46.2	4,03
5. Item	3	3.8	3	3.8	9	11.5	15	19.2	48	61.5	4,30
6. Item	60	76.9	9	11.5	3	3.8	3	3.8	3	3.8	1,46
7. Item	3	3.8	3	3.8	12	15.4	24	30.8	36	46.2	4,11
8. Item	3	3.8	3	3.8	9	11.5	21	26.9	42	53.8	4,23
9. Item	54	69.2	15	19.2	3	3.8	3	3.8	3	3.8	1,53
10. Item	3	3.8	3	3.8	6	7.7	12	15.4	54	69.2	4,42
11. Item	3	3.8	6	7.7	3	3.8	18	23.1	48	61.5	4,30
12. Item	3	3.8	3	3.8	9	11.5	21	26.9	42	53.8	4,23
13. Item	3	3.8	6	7.7	12	15.4	15	19.2	42	53.8	4,11
14. Item	3	3.8	3	3.8	15	19.2	18	23.1	39	50.0	4,11
15. Item	3	3.8	3	3.8	9	11.5	24	30.8	39	50.0	4,19

When table 2 is examined, it is seen that the students chose sometimes option for the expression “I asked more questions to my teacher with the flipped classroom application” ($\bar{x}$ = 2.96). 38.5% of the students stated that they had the same opinion. Accordingly, it can be said that the students help themselves to learn on their own with less need for their teachers' help. It is seen that the students chose often option for the expression “I communicated more with my teacher and my friends thanks to this application” ($\bar{X}$ = 4.15) and they often communicated. 76.9% of the students (19.2% often, 57.7% always) stated that they had the same opinion. In line with this result, it can be said that the students interacted more with teachers and friends in the classroom thanks to flipped classroom practice. When we look at the data regarding the expression “I

can better identify the subjects I do not understand with this application", it is seen that the students ($\bar{X}$ = 4.50) preferred always option. 84.6% of the students (7.7% often 76.9% always) stated that they had the same opinion. Accordingly, it can be said that students correct their deficiencies more easily with video, lecture notes and study questions. It was observed that students ($\bar{X}$ = 4.3) marked the often option regarding the expression "I remember better what I learned with the flipped classroom application". 73.1% of the students (26.9% often, 46.2% always) stated that they had the same opinion. According to this, it can be said that the students most of the time remember what they have learned better because flipped classroom application provides learning by practicing and experiencing.

The students ($\bar{X}$ = 4.30) stated that they always learned the subjects better regarding the expression ''since I can repeat the presentations and videos whenever I want, I have learned the subjects better''. 80.7% of the students (19.2% often, 61.5% always) stated that they had the same opinion. It can be said that this situation is due to the fact that the students have the opportunity to access the course topics in online environment at any time they want. It is seen that students ($\bar{X}$ = 1.46) preferred never option regarding the expression ''flipped classroom application is unnecessary and it does not have any benefit for the lesson". 76.9% of the students stated that they had the same opinion. It can be said that students consider the flipped classroom environment as necessary and it is beneficial and effective since it provides learning in the classroom environment. It is seen that students ($\bar{X}$ = 4.11) preferred often option for the statement "I followed the lesson better since I was able to access all the information and news about the unit from the website". 77% of the students (30.8% often, 46.2% always) stated that they had the same opinion. In this situation, it can be said that students can access the subjects more easily through their online environment. It is seen students ($\bar{X}$ = 4.23) stated that their successes always increased with this application regarding the expression "my success increased with flipped classroom application". 80.7% of the students (26.9% often, 53.8% always) stated that they had the same opinion. Accordingly, it can be said that the flipped classroom application has a positive effect on academic achievement.

It is seen that students ($\bar{X}$ = 1.53) preferred never option for the statement "flipped classroom application is time consuming". 69.2% of the students stated that they had the same opinion. In this situation, it can be said that flipped classroom application is usable in terms of time. It is seen that students ($\bar{X}$ = 4.42) preferred always option regarding the expression "I learned more permanently when I carried out the activities in the lesson after watching the videos on the internet". 84.6% of the students (15.4% often, 69.2% always) stated that they have the same opinion. In this situation, it can be said that the lesson videos used in the application

motivated the students. The students ($\bar{X}$ = 4.30) stated that they have always studied according to their own learning pace regarding the expression “I have studied on the internet according to my own learning pace with this application’’ 84.6% of the students (23.1% often, 19.5% always) stated that they has the same opinion. According to this, it can be said that flipped classroom practice provides students with opportunities according to their individual differences. It is observed that the students ($\bar{X}$ = 4.23) always participated in the lessons more actively related to the expression “I participated in the lessons more actively thanks to the flipped classroom application”. 80.7% of the students (26.9% often, 53.8% always) stated that they had the same opinion. In this situation, it can be said that flipped classroom practice makes students more active and effective in the lesson.

The students ($\bar{X}$ = 4.11) preferred often option regarding the expression "I learned the subjects in more detail with this application". 73% of the students (19.2% often, 53.8% always) stated that they had the same opinion. It can be said that flipped classroom application reinforces students’ learning the subject as the reason of this situation. Students ($\bar{X}$ = 4.11) chose often option for the expression “I did more research related to the subjects I learned thanks to the flipped classroom application”. 73.1% of the students (23.1% often, 50% always) stated that they had the same opinion. It can be said that the flipped classroom application provides a student-centered learning environment. It is seen that students ($\bar{X}$ = 4.19) chose the always option regarding the expression “I participated in the lesson more since I studied the subject in the flipped classroom application”. 80.8% of the students (30.8% often, 50% always) stated that they had the same opinion. According to this, it can be said that the flipped classroom practice will increase the participation in the lesson and in-class competition.

What are the opinions regarding the effectiveness of the flipped classroom practice?

As a result of the interviews, it was seen that all participants expressed a positive opinion about the effectiveness of the flipped classroom practice. Students stated that the lessons were more fun, they understood the subjects better, the practical activities were more memorable, lessons were more efficient and they were given the opportunity to repeat the subjects according to their own needs. Some students also said that their skills had improved. Some examples of opinions of the students are presented below.

> *S1: “Yes, the lesson was very enjoyable. Because, I can study the subjects whenever I want and easily complete my deficiencies with flipped classroom environment."*

S2: "This application was very effective and it was very fun. Because, I can understand the subject more quickly with the flipped classroom environment."

S3: "... I can better comprehend the lesson because activities suitable for both my visual and cognitive intelligence are abundant in the lesson."

S7: "... I had difficulty in distinguishing right and wrong information when I made a research on the internet in subjects I didn't know before and thanks to this environment, I can access lecture notes and study questions and easily apply what I learned."

What are the positive and negative aspects of the flipped classroom practice?

At the end of the interviews, students stated that this practice increased their interest in the courses, created a competitive environment, the practice was beneficial and students learned the subjects better, their motivations increased, students were more active in the lessons and they learned information more permanently as the positive aspects of the flipped classroom practice. When it comes to the negative aspect of the flipped classroom practice, students stated that this application is not suitable for some students and some students may experience difficulties in learning. Some examples of opinions of the students are presented below.

S3: "While I am in class, I can quickly answer the questions asked by my teacher because I have knowledge about the subjects and my motivation increases."

S4: "In this application, I was more interested in the lesson, I learned better."

S5 "This practice has been difficult for some of my friends. They do not learn the subject taught during the week if they are absent that week. Therefore, they may be less interested in the lesson."

S8: "... the positive aspect is that we discussed the subjects with our friends, our motivation increased."

S12: "... I can participate more actively in the lesson."

S14: "Some of my friends have different learning pace. So, it may not be suitable for everyone."

What are the problems encountered in flipped classroom practice?

As a result of the interviews conducted, it was stated that the students did not have any problems in general. Some of the problems that have been encountered have been found to stem from hardware and technical

problems or access to online learning environments. Some examples of opinions of the students are presented below.

S1: "When I login to Edmodo program, the videos do not open because the computer is frozen."

S6: "Some computers are not working due to the hardware problems of the computer."

S9: "I have difficulty in hearing the sound because the sound level in the videos is low."

What is the difference of flipped classroom practice compared to traditional classroom?

As a result of the interviews, the majority of students stated that the flipped classroom practice is more effective than the traditional classroom environment. When the flipped classroom application is compared to the traditional classroom environment, student stated that flipped classroom application was effective, more fun and permanent. In addition, they stated that it was easy to access resources, there was the possibility of repetition and there was no time limitation. Some examples of opinions of the students are presented below.

S4: "To me, the effects of the flipped classroom environment are more useful and I have the opportunity to open the way I want and whenever I want."

S7: "The flipped classroom environment is less tiring for us."

S13: "I am not bored in the flipped classroom environment."

S15: "Because of the complexity in the classroom in the traditional classroom environment, not all of the subjects can be finished on time but I can have the opportunity to repeat the subjects with the flipped classroom environment."

What are the effects of the flipped classroom practice on learning?

As a result of the interviews, all students stated that the effect of the flipped classroom practice on learning is positive. Students expressed that they learned better, the lessons became easier to understand, they learned more permanently, their participation in the lessons increased as well as their academic performance. Some examples of opinions of the students are presented below.

S5: "I have improved my success with these methods and practices."

S6: "I participated more in the lesson."

S9: "When the lessons were taught that way, I learned easily and the information I learned became permanent."

S13: "It affected me positively. With the study questions applied at the end of the lesson, the information became more permanent and I do not forget what I learn."

RESULTS

Discussion

In the flipped classroom practice, the teacher guides and directs the students rather than being the information source. The student is in a position to investigate and search. While most of the burden is on the teacher in traditional education, most of the burden is on the students in flipped classroom practice. In this context, the opinions of the students regarding the flipped classroom practice were examined and the results were tried to be explained.

In this study, it was concluded that the flipped classroom practice creates a positive effect on students, they identify the subjects they have difficulty in understanding and their deficiencies better, they remember the subjects better as the practice provides the opportunity to learn by doing or experiencing, the practice increases in-class competition so that students show more interest and participate in the lessons thanks to the flipped classroom application. When the literature is examined, some research results (Alsancak-Sırakaya 2015; Frydenberg, 2012; Hung, 2015) are seen to be in line with this result. In addition, it was concluded that students participated more in the lessons and learned better since they had the opportunity to access the lecture notes and videos before the lesson with the flipped classroom application. Similarly, students stated that the flipped classroom practice made the lessons more efficient as it provided students with the opportunity to prepare and gain prior knowledge about the subject before the lesson (Alsancak Sırakaya, 2017; Görü-Doğan, 2015; Stone, 2012).

It is seen that students ask more questions to their teachers with the flipped classroom environment application and communicate more with their teachers and friends in the classroom environment. This result of the study is similar to the results of the study conducted by (Bergmann & Sams, 2012; Alsancak, Sırakaya, 2017; Halili & Zainuddin, 2015). Students think that flipped classroom practice is not useless, time consuming and unnecessary. In addition, they think that they have a fun process without getting bored with this practice and thus their motivation and success increase. Similar results have been obtained in some studies (Alsancak Sırakaya, 2015, 2017; Boyraz, 2014). However, in the study conducted by Turan and Göktaş (2015) and Göğebakan Yıldız, Kıyıcı and

Altıntaş (2016), students stated that flipped classroom practice takes a lot of time and that is a disadvantage. Although the students thought that the flipped classroom application has a positive effect in general, some of the students stated that the flipped classroom application may not be suitable for everyone and some individuals may have difficulties in learning. In the study conducted by Alsancak and Sırakaya (2015, 2017), it was concluded that although the students liked the application, their anxiety towards the lesson did not decrease and it could not be suitable for every student.

Students stated that the flipped classroom practice is more effective than the traditional classroom environment. When the flipped classroom application is compared to the traditional classroom environment, student stated that flipped classroom application was effective, more fun and permanent. In addition, they stated that it was easy to access resources, there was the possibility of repetition and there was no time limitation. Karadeniz (2015) stated in his study that the flipped classroom method would have better results than the traditional method. Similarly, Frydenberg (2012) stated that the flipped classroom practice has been adopted more than the traditional class and should be adapted in different courses. When the literature is examined, the participants of the studies stated that they use time more efficiently with the flipped classroom environment (Mason, Shuman, & Cook, 2013-b; Lage & Platt, 2010; Herold, Lynch, Ramnath and Ramanathan, 2012).

CONCLUSION

When the results obtained in the study are summarized in general, it can be said that the opinions of the students towards the flipped classroom application are positive. In this context, it is anticipated that the use of flipped classroom practice in the learning-teaching process will yield positive results. In addition, it is thought that the flipped classroom practice can be effective for students to have an effective learning process and increase their academic success.

RECOMMENDATIONS

In the light of these results, suggestions regarding research and application are presented below.

- The effectiveness of the flipped classroom practice regarding classroom environment and classroom management can be investigated.
- Experimental research can be done related to the effectiveness of flipped classroom practice.
- Similar research can be carried out with different online learning environments and different sample groups.

- In order to further increase the effectiveness of the flipped classroom practice, the technical infrastructure needs to be improved and strengthened and the necessary facilities should be provided at the same time.
- It is recommended to apply a pilot study before starting a similar research.

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CHAPTER II

THE CONTENT ANALYSIS OF STUDIES ON INDIVIDUAL DIFFERENCES IN EDUCATION IN TURKEY FROM 2000 TO 2020

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1. INTRODUCTION

The wars and the pandemic that happened during the first part of the 20th century had various costly dimensions, one of which was the disruption of the educational process. The first step to recover was to stop the disruption and increase the quantity of education provided. The numerous scientific research findings were used to advance these studies and improve education quality as the second step. The assumption was that information and communication technology (ICT) would enhance the teaching and learning process quality and cease the teacher-oriented classrooms (Paul, 2002; Papert, 1987; Voogt & Pelgrum, 2005; Watson, 2001; Well-Strand, 1991). Therefore, there needed to be a synergy and coherence between education - learning and instructional theory, and science of computing disciplines. In other words, the improvements needed to be grounded in educational theories to identify the circumstances and the reasons for the employment of specific learning and teaching methods and educational technology and designed accordingly. Since education provides pedagogy and virtual didactics while computing science provides the platform for educational technology. Behaviorism, Cognitivism, and Constructivism were the major learning theories that were mostly used for sophisticated choice in learning, teaching, and educational technology in the 20th century. The primary concern in education was the organization and instruction presentation (Quey, C., Cheng, Y., Shibata, 2010). In 1954 Skinner started to experiment with "teaching machines" that made use of programmed learning. The aim was to computerize teaching to structure information,

test learners` knowledge, provide immediate feedback, and enable learners to have more control of their learning.

The teaching machine of the Behavioristic learning theory is described as the early version of computer-based learning. Computer-assisted instruction was used in Cognitive Learning theory to develop learners` creative thinking, problem-solving, and information analysis capabilities. Constructivism is described as "a theory of knowledge rotted in philosophy, psychology, and cybernetics." The main common feature of these learning theories was to fulfill the individual needs of the learners. Since the late 1990s, "21st-century skills" have been the catch-phrase in education to fill the needs and emphasize the uniqueness of learners (Quey et al., 2010). The assumption was that the rapid movement towards automation and an information-saturated world requires education to equip young generations with the necessary skills, abilities, and knowledge to thrive in an ever-changing world. Therefore, all the countries were redesigning their curricula per the 21st-century skills framework.

As the countries had just started implementing their curricula, life in the world changed dramatically as China informed the World Health Organization (WHO) of novel viral pneumonia on the last day of 2019 and the first death on January 11, 2020. Upon the alarming level of the COVID, 19 virus spread and severity (Wickramasinghe et al., 2020; Wong, 2020), WHO assessed it as a pandemic, and all educational institutions were closed just like it was done during the Spanish Flu. There was a sudden and unexpected transition to distance education all over the world. It was time to put these 21st-century skills to use. The studies have shown that none of the parties involved in education were fully equipped to cope with distance education (OECD, 2020). This could be due to the curriculum not being redesigned so that each learners` talents and individualities, as pointed out in the humanistic approach and digital humanism, are supported. It could be said that there was a transition, but the synergy and the coherence between education and digital technologies were not enough in terms of the measurable quality of education. Distance education requires learners to have network self-efficacy and self-directedness. Network self-efficacy is learners' perception of their readiness level to use the technology (Hung et al., 2010). Self-directedness is the realization of learners` responsibility to guide and direct their learning and take a more active role (Hartley & Bendixen, 2001; Hsu & Shiue, 2005). These can only be achieved if and when it is realized that education is made by individuals for the individuals and their differences matter and thus need to be supported (Palmer, 1997). The curricula need to support their differences and uniqueness. Our experience during the Covid has shown that the benchmarks and goals are needed, yet they should be

altered to fulfill learners' humanistic needs stemming from their differences.

Individuals differ psychologically, physically, and behaviorally and understanding the characteristics and reasons for these differences is studied by psychology. Educational psychology looks into the differences in learners in terms of intelligence, cognitive and affective development motivational level, self-regulation, self-concept, and their role in the learning process. These concepts form the description of education and learning today. Education is described as the individuals' activity of gaining knowledge, skills, habits, and attitudes. In other words, education is the process of bringing about the desired change in the behavior of an individual through his or her own lives in a planned and programmed way (Ertürk, 1972, p. 12; cited in Günay, 2015).

On the other hand, learning is described as the *change* in knowledge, attitude, and behavior resulting from an individual's own life (Saban, 2005). "Learning and *individual"* seem to be the primary keyword; however, the quality and extent of schooling or learning experiences that accommodate the individual needs can be quite tricky in this overpopulated world. It seems not easy to create a learning environment where learners` learning experiences are designed based on their characteristics. Especially with educational systems where a centralized curriculum is implemented, and transitions are based on standardized assessment. When that is the case, students are classified based on their intelligence and personal characteristics. The students are usually labeled as "hardworking, smart" or "lazy, slow-learner." The problem with such labels is that individual differences are masked by averaging or broad-classifications. However, individual differences are more-or-less, enduring psychological characteristics that distinguish individuals from each other and describe each person's individuality (Baumeister & Vohs, 2007).

The causes of individual differences are broadly described as *heretical, environment, race and nationality, gender, age, motivation, behavior, attitudes (Cook, 2008;* Cohen & Dörnyei, 2002). Among these causes, teachers can only control or impact motivation, behavior, and attitudes, in other words, on their executive functions (Dörnyei, 2001; Horwitz, 2001; Ehrman & Leaver, 2003; Anderson, 2005; Benson, 2007) since every individual has feelings of love, anger, fear and pleasure, and pain. An individual's stress management, empathy, awareness of others, and feelings are related to the concept of emotional intelligence. The executive functions, on the other hand, control and manage the implementation of targeted behavior; multiple cognitive processes such as focusing, planning, strategy development, emotion control, sustaining attention, cognitive flexibility, procrastination, time management, empathy, and decision making (Mesulam 2002; Stuss & Alexander, 2008;

cited in Ahçı, 2016), actively keeping the information in memory for processing and continuously update it with the new information obtained (Baddeley, 2000; Ahçı, 2016), and self-regulation (Barkley, 2011). The other two individual differences, which are naturally cognitive but open to external influences, are learning style and learning strategy. These two factors are often cited together in the literature. One of the reasons for this situation is that the students' strategies to overcome the problems they face during their learning processes must be in harmony with the learning styles (Cohen & Dörnyei, 2002; Dörnyei&Skehan, 2003; Oxford, 2001). Individual differences often explain differences in learning and performance among learners because the differences affect the learners` learning processes.

Education is the leading cause of individual differences and the main accommodator of the individualized curricula rather than one size fits all. Education can be as successful as it can be sensitive to differences between individuals. Focusing on similarities in education is economical, comfortable, yet focusing on differences is difficult and expensive. However, the richness of human nature diversity needs to be identified and accommodated (Kuzgun & Deryakulu, 2004, p.1, cited in Aktepe, 2005). The primary means to do so research since it addresses three broad questions: 1) developing an adequate descriptive taxonomy of how people differ; 2) applying differences in one situation to predict differences in other situations; and 3) testing theoretical explanations of the structure and dynamics of individual differences (Revelle, 2011). The answers to these broad questions will enable all parties involved in education to shift focus to the individual's nature and needs since the quality of education cannot be understood without examining what happens in the classroom.

To the best of the researchers, two studies reported data from the largest population. The first one was carried out by Schneider & Preckel (2017). They reviewed 38 meta-analysis studies that correlated 105 variables of *achievement* from 2 million students. The significant findings were a close relationship between achievement, social interaction in courses, and the stimulation of meaningful learning by clearly presenting information, relating it to the students and using conceptually demanding learning tasks. The study also reported that teachers with high-achieving students invest time and effort in designing their courses' microstructure, establishing clear learning goals, and employing feedback practices. It was also pointed out that high achieving students were characterized by high self-efficacy, high prior achievement and intelligence, conscientiousness, and the goal-directed use of learning strategies. The researchers also pointed out that there were limited controlled experiments and a lack of meta-analyses on recent educational innovations. The second study was carried out by Sackett, Lievens, Iddekinge, & Kuncel (2017). It reviewed

100 years of research on *individual differences and their measurement*. The study focused on three significant individual differences domains: (a) knowledge, skill, and ability, including both the cognitive and physical domains; (b) personality, including integrity, emotional intelligence, stable motivational attributes (e.g., achievement motivation, core self-evaluations), and creativity; and (c) vocational interests. The domain's evolution across the years and relationships between individual differences and variables such as job performance, job satisfaction, and career development were looked into. The researchers pointed out that trends in the literature include a growing focus on substantive issues rather than on the measurement of individual differences, a differentiation between constructs and measurement methods, and the use of innovative ways of assessing individual differences, such as simulations, other-reports, and implicit measures and hence needed to be further studied. In a study that aimed to develop and validate the inventory of child development and validation of the inventory of child individual differences via comparison of two Slavic countries, it was seen that culture-gender-age interaction had an impact on different patterns of personality development in boys and girls (Slobodskaya & Zupančič, 2010). Yeung (2018) reviewed the studies carried out in Hong Kong and found out that students' different psychological traits such as a natural liking for communicative learning activities, low confidence and anxiety, attitude, self-assessment, and gender were considered. It was also stated that these results shed light upon the quantitative (rate of learning) and qualitative (way of learning) individual differences and the dynamics of individual differences in different contexts.

This study is significant because it depicts the studies' inclination on individual differences in education in Turkey. Besides, the scarcity of content analysis studies about this field increases the relevance of this study. For example, it is seen that there was only a study that studied nation-wide individual differences in education via content analysis. The current study was conducted to contribute to this related literature. This study aims to carry out a content analysis of the studies on individual differences in education to determine the tendencies in this respect within this framework. The sub-research questions are as follows:

1) How did the studies' topics about individual differences in education in Turkey fluctuate over the 20 years?

2) How did the research and data collection methods in individual differences in education in Turkey fluctuate over the twenty years?

3) How did the data analysis methods in individual differences in education in Turkey fluctuate over the twenty years?

2. METHOD

2.1. Research Design

In this study, the content analysis method, one of the qualitative research methods, was used to analyze individual education differences. Qualitative research includes interviews, observation, personal experiences, life stories, historical documents, and visual texts (Swanson et al., 1999). Content analysis is a scientific approach that allows an objective and systematic examination of verbal, written, and other materials (Tavşancıl & Aslan, 2001; Büyüköztürk et al., 2018). Accordingly, content analysis refers to the systematic and impartial digitization of research data obtained with written or verbal expressions (Young and Schmid, 1968). At the core of this approach lies the categorization of what is written and spoken and counting how often they are (Hepkul, 2002); Thus, the existing data are summarized, standardized, and compared (Smith, 1991).

The primary purpose of content analysis is to reach the concepts and relationships that explain the collected data. The collected data should first be conceptualized and then arranged logically according to the emerging concepts, and the themes explaining the data should be identified (Yıldırım & Şimşek, 2006).

2.2. Sample

A purposive sampling method was used in sample selection. The purposive sampling method is a non-probability sampling method, and the researcher determines the sample according to the criteria determined by itself (Cohen, Manion & Morrison, 2000: 103). In this study, criterion sampling was chosen among purposive sampling methods. The researchers can create the criterion or criteria mentioned here, or a list of criteria can prepare beforehand (Yıldırım & Şimşek, 2006: 73).

2.3. Data Collection Process

Considering that sample selection is essential in ensuring validity and reliability, the documents were selected correctly and impartially, and they were provided with the needs of the subject area of the research. Wherever possible, the works of authors from different fields of expertise and cultures were examined. To determine the documents to be used in the study, the researcher determined the number of screening and selection criteria. After the criteria were determined, the researcher examined individual differences, learning, education, and content analysis resources. Theses and articles published in academic journals were used as documents. The articles were accessed using Istanbul Technical University Ratip Berker Library and Mustafa İnan Library database (http://www.itu.edu.tr), ProQuest database, and Social Sciences Citation

Index (SSCI). Dissertations and theses were written in Turkey's Higher Education Board / National Thesis Centre (https://tez.yok.gov.tr). The studies encountered were purposively chosen and saved on a Google Drive file so that researchers had proper access to the studies chosen. Within the study's scope, three doctoral dissertations, ten master theses, and 18 articles total of 31 pieces of research were gained from the databases. Each study was listed on a Microsoft Excel page and coded under the identified variables. For the study's validity and reliability, the researchers paid utmost importance to have consensus about finding variables, categories, and coding data correctly. After completing the data, the researchers examined the data to ensure that the data was coded appropriately. Also, two experts in the field of individual differences checked the codes, categories, and variables.

2.4 Data Analysis

As part of the data analysis, 11 variables were identified; (1) Publication type, (2) Language, (3) Publication years, (4) Research design, (5) Number of sources of data, (6) Data collection tools, (7) Sample, (8) Sample size, (9) Analysis type, (10) Area of study, and (11) Research findings. Each variable had some categories, and they can be seen in Table 1.

Table 1. Research variables and categories

Themes	Categories
Publication Type	• Master Thesis • Doctoral Dissertation • Article
Language	• Turkish • English
Publication Years	• 2001,2005, 2007,2008, 2009, 2010, 2011, 2012, 2013,2014,2015,2016, 2017, 2018, 2019
Research Design	• Quantitative Design • Qualitative Design • Mixed-Method Design • Quasi-Experimental
Data Collection Tools	• Survey • Survey & Academic achievement scores • Semi-structured interview • Review
Number of Sources of Data	• One Sources of Data • Two Sources of Data • Three or More Sources of Data

Sample	• Student • Teacher-Preservice Teacher • EFL Learners
Sample Size	• 0-30 • 31-50 • 51-100 • 101-250 • 251-500
Analysis Type	• Descriptive • Predictive • Qualitative
Area of Study	• Individual Differences in EFL • Individual Differences in Higher Education • Modeling the influence of individual differences • Individual differences from the preschool period to high school • Individual differences in the learning process • Individual differences reviews
Findings	• The negative relationship between individual differences and achievement and attitude in the learning process • The positive relationship between achievement and attitude in individual differences in the learning process • The positive effect of individual differences in teaching. • The negative attitudes about individual differences in classrooms • Teachers' anxiety to overlook individual differences in teaching. • The importance of individual differences in curriculum evaluation and teaching process • The determinative and positive effect of individual differences in EFL

As can be seen in Table 1, the subcategories of each variable were listed. The studies were examined, and the data were coded into the columns. After the coding and categorization were completed, the data were analyzed with Excel 2016 version, and clustered columns were used in the findings section to visualize the data.

3. FINDINGS

The findings of this study are presented under each of the sub-research questions.

3.1 How did the topics of the studies carried out about individual differences in education in Turkey fluctuate over the 20 years?

The final analysis framework consisted of the following research topic categories and subcategories:

1. **Prior knowledge -** readiness level of participants' to the learning processes and outcomes.

2. **Home background** - emotional support and stability, genetic and nurture components of intelligence, and the available educational and material resources.

3. **Motivation -** beliefs, attitudes, and behavioral change.

4. **Cognitive characteristics** – inhibition, attention, working memory, anxiety–stability, gender, wholist–analytic style, verbal–imagery style, and introversion–extraversion

5. **Metacognition** – planning, visualization, perception (and awareness), and self-evaluation.

6. **Instruction** – instructional approaches, characteristics of the tasks and difficulty level, availability of resources and their quality

7**. Learning climate** - Interactive learning environment and learning community

8. **Educational system** - curriculum content and its perceived relevance to the pupil, ethos of the institution

According to the findings, master theses, doctoral dissertations, and articles were included in the study's scope. Of the 31 studies, 18(58, 2 %) of them were an article, 10(32, 2 %) of them were master theses, and 3(9,6 %) of the doctoral dissertations.

Of the 31 studies, 23 (74 %) were Turkish, while 14 (26 %) were written in English.

The most frequently studied areas are individual differences in EFL and Individual differences in the learning process (n=8). Individual differences in higher education followed these studies (n= 6).

3.2 How did the research and data collection methods in individual differences in education in Turkey fluctuate over the twenty years?

In 31 studies that were investigated within the study's scope, there were four main research design models: Quantitative, qualitative, mixed research, and quasi-experimental design.

The most frequently used research designs were quantitative and qualitative research designs, with 13 studies for both. The mixed research design was used in three studies, and quasi-experimental research design was used in two studies.

The most frequently used data collection tool was the survey-academic achievement, which was used in 11 studies. The following data collection tool follows review research. Semi-structured interview and survey studies are listed with the latest seven studies.

The most frequently used sample type was students who continue their education at all levels (from preschool to university). In 18 of the studies, students were used as the sample. Then, EFL learners constituted seven samples of the studies. Lastly, teacher-preservice teachers were encountered in six studies.

The most frequently encountered sample size was 0-30. 11 of the studies were carried out with a sample size ranging between 0-30. There were six studies carried out with a sample size of 51-100 and 101-250. Four of the studies were carried out with 31-50 and 250-500 participants.

3.3 How did the data analysis methods in individual differences in education in Turkey fluctuate over the twenty years?

It is seen that the most studied analysis type was descriptive (n=15). Qualitative analysis (n=14) follows it. According to the investigated studies, only two predictive studies were conducted.

The research findings showed a positive relationship between individual differences and student achievement and attitudes (n = 10). A qualitative study conducted with students concluded that students have negative attitudes towards individual differences.

4. DISCUSSION, CONCLUSION, AND IMPLICATIONS

Individual differences such as age, culture, race, gender, attitude, motivation, self-regulation, personality traits, learning styles, learning pace, emotional intelligence, cognitive characteristics, and so on are determinants of learning. This study aimed to carry out a content analysis of the studies on individual differences in education and determine its tendencies. As a result of the examinations, research questions were identified based on 11 different variables: publication type, publication language, publication years, research design, number of data sources, data collection tools, sample, sample size, analysis type, area of study, and research findings. The findings were obtained by making a data analysis of

these variables. According to the findings of the study of the 31 studies, 18 of them were an article, 10 of them were master theses, and three of them doctoral dissertations. According to the findings, it is seen that doctoral studies on individual differences in education are limited. More studies of doctoral studies are necessary for us to see the quality of learning and student differences. According to the study's findings, of the 31 studies, 23 were Turkish, while 14 were written in English. According to the findings of the study, in 31 studies conducted on individual differences, it was found that there were five publications in 2019. The increase in the studies on individual differences in recent years is remarkable in understanding the subject's importance. According to the findings of the study, the most frequently used research designs were quantitative and qualitative. In the current research, the number of qualitative and quantitative researches showed an equal distribution in individual differences in education- 13 studies for both. However, Ilgaz (2018)" A Systematic Review of Online Learning Researches in the Context of Individual Differences" concluded that quantitative studies were examined more.

According to the findings of the research, it is seen that one data source is used, with 13 studies at most in the data source theme used. However, it may be more beneficial to study individual differences with more resources to investigate student differences. According to the study's findings, the most frequently used data collection tool was the survey-academic achievement used in 11 studies. According to the study's findings, the most frequently used sample type was students who continue their education at all levels (from preschool to university). In 18 of the studies, students were used as the sample. Studying individual differences at all levels of education may be related to the capacity to affect learning directly. Therefore, it is crucial to continue and increase studies on the subject.

According to the findings of the study, it can be seen that the most frequently encountered sample size was 0-30. Since the studies were examined, it was revealed that the sample size was no more than 500 participants; it could be said that studies with a higher group of participants are needed. According to the findings of the study, It is seen that the most studied analysis type is descriptive (n=15). According to the study's findings, the most frequently studied areas are EFL and the learning process, with a total number of eight studies. Student differences directly affect learning and student achievement both in the learning process and in foreign language teaching. According to the study's findings, the research findings showed a positive relationship between individual differences and student achievement and attitudes. Individual differences positively affect student achievement and attitude.

5. LIMITATIONS AND RECOMMENDATIONS

The studies examined in this research, doctoral theses, master theses, and the main subject of education and individual differences are limited to the sources and data reviews. In this sense, more comprehensive and detailed content analysis can be made for individual differences. In this sense, broader and more detailed content analysis could be made regarding individual differences. In the studies reviewed, the suggestions variable was not included in the current study since it was not available in every study and was not generalizable. It was revealed that the effects of individual differences in students' attitudes and achievements in the learning process have a positive meaning. This finding is important data for us to see the importance of the subject. Therefore, quantitative, qualitative, and mixed studies and quasi-experimental studies could be done in this field. The findings examined from the research results show that individuals have significant individual differences in learning characteristics. Traditional methods do not provide equal benefits for all individuals. Individual differences, quantity and quality problems in learning, the structure of teaching materials, the impossibility of having a mental knowledge level, and similar reasons require education according to the individual and his/her needs.

While designing the curriculum, it is necessary to arrange it according to the students' interests and needs, considering individual differences in each of the objectives, content, learning-teaching processes, and assessment elements. Embedded systems, coding education, and robotic applications should be included in the curricula, especially during the pandemic when distance education is discussed. Providing coding training at all educational levels can support the increase in individual training and individual productivity. Individualized and computer-aided software applications and curriculum designs should be made. In this context, it is necessary to develop digital literacy that will support individuals' self-regulation skills. It is a need to meet students' computer and tablet needs and strengthen internet connections in both school and family life. In-service or distance learning teleconferences should be organized to improve teachers' and students' knowledge, technology, and digital literacy.

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CHAPTER III

EFFECTIVENESS OF REMOTE TRAINING WITH COVID-19 PANDEMIC SOURCE

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1.INTRODUCTION

It is a fact that today's practices in the classroom to provide education at different levels have started to lose their quality as universal satisfying and effective practices. In this context, the importance of open and distance education applications aiming to provide various educational options and to create different learning environments for individuals with different interests, needs, individual abilities, ages, educational levels, geographical and economic conditions, or educational disabilities for any reason increases.

It is a concept where interactive media such as open and distance education, computer communication, audio, and video conferences are used and learning is defined as a social process. Open and distance education is a planned and formal education in which the educator and the student are generally at a distance, and communication can be realized with technologies.

The issue of how to implement open and distance education is important in this context. In the teaching practices conducted in open and distance education, it is necessary to emphasize the individual qualities of individuals and emphasize their advanced aspects. In the process of open and distance education, the use of educational media (computer, telephone, etc.) and the content of the courses are provided to the students with these tools to ensure that students and teachers are located in separate physical spaces and to communicate between the student and the teacher.

This education model, which is called open and distance education and has become widespread recently, has been preferred by many institutions and universities in our country. It is certain that this education system, which enables students and teachers to live in different places to communicate actively, to enter individual and collaborative educational environments independent of many variables, will become more and more

important in today's world with increasing new information and applications.

Learning and teaching processes in the open and distance education system are regulated depending on the environments used more. For this reason, the renewal of communication technologies and developments in this field affect the processes of creating and organizing educational experiences in the structuring and presentation of information, recognition of application opportunities, motivating students, and evaluating their achievements. As in all educational applications, interaction is the basis of learning-teaching processes in open and distance education applications.

Distance education is defined in different ways. Alkan (1987) defines distance education as a teaching method prepared for individuals who have been out of formal education for various reasons, interacting between those who carry out educational activities and learners, and specially prepared educational content is offered by a certain center with various environments. According to İşman (2011), distance education is defined as activities carried out using communication technologies and e-mail services in educational activities where the learner and the instructor are located in different environments. In the European Union Distance Education Operations Plan (Europa, 2005), the distance education system is defined as accessing resources, exchange of information and cooperation by using internet and multimedia technologies to improve the quality of educational activities.

The first phase of the work done for distance education in Turkey was carried out between the years 1926-1960. 1933-1934 between the years of correspondence conducted distance education studies and in 1950 Ankara University Faculty of Law, Banks, and Commercial Law Studies Research Institute is displayed as the first example of distance education applications in Turkey (Eğitek, 2005). In this sense, the first study carried out by the Ministry of National Education is letter-teaching studies carried out in 1961. The first distance education faculties in Turkey, in 1983, enacted opened in 2547 the number of Anadolu University with the Higher Education Act and in this way the TV Academy and radio lessons and to all individuals who wish to study via distance education was presented with educational opportunities.

The Internet-based distance education applications in Turkey for the first time in the 1996 Middle East Technical University (METU) were initiated under the leadership of the Informatics Institute.

It made all these trials, effective and sustainable can not be converted to a system of distance education in Turkey between the years 1960-1980 and shows distance education can not be institutionalized. However, with the implementation of the distance education model of Anadolu University Open Education Faculty, a system consisting of printed materials,

television and radio programs, and academic consultancy activities has been established. However, it is a fact that these activities are implemented at the higher education level.

Turkey in the first and in the teaching process at the secondary level educational potential of e-technology can not be utilized sufficiently provided (Özkul, 2004). However, the content of the education programs prepared in distance education applications are not based on a certain standard and prevents the sharing of content and student records between the programs (Gülnar, 2003; Düzakın & Yalçınkaya, 2008). Internet usage rate in Turkey is lower than in the EU countries (Düzakın and Yalçınkaya, 2008). The reasons for this include the monopolization of internet service companies, the problem of high prices, the scarcity of Turkish content sites that provide information and contribute to production. Due to the above-mentioned reasons, distance education practices at primary and secondary education levels could not be utilized effectively.

There are many types of research about the effects of distance education applications on student achievements (Yorgancı, 2015; Düzakın & Yalçınkaya, 2008; Kör, Çataloğlu & Erbay, 2013). Considering the results of the research conducted by Köre, Çataloğlu, and Erbay (2013); It has been concluded that students with distance education have higher academic success than those with formal education, but it is stated that whether this difference in success is affected by the social-economic situation, the demographic characteristics of the students or the content of the course may be the subject of another study. Düzakın and Yalçınkaya (2008) state that the distance education system is as effective as traditional education systems if the interaction between students and instructors who use the appropriate methods and techniques in e-content preparation and interaction with the students who constitute the components of distance education is provided. To improve student achievement and supporting both the motivation must be carried out in this context the application of distance education in primary and secondary education in Turkey is important.

As of March 23, distance education applications originating from the COVID pandemic in our country have been carried out by taking these interactions into account. In this context, the distance education model in formal education was initiated and pieces of training were provided through the Education Information Network (EBA) and TRT channels reached over the internet. Schools specific to distance education activities are also available through the sites of their schools and vitamins, eduforn etc. including using auxiliary resources. Besides, these activities supported by live lessons were applied to students with different social statuses and different cognitive levels. In this context, students can access video lessons from eba.gov.tr, students, teachers, and parents with passwords registered

in e-school can enter the platform. The system also offers customized learning environment and interface, student-specific calendar, support publications and resources, games, one-stop access to all course content, question and exam bank, teacher support. In this context, students are provided with access to social environments.

The study aims to determine the parents' views on the effectiveness of distance education applications carried out under the COVID 19 pandemic. In this context, 20 students are enrolled in private and public schools.

2.METHOD

In the research, an electronic questionnaire developed for the parents of the students was applied and a focus group interview was held with the parents via zoom. This research is in a relational screening model. General screening models are screening arrangements made on the whole universe or a group, sample or sample to reach a general judgment about the universe in a universe consisting of many elements. With general scanning models, single or relational scans can be done. Relational screening models are research models that aim to determine the presence and / or degree of co-exchange between two or more variables. These are generally correlation and comparison (Karasar, 2005).

In the research, a questionnaire consisting of 7 items was applied to get the opinions of parents about distance education applications. The first three items of the questionnaire consist of personal information, the 6th article consists of determining the level of satisfaction regarding distance education practices and the last item is the question of determining the suitability of the distance education activities for its purpose. In the focus group meeting, the opinions of parents about these activities were collected through a semi-structured form.

3.RESULTS

Research findings are included in this section. According to these findings, the data obtained from the focus group meeting are categorized and grouped as public and private schools and presented in Table 1.

Table1: Focus Group Interview Parent Interview Results

	State school	Private school
Subject Headings		
Physical Infrastructure and Hardware	K3: When opening videos via EBA, I see an overload due to everyone's desire to watch similar videos. I had difficulty adjusting the satellite settings	K5: We followed the lessons over their database with the password that our school gave us. Online exam application time could be

since I was not very interested in electronic works or computers on television. I had to get help from a neighbor.

K5: We did not have any problems with access, but there were occasional stops watching videos as I thought it was due to our internet network. This lowered my child's motivation considerably.

K9: We had a hard time finding videos and content that we had to watch over EBA. We couldn't watch much on TV.

K10: Our teacher did live lessons through zoom. In fact, it was very useful, but he announced that he could not continue his distance education activities in this way due to a license problem.

opened after 20 minutes, even for the exam, which was 1 course hour. Also, we had difficulties when connecting to PE many times while doing live lessons.

K7: The first day was very bad. However, in the following days, we followed the live lessons, and we were able to carry out the homework assignments over ancillary electronic resources such as morpa and edufurn.

K9: Although we sometimes have trouble connecting to live lessons, I did not encounter a problem that I can say that it is very difficult for the child to use this structure in normal time.

K10: Although we had three computers at home, we had difficulty following up. It may be difficult to follow the lessons for those who are not

		in good economic condition or have a computer at home.
Educational Content	K4: I think the educational content is prepared beautifully for those given from EBA. He/She enjoyed watching it and was able to answer the questions I asked after the program was completed. K8: In the lessons given on TV, I think the content is below our class. Although I am not a teacher, the gains given in the classes seemed both below the level and behind the ranking, we taught at school. Different applications could be considered for TV content.	K6: The content was satisfying, except for living lessons. I saw that time wasted until the group gathered in live classes. Besides, my child was given numerous electronic resources and numerous exam applications. The contents were rich and sufficient. K9: What more? The child did homework from morning to evening, solved the test, watched the video, there was only 1 error in the practice exam. So it is enough. K10: Since our school is already a member of all assistive electronic resources, and our teachers have reported how to use these resources every day, in what order and at what level, we had no trouble. The contents are patented and the content we use before moving on to distance education. We have no worries about this.

Measurement and Evaluation Activities	K9: I know we haven't had an exam yet. But we do the questions at the end of the videos and answer the questions on TV. K8: I think there are few applications regarding measurement and evaluation. I think it would be great if at least an electronic exam was held or performance and project assignments were collected through different programs from students.	K2: Everyday homework, everyday exam, everyday practice notebooks are tracked online and unit exams are done online or at the end of the video. Especially, there are reading, listening and patch exams in a foreign language. K7: I think there are enough exams.
Guidance services	K4: I was hesitant at first because it was decided to switch to distance education. Because there was no information in the school about how to follow. I wish a guide was printed and we were scattered. I had a hard time in the first week. K7: I had a hard time and I was very tired. I always got help from the parents of my daughter's friends in this regard. I wish we could get more help from the school.	K3: Our counselor and guidance counselor always followed the process. He/She informed us both via SMS and e-mail and called and told the phones every day. There was also a message for all of the assignments that my child didn't do or miss. K9: I think the school was fine in terms of guidance.
Productivity	K6: I think the application is good, of course. But it could have been better. Better	K5: I do not think that we will get so much money for distance education. Because

	results could be obtained if you were prepared before.	my child perceived this not as a school, but as an activity he/she met with his friends.
	K7: I think it's not successful. The boy/girl sat down on the TV or computer but I don't know how much he learned.	K8: I do not think it is cultivated and I will complete the shortcomings by taking private lessons when the school period is over.

When the data obtained from Table1 are examined, it is seen that parents have difficulties in physical education, such as structure or equipment in distance education and this is expressed more by the parents who are students of public school. Again, according to the results of the focus group interview, it is seen that parents are generally satisfied concerning their educational content, and parents who are students who go to public school in dying and evaluation practices find the practice inadequate. However, it is seen that the most obvious difference in the effectiveness of distance education between private and public schools is in guidance services. While all of the parents who are students in the private school stated that the guidance services were carried out by the school with activity and through many channels, it was observed that there was no such situation in public schools. It was observed that parents who have students in both schools stated that distance education was partly effective and that their children would need support regarding their deficiencies after this process.

When the data obtained from the questionnaire is analyzed, the answers of the parents regarding how they continue distance education are given in Table 2.

Table 2: Distribution of Parents' Opinions Regarding Which Vehicle The Distance Education Applications Are Continued

	State school	Private school
Eba Tv-TRT Tv	5	-
Education Information Network	10	-
Private School Database	-	10
Live Lessons	4	10
Other auxiliary education portals (Morpha, Vitamin etc.)	1	10

As can be seen from Table 2, it is seen that all parents who have students at the public school follow the lessons over the education informatics network, half of the study via TV or size TV, 4 use live lessons and only 1 watch lessons or videos from other auxiliary portals. However, it is seen that all parents of private schools follow the education and training activities offered by the school and do not benefit from EBA or TRT TV. The question posed in the focus group meeting on this issue, parents explained that their children are more advanced in lessons in the context of the unit and that the lessons given on TV are already known by the students. In this context, it is understood that the content of the lessons is given faster in private schools and therefore the content given in eba or trt tv is given in advance in the private schools that are more advanced in terms of the acquisition. In this context, parents with synchronization problems tend to other channels.

The responses of parents to the research, which asked the satisfaction levels of distance education, are presented in Table 3.

Table 3: Findings Related to Parents' Satisfaction with Distance Education Applications

Phrase	State schoo	Private schoo
Information on channels for distance education	20	30
Access to distance education channels	20	34
Planning the distance education process	16	36
Identification of distance education users	12	40
Managing distance education users	24	34
Guidance services for the troubles experienced with distance education applications	18	36
The nature of distance education contents	30	32
Duration of distance education contents	30	30
Distance education teaching processes	28	34
Diversity in distance education processes (method, technique, material or measurement diversity)	16	36
Measurement and evaluation applications	22	28
The self-confidence of the education process	28	33
Creating interactive communication environments	17	36
Realization of individual education for students	16	31
Exam applications for lessons	18	27
Solution skills for problems encountered in distance education	21	34
Physical infrastructure and equipment related to distance education	20	24

According to Table 3, where parents' satisfaction levels for distance education practices are given, the average satisfaction level of parents in distance schools is 32, 647, while the average satisfaction level in public schools is 20,941. When the table is examined, it is seen that the situations in which the parents who are students at the private school are most satisfied are the guidance service, the planning of the educational process and the creation of interactive communication environments; It is observed that the areas where the parents who are students at public school are most satisfied are the quality and duration of the educational content. It is thought that one of the main reasons for the high level of satisfaction of the

parents who teach students in the private school in the satisfaction scale is because the private schools are already using interactive communication environments and auxiliary electronic materials on a platform.

Finally, the parents were asked about their opinions on whether the distance education applications achieved their goals. In this context, 10% of parents who are students in public school respond to no, 20% yes and 70% respond partially, 50% of parents who are students in private school are no, 10% yes and 40% It is seen that they respond partially in the form of. It can be seen from this result that although the satisfaction level of the parents, who are students at the private school, is high, they are not happy about the education to reach their goals. In public schools, satisfaction is low compared to private schools, but the proportion of parents who think that implementation has reached its purpose is 90%.

4.DISCUSSION

When the research findings are analyzed, it is seen that the average satisfaction level of parents in private schools for distance education practices is 32, 647, while the average satisfaction level in public schools is 20,941. Considering the components of the difference between satisfaction levels, it is seen that parents who are students at private school are especially pleased with the guidance services offered by private schools. While it is seen that the parents who are students at the private school are most satisfied, guidance service, planning the education process and creating interactive communication environments; It is observed that the areas where the parents who are students at public school are most satisfied are the quality and duration of the educational content.

Educational content has a very important effect in distance education applications. Unless the training contents are developed to motivate the distance learning user, to provide mental performance and to see the results of what they do, the resulting products will not be more than electronic books. Content quality is one of the most important factors in the success and testing of distance education (Şahin, 2003). In this respect, strong educational content will increase student success and parent satisfaction towards distance education.

One of the areas where parents, who are students studying in private schools, are most satisfied with distance education is creating effective communication environments. In the study conducted by Chandani (2000), the necessity of enriching learning environments for successful education in distance education was emphasized and the importance of developing teaching materials by the teacher was emphasized to achieve this. For student-educator communication, which is the basic element of face-to-face education (formal education) to take part in distance education, new approaches should be used. İbicioğlu and Antalyalı (2005) list the factors

affecting the success of distance education in terms of the student's ability to access the computer at any time, motivation, level of perception and interaction related to distance education. It is seen that there is a positive relationship between the findings of this study and the parents' opinions.

Alakoç (2001), Willhelm (2003), Demirli (2002) and Turhan (2005) have also stated that the most important feature of distance education is that there is no time and space limitation. In this context, the planning of the distance education process has great importance as in private school parents. It is important for students to integrate the system within a plan, to perform their educational processes (live lessons, video, exam applications, etc.) in a certain order and to provide guidance services to the students in need during this process.

5.CONCLUSION

According to the results of this research, in this context, the distance education planning process in Turkey seems to be short and concluded that although overall successful realization. It is observed that especially the distance education activities that are implemented with a wide mass over different communication channels are monitored by parents and students. In this context, it is thought that increasing the activities of our Ministry in this regard, combining qualified distance education contents with planned and efficient guidance services and presenting them as auxiliary resources after the mentioned epidemic has passed will affect the educational processes positively.

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CHAPTER IV

INVESTIGATION OF AWARENESS OF PARENTS IN THE PANDEMIC PROCESS AND THE PERSPECTIVES RELATED TO SCIENCE AND EDUCATION IN THIS PROCESS*

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1. INTODUCTION

COVID-19, an infectious disease occurring globally and caused by the newly discovered coronavirus, affected millions of people worldwide and caused hundreds of thousands of people to die. The first cases began to be seen as of March 11, 2020, in Turkey and as of this date with the World Health Organization declaring the new coronavirus epidemic as a pandemic, more attention has been drawn to the epidemic. Since the first days of the COVID-19 pandemic, news with scientific content has been frequently discussed in a versatile way in the media. Since the first cases detected in Turkey Ministry of Health publishes daily koronovirüs table. The coranavirus table includes the total number of tests, cases, deaths, intensive care patients, intubated patients and recovering patients, and the number of daily tests, cases and deaths. Later, instead of intubated and intensive care patient data, serious patient data were used in the table and additionally, pneumonia rate was started to be given in patients. In addition to the total and daily data in the table, weekly data are also started to be shared. Weekly data is included pneumonia rate, bed occupancy rate, adult intensive care occupancy rate, ventilator occupancy rate, average contact detection time, and filiation rate. In the news as a society, etc. we are dealing with scientific concepts and data about coronovirus pandemic in mass media. In this process, the most common scientific concepts we encounter as a society; coronavirus, epidemic, pandemic, intubated patient, symptom, antibody tests, virus mutation, herd immunity, fillation, transmission coefficient, herd immunity (social immunity), negative

* This study was presented as an oral presentation at the 7th Internetional Eurasian Educational Research Congress Online congress held online in Eskişehir on 10-13 September 2020

pressure ventilation systems. The best measure that can be taken for COVID-19, which has a high human-to-human contagion and has no definitive treatment yet, would be to take the necessary precautions to avoid the disease. By increasing the awareness of the society in combating the pandemic, managing the process well will ensure that this process is overcome with the least damage and loss both in terms of education and socioeconomics.

Emphasizing the relationship between individual behavior and group risk, the COVID-19 pandemic is above all a Public Health issue (Mantzari, Rubin, & Marteau, 2020) and initially scientists and drug manufacturers focused on the production of vaccines or other drugs to mitigate the impact of COVID-19, which causes the pandemic for treatment. However, over time, it has been seen that the pandemic should be viewed not only as a Public Health issue but also from social, economic, political and educational perspectives.

The restrictions on the mobility caused by the social distance have seriously affected the businesses by reducing the economic supply and demand and also affected education to a great extent. In this process, students carried out their education and training processes through distance education. Mass education of all social strata of a country's entire population is critical to mitigating a pandemic (Lopes, & McKay, 2020). Differences in families' provision of educational opportunities to their children directly from home or privately, differences in the capacity of different types of schools to support learning, and differences in motivation and independent learning situations among students also greatly affect the success of distance education. For unintentional reasons, the COVID-19 pandemic will likely disrupt the education of a generation worldwide, and these disruptions will affect the livelihoods of individuals and communities (OECD, 2020). With the pandemic in the distance education process, families have a great responsibility in minimizing these disruptions in education.

Families undertook the task of guiding their children in this process and tried to manage this process with the least harm. During the pandemic process, individuals frequently follow scientific news and the vaccine and drug development studies for COVID-19, which has not yet a clear treatment, and learn that the process of developing the most effective treatment against a disease is not that easy and indirectly, they follow the stages of the scientific process steps with multi-dimensional discussions in a real case study. Science news in the media should be interpreted correctly in order to manage the process well by taking the necessary measures. The low level of literacy in scientific developments also constitutes an important obstacle for scientific news, which is one of the most important tools used in conveying research results to the public, and for scientists

who want to convey their research results and ideas to the public through these news (Utma, 2017).

In this context, the study aimed to determine the awareness of parents about the scientific concepts of the pandemic process, which we have encountered especially in the news, and how families' perspectives on science have changed in this process, and what difficulties they face.

2. METHOD

2.1. Design

In this study, a case study approach from qualitative research designs was used. Case study is a research method that is based on how and why questions and enables a detailed investigation of a phenomenon or event that the researcher cannot control (Yıldırım & Şimşek, 2006). According to McMillan (2000), case study is a method in which one or more events, environment, social group or another interconnected system is examined in depth (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2016). The study group of the research consists of 147 parents. While selecting the participants, maximum diversity from purposeful sampling methods and easily accessible sampling techniques were used. In the maximum diversity sampling, it was aimed to obtain different opinions about the same phenomenon, while easily accessible individuals were selected with an easily accessible sample (Yıldırım & Şimşek, 2013).

2.2. Study Group

Table 1: Distribution of participants according to demographic variables

Gender	Female	128
	Male	23
	Total	151
Age	25-34 age	47
	35-44 age	84
	45-54 age	20
Number of children	1 child	14
	2 children	54
	3 children	55
	4 children	22
	5 children and above	6

Table 1: (continued)

Educational status	Illiterate	1
	Literate	4
	Primary school	37
	Middle School	26
	High school	64
	University	17
	Postgraduate	2
Income level	Below the minimum wage	38
	Minimum wage	80
	Twice the minimum wage	23
	Three times the minimum wage	8
	Four times the minimum wage	2
Job	Housewife	99
	Teacher	28
	Laborer	14
	Tradesman	8
	Official	2
Chronic diseases	Without chronic diseases	112
	Diabetic	5
	Cardiac	9
	Blood pressure	13
	Asthma	5
	Kidney failure	2
	Cancer	3
	Anemia	2

2.3. Data Collection Tools

The research data were collected using the demographic information form prepared in order to determine the awareness of the parents about the scientific concepts that are frequently encountered during the pandemic process and a questionnaire form consisting of 12 items. In the demographic information form, the participants were asked to first fill in the form containing demographic information about gender, age range,

number of children they have, education level, income level, occupational information and whether they have any chronic diseases. The questions in the questionnaire, which aims to determine the awareness of individuals about scientific concepts frequently encountered during the pandemic process, are given below:

1. Mark the concepts you have heard for the first time with the covid-19 pandemic and have not heard before the pandemic process.

- Pandemic
- Epidemic
- Coronavirus
- Intubate
- Symptom
- Antibody test
- Virus mutation
- Herd immunity (social immunity)
- Negative pressure systems
- Filiation
- Contamination coefficient

2. Which of the concepts given below do you have difficulty understanding?

- Pandemic
- Epidemic
- Coronavirus
- Intubate
- Symptom
- Antibody test
- Virus mutation
- Herd immunity (social immunity)
- Negative pressure systems
- Filiation
- Contamination coefficient

3. Does explaining the epidemic using scientific concepts in mass media make it difficult for you to understand the epidemic process?

- Yes
- No

4. Briefly explain what you have learned about the viruses known to cause Covid-19 during the pandemic process.

5. What are the transmission ways of coronavirus? Briefly explain.

6. Why was the name of the disease caused by coronaviruses abbreviated as Covid-19? (Why Covid expression, why number 19 was used?)

7. How did the pandemic process affect your perspective on science? Briefly explain.

8. During the pandemic process, our students continued their education through distance education systems. Would you like to receive education on various subjects through distance education?

9. What topics would you like to include in this training?

10. If there is a vaccine for Covid-19, would you get this vaccine yourself?

11. If there was a drug for the treatment of Covid-19, would you use the drug produced? Briefly explain your answer and its reason.

12. How did the pandemic process affect your children's education and what kind of difficulties did you encounter during this process?

Qualitative data were collected from the sample by taking with google form. Qualitative content analysis was used to analyze the data collected after the written opinions were taken. The purpose of qualitative content analysis is to reach the concepts and relationships that can describe the data obtained. In qualitative content analysis, the stages of coding and categorizing data, finding themes, organizing and defining data according to codes and themes, and interpretation of the findings follow each other (Yıldırım & Şimşek, 2013).

2.4. Data Analysis

Parents' awareness of the pandemic process and their views on science and education in this process were analyzed with content analysis.

3. FINDINGS

1. Mark the concepts you have heard for the first time with the covid-19 pandemic and have not heard before the pandemic process.

Table 2: Distribution of the answers given by the participants to the first question

Cocepts	**N**	**%**
Pandemic	109	72.2
Epidemic	82	54.3
Coronavirus	123	81.5
Intubate	91	60.3
Symptom	44	29.1
Antibody test	80	53
Virus mutation	67	44.4
Herd immunity (social immunity)	53	35.1
Negative pressure systems	61	40.4
Filiation	106	70.2
Contamination coefficient	73	48.3

72.2% of the participants (109) pandemic, 54.3% (82) epidemic, 81.5% (123) coronavirus, 70.2% (106) intubated, 29.1% (44) symptoms, 53% (80) antibody testing, 44.4% (67) virus mutation, 35.1% (53) herd immunity, 40.4% (61) negative pressure ventilation systems, 70.2% (106) fillation It was observed that 48.3% (73) first heard about the concepts of contamination coefficient during the COVID-19 pandemic process.

2. Which of the concepts given below do you have difficulty understanding?

Table 3: Distribution of the answers given by the participants to the first question

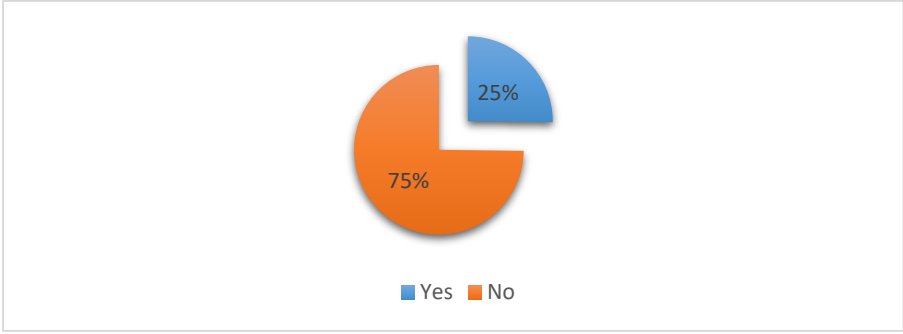
Cocepts	**N**	**%**
Pandemic	38	25.2
Epidemic	69	45.7
Coronavirus	24	15.9
Intubate	40	26.5
Symptom	32	21.2
Antibody test	51	33.8
Virus mutation	35	23.2
Herd immunity (social immunity)	37	24.5

Table 3: (continued)

Cocepts	N	%
Negative pressure systems	61	40.4
Filiation	97	64.2
Contamination coefficient	45	29.8

25.2% of the participants (38) pandemic, 45.7% (69) epidemic, 15.9% (24) coronavirus, 26.5% (40) intubated, 21.2% (32) symptoms, 33.8% (51) antibody testing, 23.2% (35) virus mutation, 24.5% (37) herd immunity, 40.4% (61) ventilation systems with negative pressure system, 64.2% (97) fillation and 29.8% (45) contamination coefficient were found to have difficulties in understanding.

3. Does explaining the epidemic using scientific concepts in mass media make it difficult for you to understand the epidemic process?



To the question of whether explaining the epidemic using scientific concepts frequently in mass media means it makes it difficult for you to understand the epidemic, 25% (38) of the participants answered yes, 75% (113) answered no.

4. Briefly explain what you have learned about the viruses known to cause Covid-19 during the pandemic process.

Thirty-two of the 151 participants gave scientific answers, and the other participants mostly talked about the effects of viruses on social life.

"*I learned how viruses reproduce and settle in the human body even in the smallest environment, causing severe damage*."

"I learned that viruses are transmitted very quickly and mutate."

“They can stay in the air for a long time, they are much more contagious.”

“We have learned to be more careful.”

"We understood that we should be more careful about viruses."

“The importance of cleaning and hygiene, the distance rule, staying at home, not going out without a mask, The virus taught us that our lives are precious and that you must follow the rules."

5. What are the transmission ways of coronavirus? Briefly explain.

69 of the participants emphasized that it was caused by contact, 16 by respiration, 4 by droplet, and the other participants emphasized that mostly caused by hygiene, lack of hygiene, mask and distance rules.

“Crowded environment, failure to comply with cleaning rules.”

“By contact, by air and wherever sick people touch, through the respiratory tract.”

“Not maintaining social distance, not wearing a mask, etc.”

“It is transmitted by air and droplets.”

6. Why was the name of the disease caused by coronaviruses abbreviated as Covid-19? (Why Covid expression, why number 19 was used?)

95 of the participants answered that they do not know and 5 of the participants gave exactly the correct answer. 51 participants could not give the correct answer exactly.

“I do not know, but I will investigate.”

"Because it is the 19th of these types of microbes."

“Due to the 19th epidemic of epidemic diseases in the world so far”

“Co: corona vi: virus d: disease 19 is 2019”

"Corona was a virus that has been known for years, but now the disease affecting the world is the type of covid, the version of this known virus that mutates and infects humans, I know that it takes the name from there."

7. How did the pandemic process affect your perspective on science? Briefly explain.

72 of the 151 participants stated that the pandemic process affected their perspective on science positively, 60 of them negatively, and 9 people stated that their perspective on science was not affected.

"I realized how important knowledge is."

"It taught how necessary science is in human life."

"I learned about scientific developments that I did not know about health from our health minister and scientists."

"I learned how dangerous infectious diseases are, and fortunately, science has improved this much, otherwise we could have suffered much bigger losses as before.

"I realized that science is very important to people's lives."

"I learned that we actually don't know anything and we need to learn more."

"Since we were bored at home, we learned information about science and changed our perspective."

"Our experts need more academic knowledge and the country's scientists"

"I think the virus is a biological weapon. It turns out that science has become very foul."

"Although science is knowledgeable about every subject, the inability to find a cure for a virus has negatively affected our perspective on science."

"I realized that medicine cannot solve everything."

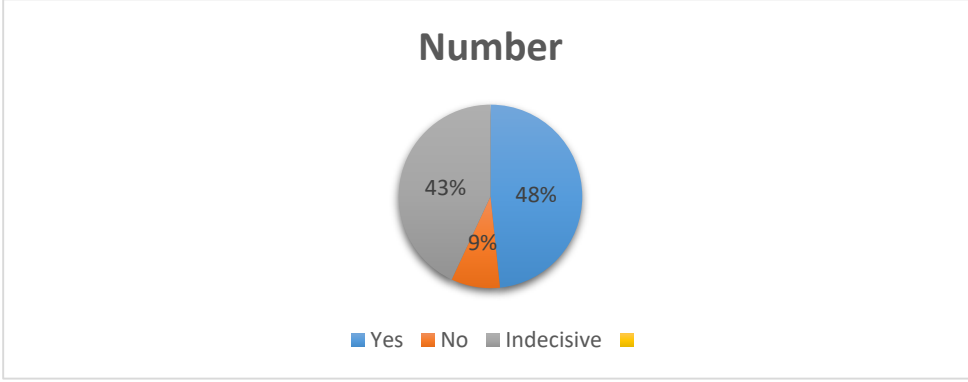
8. During the pandemic process, our students continued their education through distance education systems. Would you like to receive education on various subjects through distance education?

86 (57%) of the participants answered yes, 65 (43%) answered no to the question.

9. What topics would you like to include in this training?

Some participants stated that they wanted to receive distance education in areas such as psychology (19), counseling (3), health (22), adolescent psychology and maternal mental health (4), mathematics (10), general culture (6), and in all subjects (13).

10. If there is a vaccine for Covid-19, would you get this vaccine yourself?



48.3% (73) of them "yes I will do it", 43% (65) of them answered "I am undecided" and 8.6% (13) of them "no I do not do it".

"Maybe it will have a side effect."

"I said I was indecisive to understand that this vaccine will not harm the body."

"If the Turks find the vaccine, it's okay, but I don't trust foreign countries."

"Because I think that even the dead germ of this disease vaccine is harmful when we compare the conditions we are experiencing now in all the epidemic diseases experienced in the past."

11. If there was a drug for the treatment of Covid-19, would you use the drug produced? Briefly explain your answer and its reason.

59 of the participants are yes, 37 of them are yes depending on the condition, 23 of them are unstable and 23 people answered no.

"I do not use it because I do not know what the side effects of the drug and how it affects it."

"I would use it, if the health minister approves, I would use it as a remedy."

"No, I will follow the society before I use it."

"First I want to know if it harms another part of my body."

"I would use the drug if the Turkish scientific committee recommended it."

"Yes, I use it, because this disease has never stopped and it will not end unless attention is paid."

12. How did the pandemic process affect your children's education and what kind of difficulties did you encounter during this process?

When we examined the answers they gave to the question, it was seen that all participants stated that they had difficulties in this process.

"He thought it was a holiday, he could not adapt, he had a hard time doing homework."

"Of course, distance education is not like a school."

"My child had a hard time with his lessons and homeschooling was not as effective as an educator gave."

"It negatively affected. We could not get the lecture."

"I could not get enough because they were all at home and in different classes, and they also fell behind in their education."

"My daughter, who started the first grade, was fully accustomed to the school lessons, but her education was interrupted, she only learned to read and could not learn mathematics and other lessons in writing. This process was like a holiday because it was in the age of play, she was left behind from the lessons, she has to repeat the first grade."

"There was a disorder in education. I have more faith in how devoted doctors and teachers are and the sanctity of these professions. Thanks to all of them."

"Education away from school is difficult, of course. No one is like a teacher, unfortunately. Being away from teachers and friends made the kids and us very difficult. We had a lot of trouble focusing and being motivated."

"It affected badly because it wasn't enough. Which of the students was behind and which was ahead was not known. Education for children was not enough at home."

"My child started having trouble understanding the lessons because he could not concentrate his attention."

"We understood how beneficial face-to-face training is in education. It affected the psychology of the children a lot, they became angry and aggressive, they did not study."

"I realized that it was not as efficient as the face-to-face training. I had a hard time because the children were reluctant."

"It affected badly, lost a period, did not care much, they did not study, we could not establish the order such as school."

"I had a hard time. My child, who was preparing for the high school entrance exams, was very impressed. He could not achieve the success he wanted in the exam."

"I have three school-going children and my children declined in education. My child who entered high school entrance exams graduated without seeing his teachers and school."

4. DISCUSSION & CONCLUSION

When the answers given by the families to the questions in the questionnaire were examined, it was seen that the individuals heard most of the scientific concepts they encountered in the mass media during the pandemic process for the first time and they had the most difficulty in understanding the epidemic, filiation, antibody testing and negative pressure systems.

Failure to understand the concepts related to the pandemic may cause the rules to be followed in the fight against the pandemic to be ignored. This can be associated to health literacy, which requires people to acquire, process and understand health information and services, knowledge and competencies to make appropriate health decisions. In the study, it was observed that parents had difficulty in understanding concepts such as epidemic, filiation, antibody tests, negative pressure systems during the pandemic process. It is observed that individuals with low health literacy levels react excessively and under-reactively because they cannot make sense of these concepts that enter their lives (Dikmen & Özkan, 2019). Examples of these reactions include panic exchanges in societies or failure to enforce recommended safety rules. The importance of the measures taken to control the pandemic, which should not be forgotten, will be realized by understanding the importance of the society by the society and then implementing it (Akbal & Gökler, 2020). For this reason,

importance should be attached to the education of scientific concepts used in the pandemic process. The fact that individuals have a command of scientific concepts related to the epidemic will increase the behavior of obeying the rules and therefore families will be able to raise their children more consciously on this issue.

When the participants were asked what they learned about viruses during the pandemic process, it was seen that only 32 of the 151 participants gave scientific answers. And scientifically responsive individuals generally stated that viruses spread and mutated rapidly. However, no answers have been found regarding the properties of viruses such as their applications that will break down their membranes and their residence time on surfaces. Especially for Covid-19, which has no definitive cure, the most effective and easiest method is to use water and soap to loosen the interactions that hold RNA, lipids and proteins in the virus together, and none of the participants responded to the nature of the viruses. In this respect, we need to know more about the coronavirus that causes the Covid-19 epidemic that we have heard about in the media every day for about 8 months and shapes our lives. 69 of the participants stated that Covid-19 was transmitted by contact, 16 by respiration, 4 by droplet, and other participants stated that the virus was transmitted mostly due to hygiene, lack of hygiene, mask and distance rules. While 89 of the participants expressed the means of transmission of the virus, it was observed that 62 participants did not give the correct answer regarding the transmission routes of the virus. This result, showing the lack of knowledge about viruses and their transmission routes, may explain the increase in the number of cases. To the question of what the Covid-19 abbreviation means, only 5 of the 151 participants gave exactly the correct answer.

When the answers given were examined, it was seen that individuals' perspectives on science were positively affected during the pandemic process. This result has enabled individuals to increase the importance they attach to science and to see the scientific process steps in a real case study, and to understand that vaccine development studies are not as easy as thought.

Most of the participants stated that they also want to receive education in areas such as psychology, guidance, health, adolescent psychology and maternal mental health, mathematics and general culture through distance education. It has been observed that individuals want to receive training to cope with the psychological problems experienced during the adaptation to distance education, and to increase academic success and motivation.

When asked if Covi-19 vaccine is available, would you have the vaccine yourself, 73 of the 151 participants stated that they wanted to have

it, and 13 of them stated that they did not want to be vaccinated. This result can give us information that the Covid-19 pandemic reduces vaccine opposition. While most individuals generally refuse to be vaccinated, the long pandemic process, the rapid spread of the virus and the death of hundreds of thousands of people enabled individuals to develop a more positive approach to vaccination.

All of the participants stated that they had difficulties in terms of education during the pandemic process and that they mostly experienced difficulties in motivating their children towards the lesson, not being able to provide discipline and interest at home at school, and that face-to-face education was the most effective education model.

More explanatory content can be prepared and educated about the scientific concepts, viruses and ways of spreading that individuals encounter in the mass media.

In addition, accurate, understandable and easily accessible information can be presented to the society in order to increase the health literacy and awareness of the society and to gain positive health behaviors.

Providing families with discipline at school at home, increasing the motivation of children against the lesson, trainings can be given on the psychological effects of the pandemic, methods of combating the tension caused by being at home all the time.

In addition, it was observed that the participants in the study had more individuals who were indecisive about the vaccine. It has been observed that the main reason for these insdecisiveness of individuals is because they do not know the vaccine and development process. For this reason, individuals can be given training on vaccination and development processes in connection with the pandemic.

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CHAPTER V

MULTIPLE INTELLIGENCE THEORY AND EFFECTIVE LEARNING IN VISUAL ARTS EDUCATION

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INTRODUCTION

Multiple intelligence theory has been a very noticeable topic in recent years. Gardner (2019) believes that education can also progress greatly when each student becomes aware of their tendency and tries to guide them to the extent possible according to the suitability of their intelligence profile. In this direction, it can be said that directing students according to their wishes, interests and intelligence is a requirement in order to ensure success and efficiency in education.

Given the constructivist approach and explaining the program approach, it seems to be supported by the theory of multiple intelligence, whose importance is emphasized. It is believed that the idea of supporting the constructivist approach with multiple intelligence, the most important of which is "Individual Differences", is also the basis of the principles of the said theory, as well as individual differences and the diversity expected in educational processes due to these differences (Koç & Şahin, 2014).

It can be assumed that supporting visual arts education programs with multiple intelligence theory will contribute to the individual in terms of achieving the goals of visual arts education and effective learning.

MULTIPLE INTELLIGENCE THEORY AND EFFECTIVE LEARNING

Perceiving that all mankind asserts the world through at least seven intelligences Gardner (2019), assumes linguistic, logical-mathematical analysis, spatial representation, musical thinking, solving problems, or doing the job about the use of the body, we know the world through understanding other individuals and ourselves. However, he explains that the point at which people are separated from each other lies in the strength of these intelligences, that is, the intelligence profile, and their ability to perform different tasks, solve various problems, and progress in different areas.

The theory of multiple intelligences, individual differences expressed as to the validity of the idea that is important, Dilli & İz Bölükoğlu (2014), the use of this theory in education, each student's special interests and abilities, as well as all paths to realize and respect that is linked to student learning highlights.

Accepting Gardner's theory of multiple intelligences for teachers in terms of classroom training have various effects, this theory is the theory that are required for the productive function of society, and stating that the teachers is to think all of intelligences is equally important, Brualdi Timmins (1996), underlines that the theory of multiple intelligences, implies that educators should recognize and teach more a wide range of talent and skill.

Given that the education system is based on information restructuring, it can be said that it also brings with it many activities that require different areas of intelligence to be employed. From this point of view, it can be considered that the inclusion of areas of intelligence in activities can be quite useful for all disciplines involved in educational programs. Ayaydın (2004) states that the new understanding that comes to the field of education with this theory covers all areas of education, as well as makes it inevitable to make innovations in art education.

VISUAL ARTS EDUCATION, MULTIPLE INTELLIGENCE THEORY AND EFFECTIVE LEARNING

Given that the theory of multiple intelligence sets the stage for achieving permanent and effective learning goals by focusing on individual differences, it can be said that this theory serves the purposes of art education.

Buyurgan & Buyurgan (2012) states that a qualified art education can be possible through a curriculum (teaching) program that is the bearer of certain values, able to renew itself in accordance with the evolving and changing conditions of the era. Kırışoğlu (2015) emphasizes that the theory of multiple intelligence is one of the theories that is active in basing art education on a scientific basis and making the field a course that includes the teaching/learning process.

It can be said that visual arts education, which contributes to the cognitive and affective development of the individual, is an element that helps to reveal the individual potential. Considering that visual arts education has an important task at this point, it can be said that supporting it with multiple intelligence theory within the framework of the constructivist education model can have an impact on educational goals and permanent learning.

It can be said that the constructivist approach is an approach that offers multiple learning environments that can be applied to each branch. The process of structuring information makes the constructivist approach very necessary in learning environments to develop creative and critical thinking style by giving learners the ability to question and research facts and situations with a subjective perspective. It can be seen that the content, method, technique, material, activity, measurement and evaluation criteria of the current curriculum programs are also organized in this direction, that is, in accordance with the purpose of the constructivist approach (İnceağaç, 2020 :80).

In the process of evaluating success in education-training, the characteristics of the student whose success is measured are also important. In education and training, the impact of the student's age, intelligence, talent and creativity is undeniable. But although the effect of talent in fine arts education exists to a certain extent, it is sometimes thought to be more than it is (Ayaydın & Özsoy, 2011 :498). In this direction, in the fields of visual arts, talent, etc. in addition to such features, intelligence is more important than thought, so it can be inferred that the curriculum program, teaching methods and activities to be used in visual arts education are planned and organized in such a way as to allow multiple intelligence-based teaching.

Kırışoğlu (2015) explains that the creative process in visual arts develops from sense to understanding, from concept to creation, stating that visual arts include works aimed at developing visual-spatial abilities and establishing teaching on these abilities.

Teaching has an active role in the development of artistic intelligence, and this can happen through education in the arts. Each individual is different, and according to individual differences, each student's interests, abilities, attitudes, behaviors and learning patterns vary (Dilli & İz Bölükoğlu, 2014). Therefore, visual arts teachers have serious responsibilities in identifying differences in learners and ensuring effective learning.

According to the understanding of multiple intelligence in the visual arts course, courses with a wide range of methods, materials and applications can be designed. The main determining factor here is the imagination, innovation and flexible thinking of the visual arts teacher (Ayaydın, 2011). In this context, Ayaydın (2009a) indicating that visual arts education has a rich content, each topic can be varied with different activities according to different field of intelligence, as can be varied by different methods and techniques, and thus each student by their own choice, work with a product that will reveal that love.

It can be said that the theory of multiple intelligence has a comfortable applicability within the scope of the visual arts course. One of the way to effective and lasting learning in visual arts education, in-class activities from many disciplines through an interdisciplinary approach by making use of students' material that will appeal to different learning styles, teaching methods and the use of diversity techniques can be considered.

An educational program based on the theory of multiple intelligence should provide conditions in which students can use their unique abilities or intelligence to develop their own self-individuality (Özsoy, 2015). For the field of visual intelligence, Ayaydın (2009b) emphasis on the necessity of some activities that can support the existence of this intelligence in the field of the visual arts course, implies that 'animation in the mind, colors, visual metaphors, graphical symbols, mental (mind), maps, flow charts, unit cards, games, visual artwork, such as a web page' events, media, and visual arts using visual learning tools in the classroom that can improve the field of intelligence.

It can be seen that the theory of multiple intelligence directly serves the learning gains that are intended to be gained in the visual arts course with the constructivist approach based on individual-centered learning, learning to learn, structuring knowledge, living by doing and effective learning adopted by the educational curriculum program. Because art education can be considered as a discipline that centers the individual according to its structure, occurs through active participation, is obtained as a result of effective learning, knowledge is structured by interpreting each student from a subjective point of view and can address many areas of intelligence at the same time. Therefore, if the aims of art education are to be gained to the student, effective learning can be achieved by using the theory of multiple intelligence.

CONCLUSION

Gardner (2019) notes that true understanding occurs when people have various methods of representing knowledge about a concept or skill and can easily switch between these types of knowledge, emphasizing that no one can have all types of knowledge, but at least everyone should have several.

Multiple intelligence theory and artistic intelligence research include important points that directly concern art education (Kırışoğlu, 2005 :33). Students' knowledge and skill level with the expectations, considering their individual needs and their learning styles are different from each other judging from the fact that visual arts teachers in expressing the necessity of diversification of teaching approaches Demirci Katırancı

(2020), highlights that teachers are expected to plan a creative process of visual arts teaching.

Ayaydın (2011), who stated that the main goal in activities prepared according to the understanding of multiple intelligence is to focus the student's interest on the subject depending on the field of intelligence, expresses the difference of plans prepared in this understanding from other lesson plans as the activities prepared vary according to different types of intelligence of students.

Art education is essential for individuals of all ages and occupies an important place in human life. Art education is necessary for educating the creative powers and potentials of the individual, organizing aesthetic thought and consciousness (Yolcu, 2020 :122). Buyurgan & Buyurgan (2012), who states that art education as a creative process tries to lead the child to think freely and work freely, emphasizes the need for each student to try to develop according to their own personality in the process of art education, to be guided in accordance with their own personality, tendencies and to find an environment to express themselves freely.

It can be said that visual arts education is intended to provide individual skills such as, creative thinking, critical thinking skills such as thinking, analysis and synthesis to improve their level of cognition, such as the top of an individual, the individual awareness, authenticity and self-expression. It can be thought that the theory of multiple intelligence, which advocates the diversity of learning by taking the individual into the center, can also make positive contributions to the goals of the visual arts course in this direction and support the visual arts course in terms of effective learning.

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CHAPTER VI

THE RELATIONSHIP BETWEEN THE VIEWS OF THE PRE-SERVICE MATHEMATICS TEACHERS ON PROOF AND THEIR MULTIPLE INTELLIGENCE

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INTRODUCTION

From the point of view of some mathematicians, mathematical proof is to use the predecessors and move forward through logical inferences to show whether an expression is true or false (Guven, Celik & Karatas, 2005). It is a process used to eliminate doubts about the accuracy of a mathematical expression (Harel and Sowder, 2007). The purpose of mathematical proof is to justify, convince, discover and present of the results in a deductive way (Almeida, 2003).

Not every mathematical text or argument can be considered as a proof. Because if a content that indicates the accuracy of a mathematical expression is considered valid by mathematicians, they will have the title of proof (Grandfather, 2013). Furthermore, the sole purpose of mathematical proofs is not to find a result through logical steps, but also to understand how to achieve this result (Tall, 1998). In parallel with this idea, Bell (1976) stated that mathematical proofs have functions of validation, explanation, and systematization.

Through mathematical proofs, students learn mathematical concepts more meaningfully (Hersh, 1993; Tucker, 1999). It offers new methods, strategies and tools for solving mathematical problems (Mariotti and Balacheff, 2008; Rav, 1999). Together with mathematical proofs, students provide an understanding of what mathematicians have done before (Imamoglu, 2010; Tucker, 1999). Accordingly, mathematical proofs can also be said to be a tool for transferring past acquired information to future generations. By performing mathematical proof activities, students enter the process of discovery, become aware of the aesthetic and axiomatic aspects of mathematics, and develop reasoning and analytical thinking skills (Dede & Karakuş, 2014; Güven et al., 2005).

Despite its importance in terms of mathematics education and the benefits it provides to students, the studies have shown that university

students are unsuccessful in proof activities (Doruk, 2019; Güler & Ekmekçi, 2015; Ko, 2010; Uygan, Tanışlı and Köse, 2014). Researchers investigating the causes of students' failures have stated that the inappropriate opinions of students for proof negatively affect the process of proving. Moore (1994), for example, found that one of the difficulties that university students had in the process of proving was negative views on proof. It was found that the views of pre-service teachers and the process of proving were related (Bayazıt, 2009; Doruk & Kaplan, 2015a; Guler, Özdemir and Dikici, 2012; imamoglu, 2010). Emotions and opinions about proof are important as they influence the selection of strategies for proving and ways to prove, such as responses to challenges encountered in proof (Furinghetti & Morselli, 2009). The source of the difficulties experienced in mathematical proof is the shortcomings for the purpose of proof (Bell, 1976). University students' perspectives on mathematics also change the way they approach proofs (Bayazıt, 2009). Güler, Özdemir and Dikici (2012) determined that the ability to prove by induction method is related to the views on proof. Imamoglu (2010) found that the views of the pre-service mathematics teachers and their proving ability were statistically related. Similar to this result, Doruk and Kaplan (2015b) found that the pre-service mathematics teachers who were not successful in proving and had many difficulties were also in negative emotions and thoughts towards proof.

Based on the findings that the views on proof affect the process of proving, studies were carried out to determine the level of the views of the pre-service mathematics teachers regarding proof and to evaluate the views in terms of various variables. In some of the studies, it was determined that the views of pre-service mathematics teachers regarding proof were positive (Basturk, 2011; Iskenderoglu & Baki, 2011). In most of the researches, the views of pre-service mathematical teachers on proof were found to be positive. It was found they did not have fully formed or had negative emotions (Jones, 2000; Doruk & Guler, 2014; Kayagil, 2012). It was revealed that pre-service mathematics teachers were not aware of the importance of proofs, that their self-confidence to prove was low and their perceptions were negative (Doruk & Kaplan, 2013; Doruk & Guler, 2014; Erşen, 2016; Morale, Ugur, Turnüklü & Yeşildere, 2006). In some studies (Doruk & Guler, 2014; Kayagil, 2012; Turgut, Yenilmez & Uygan, 2013). The views of pre-service mathematics teachers regarding proof were examined according to some individual differences that were considered important. Some studies tested whether the views of pre-service mathematics teacher differ according to gender, the departments they study, and their class levels. It was determined that the views of pre-service mathematics teachers regarding proof were related to the perception of self-sufficiency towards mathematics (Doruk, Özdemir & Kaplan, 2015). It was realized that no study has been conducted in the context of multiple

intelligence, which are considered important among the individual differences of the students.

Howard Gardner came up with the theory of multiple intelligence by opposing the numerical measure of intelligence and the reduction of it to a single field (Ozden, 2008). According to this setup, levels of intelligence are generated by individual powers or abilities (Demirel, 2014). According to Gardner, intelligence is not a constant innate trait, but has qualities that can constantly improve itself by being influenced by the environment due to the unique structure of the brain (Baki, 2014). Contrary to the previously accepted understanding that intelligence is limited to a field of numerical and verbal skills, the idea that people have intelligence in different fields has begun to be accepted (Ozden, 2008).

In multiple intelligence theory, there are eight different areas of intelligence called verbal, logical, visual, musical, bodily, intrapersonal, interpersonal, and naturalistic intelligence. Verbal intelligence is the ability to use language effectively and efficiently as a means of communication (Ozden, 2008). Logical intelligence emerges effectively in reasoning about the occurrence and functioning of events through establishing cause and effect relationships (Baki, 2014). Visual intelligence is the ability to visualize emptiness in the mind. This field of intelligence includes the ability to objectively observe the environment, to perceive and evaluate the world correctly, and to present visual and spatial ideas from the outside world graphically (Baki, 2014). Musical intelligence corresponds to the musical abilities of individuals who use music as a tool in the transfer of emotions (Demirel, 2014). These people are successful in capturing, perceiving and creating musical rhythms. They are skilled at the pronunciation of a language they have learned (Özden, 2008). Bodily intelligence requires controlling body movements, using physical objects for purposes, and ensuring coordination between the body and the mind (Bumen, 2011). Interpersonal intelligence can be defined as being able to differentiate between people by noticing other people, to sense their characteristics, motivations and intentions (Arslan, 2015). Individuals with high intrapersonal intelligence can show self-definition, confidences, discipline, determination of their goals and problem solving skills (Demirel, 2014). Individuals with developed naturalistic intelligence are sensitive to nature, animals and plants in nature, natural phenomena and natural resources (Baki, 2014).

The areas of intelligence in the theory of multiple intelligence are equal in terms of importance and one is no more important than the other (Bumen, 2011). According to this theory, the person has multiple areas of intelligence, areas of intelligence can be improved, the areas of intelligence are different in their way of showing, and presents new ways for the person to succeed (Ozden, 2008). The theory of multiple intelligence argues that

students learn in different ways and at different speeds. For this reason, it recommends the use of all types of intelligence in the learning and teaching process (Baki, 2014). While multiple intelligence theory is applied within the classroom, all areas of intelligence should be given equal place, and activities where students can use and develop all areas of intelligence should be prepared (Demirel, 2014).

Multiple intelligence is one of the important individual differences of the students. However, there was no study to investigate the relationship between multiple intelligence of students and their views on proof as a result of the literature review. With the study to be done, it will be revealed which area of intelligence is related to the views on proof, and if there is a relationship, what will be the ratio of explaining the views of this relationship towards proof. Since it is known that the views on proof are related to their ability to prove, the results may contribute to the arrangement of teaching methods by taking into account individual differences in the teaching process. In this study, it is aimed to reveal the views of pre-service primary mathematics teachers on proof in the context of multiple intelligence. The questions that are sought to be answered in order to achieve this goal are given below.

- What is the level of pre-service mathematics teachers' views on proof?
- What is the level of multi-intelligence of pre-service mathematics teachers?
- Are the pre-service mathematics teachers' views on proof related to their multiple intelligence?

METHOD

Research Design

Quantitative research approach was adopted in this study and is an example of a survey model. Creswell (2014) stated that analysis of a sample in the survey model provides a numerical description of trends, attitudes, and opinions across the universe. The survey model is a descriptive research method (Ozdemir, 2015).

Research Group

Participants of this study were 173 pre-service mathematics teachers in the department of primary mathematics education of two state universities at the end of the spring semester of the 2018-2019 academic year. Ninety five students were first-year and 78 of them were second-year students. In the selection of the research group of the study, it was considered that the Abstract Mathematics course in which the methods and logic of proving were taught to the pre-service mathematics teachers was completed. Therefore, the criterion sampling method is taken into account

in the selection of the research group. In criterion sampling, observation units are made up of situations that meet certain criteria (Büyüköztürk et al., 2012).

Data Collection Tools

In order to determine the views of the pre-service mathematics teachers on proof, the Questionnaire for Constructing Mathematical Proof (QCMP) was applied. QCMP was adapted from Lee (1999) to Turkish by İskenderoğlu (2010). There were 27 items on QCMP. The items were prepared as five-likert. The answer options for items on the scale were rated "never," "rarely," "sometimes," "often," and "always," respectively. QCMP has four sub-scales in the name of confidence, attitude and belief, mental process and self-assessment. Confidence from these sub-scales: it includes ways of coping with the problems one encounters in proving and self-confidence. Attitude and Belief: it expresses how the individual understands the proofs and the feelings they have towards the proofs. Mental Process: it reflects one's thoughts on knowing and individual thinking. It includes their thinking styles, motivations and opinions on sources of information while proving. Self-assessment: It includes one's thoughts on how one conducts a study for proofs. When proving one's independence, the situation of challenging problems reflect their self-assessment. The Cronbach Alpha internal consistency coefficient of the scale of İskenderoğlu (2010) was .79. The internal consistency coefficient detected for this study was .80.

Özden's (2003) Multiple Intelligence Inventory (MII) was used to identify the multiple intelligence areas of the pre-service mathematics teachers. There were eight different areas of intelligence in the name of verbal, logical, visual, musical, bodily, interpersonal, intrapersonal and naturalistic. There were 10 items in a five-likert style for each multiple intelligence field. The answer options for items were rated "not appropriate," "very little appropriate," "partially appropriate," "quite appropriate," and "completely appropriate." In this study, internal consistency coefficients for these areas of intelligence were determined as .64, .76, .62, .77, .60, .61, .60 and .76, respectively. The internal consistency coefficient of the entire MII was determined as .90.

Data Collection and Analysis

Data collection tools were applied to pre-service mathematics teachers within 60 minutes in their own classes. The data were analyzed using descriptive and inferential statistical methods. Descriptive statistics were used to determine the level of multiple intelligence and views of the pre-service mathematics teachers. The development level of the multiple intelligence areas were determined according to the ranges of "0-10: undeveloped," "11-20: a little", "21-30: moderate level," "31-40:

advanced", 41-50: very advanced" (Ozden, 2003). In determining the level of the pre-service mathematics teachers' views on proof, "1-1.80: never", "1.81-2.60: rarely," "2.61-3.40: sometimes," "3.41-4.20: often," "4.21-5: always" intervals were used.

The properties of the data were investigated before the inferential data analysis. As a result of data analysis, it was revealed that the data obtained from the study were suitable for the parametric tests. For this reason, ANOVA for repeated measures was applied to determine whether the scores obtained from the sub-scales of QCMP and MII differed statistically. Simple correlation analysis was applied to test whether there was a correlation between the views of the pre-service mathematics teachers regarding proof and the areas of multiple intelligence. In the classification of the size spawned by the analysis, the intervals of "0.00-0.30: low "0.30-0.70: intermediate," "0.70-1.00: high" were considered (Büyüköztürk, 2014). Finally, simple linear regression analysis was used to determine whether the pre-service mathematics teachers' views on proof were significantly predicted with their logical intelligence.

FINDINGS

Pre-service Mathematics Teachers' Multiple Intelligence and Views on Proof

In this section, findings on the multiple intelligence areas and the views of the pre-service mathematics teachers on proof are given. The development levels of the pre-service mathematics teachers in the areas of multiple intelligence were examined. Table 1 presents information on the multiple intelligence areas of pre-service mathematics teachers.

Table 1. Multiple intelligence areas of the pre-service teachers

Areas of Intelligence	$\overline{X}$	Sd	Percent	Level
Verbal	31.12	5.88	62	Advanced
Logical	36.79	5.93	73	Advanced
Visual	35.78	5.38	70	Advanced
Musical	31.42	6.89	62	Advanced
Bodily	36.14	5.44	72	Advanced
Interpersonal	35.40	5.38	70	Advanced
Intrapersonal	34.76	4.86	69	Advanced
Naturalistic	35.22	7.01	70	Advanced

It was revealed that the pre-service teachers had advanced levels of multiple intelligence. Accordingly, it can be said that all areas of intelligence of the pre-service mathematics teachers were developed. Although the development level was the same, it was noticed that the verbal and musical intelligence scores of the pre-service mathematics

teachers were low compared to other areas of multiple intelligence. ANOVA for repeated measures was applied to the relevant scores to determine whether these score differences made sense statistically. Table 2 contains the results determined by the application of the test.

Table 2. ANOVA for repeated measurements applied to multiple intelligence scores of the pre-service teachers

Source of Variance	Sum of Squares	df	Mean Square	F	p	Meaningful Difference
Between subjects	20299.880	172	118.023			1<2,3,5,6,7,8
Measure	5506.663	7	786.666	34.454	.00	4<2,3,5,6,7,8
Error	27490.408	1204	22.833			7<2
Total	53296.951	1383				

1: Verbal, 2: Logical, 3: Visual, 4: Musical, 5: Bodily, 6: Interpersonal, 7: Intrapersonal, 8: Naturalistic

When Table 2 was examined, it was determined that the scores obtained by the pre-service mathematics teachers from the areas of multiple intelligence differed statistically [$F(7,1204)=34,454$, $p<.05$]. It was found that the verbal and musical intelligence scores of the pre-service mathematics teachers were lower than the others. According to this findings, it could be said that the verbal and musical intelligence of the pre-service mathematics teachers were lower than the others. It was also emerged that the logical intelligence of the pre-service mathematics teachers was higher than the intrapersonal intelligence.

The study was conducted to explain the teachers' views on proof from different perspectives. Therefore, analyses were conducted primarily to determine the level of the pre-service mathematics teachers' views on proof. In Table 3, information is presented about the level of the pre-service mathematics teachers' views on proof.

Table 3. Pre-service mathematics teachers' views on proof

Views on proof	N	$\overline{X}$	Sd	Level
Total	173	3.38	.43	Sometimes
Mental process	173	3.58	.55	Often
Confidence	173	3.06	.61	Sometimes
Self-assessment	173	3.53	.68	often
Attitude and belief	173	3.37	.46	Sometimes

According to Table 3, it was found that the pre-service mathematics teachers' views on proof were at the "sometimes" level. Accordingly, it can be said that the pre-service mathematics teachers' views on mathematical proof were not fully formed and did not adopt a positive or negative opinion. When the sub-scales were examined, it was found that the pre-service mathematics teachers were at the "often" level in the mental

process and self-assessment sub-scales, while at the "sometimes" level for other sub-scales. Accordingly, it can be stated that the pre-service mathematics teachers were at a lower level in terms of self-confidence and positive attitude on proofs. ANOVA for repeated measures was applied to the relevant scores to determine whether the level differences detected in the sub-scales were statistically significant. Table 4 shows the results of the ANOVA.

Table 4. ANOVA for repetitive measures on scores obtained by pre-service mathematics teachers from the sub-scales

Source of Variance	Sum of Squares	df	Mean Square	F	p	Meaningful Difference
Between subjects	144.588	172	.841			2<1,3
Measure	28.191	3	9.397	53.851	.00	4<1,3
Error	90.042	516	.175			2<4
Total	262.821	691				

1: Mental process, 2: Confidence, 3: Self-assessment, 4: Attitude and belief

When Table 4 was examined, it was determined that the scores obtained from the sub-scales differed statistically [$F(3,516)=53,851$, $p<.05$]. It was revealed that the scores of the pre-service mathematics teachers from the confidence and attitude-belief sub-scales were significantly lower than those obtained from other sub-scales. Accordingly, it can be said that the pre-service teachers had more negative views in terms of self-confidence in proof and developing a positive attitude. It was determined that the scores obtained by the pre-service mathematics teachers from the sub-scale of attitude and belief were statistically higher than the scores obtained from the confidence sub-scale. Accordingly, the views of the pre-service mathematics teachers regarding attitude and belief of the proofs can be said to be more positive than the views on confidence.

The Relationship between Pre-service Mathematics Teachers' Views on Proof and Their Multiple Intelligence

Simple correlation analysis was used to determine whether the pre-service mathematics teachers' views on proof were related to multiple areas of intelligence. Table 5 contains the results of simple correlation analysis.

Table 5. Simple correlation analysis for the relationship between views on proof and multiple areas of intelligence

	Verbal	Logical	Visual	Musical	Bodily	Interpersonal	Intrapersonal	Naturalistic
r	.19*	.43**	.16*	.08	.29**	.19*	.18*	.23**
p	.01	.00	.02	.27	.00	.01	.01	.00
N	173	173	173	173	173	173	173	173
Level	Low	Moderate	Low		Low	Low	Low	Low

*p<.05, **p<.01

When the data in Table 5 were examined, it was found that the pre-service mathematics teachers' views on proof were statistically related to all areas of intelligence other than musical intelligence (p<.05). In the established relationships; it was determined that there was a positive and moderate relationship between the views on proof and logical intelligence, and that there were positive and low relationships with other areas of multiple intelligence. Accordingly, it could be said that the pre-service mathematics teachers' views on proof were not significantly related to multiple areas of intelligence other than logical intelligence. It was found to be moderately related to the views of the pre-service teachers regarding the proof and their logical intelligence (r=.43, r^2=.189, p<.05). The explanation ratio of views on proof and logical intelligence was approximately 19%. Simple linear regression analysis was applied to the relevant scores in order to determine the direction of this relationship and to determine whether the logical intelligence was a meaningful predictor to the views on proof. Table 6 presents the obtained data.

Table 6. Simple linear regression analysis regarding the prediction of the views on proof with logical intelligence

Variables	B	Standard error	*B*	t	P
Constant	2.211	.188		11.759	.00
Logical intelligence	.032	.005	.435	6.323	.00

r=.43, r^2= .189, F (1,171)=39,980, p=.00

According to Table 6, logical intelligence was a meaningful predictor of the views on proof [r=.43, r^2= .189, F(1,171)=39,980, p=<.05]. Accordingly, approximately 19% of the views of the pre-service mathematics teachers regarding proof could be explained by logical intelligence. The mathematical equation that emerged as a result of the analysis is given below.

$$Views\ on\ proof = 0.032_{logical\ intelligence} + 2.211$$

DISCUSSION AND RECOMMENDATIONS

As a result of the study of pre-service mathematics teachers in the areas of multiple intelligence, it was determined that all the areas of intelligence of the pre-service mathematics teachers were at advanced levels but their verbal and musical intelligence were lower than in other areas. As a result of their study with pre-service primary mathematics teacher from all grade levels, Akkaya and Memnun (2015) detected that the logical, interpersonal and intrapersonal intelligence of the pre-service teachers developed, and the other areas of intelligence developed at a moderate level. Kozağaç (2015) reported that the senior pre-service secondary mathematics teacher in the study was found to have the highest logical intelligence scores and the lowest scores of verbal and musical intelligence. The results of the study were largely similar to those of pre-service mathematics teachers in the studies in which multiple areas of intelligence were examined (Akkaya & Memnun, 2015; Kozağaç, 2015).

It emerged that the verbal and musical intelligence of the pre-service mathematics teachers were less developed than other areas of intelligence. Considering the requirements of the teaching profession, it can be said that the profession of teaching mathematics is more related to verbal intelligence. Verbal intelligence is the ability to use language effectively and efficiently as a means of communication (Ozden, 2008). Explaining and interpreting ideas and information through language (Arslan, 2015). This type of intelligence is one of the main areas of intelligence that is the source of the teaching profession (Ozden, 2008). This may be due to the fact that a small number of pre-service teachers had opportunities to express themselves at the teaching level and share their thoughts and knowledge. Accordingly, in institutions that train teachers, activities can be carried out where pre-service teachers can express themselves, develop their verbal communication skills and share their knowledge with their interlocutors. More presentation studies may be included in the evaluation process of the relevant courses.

It was found that the pre-service mathematics teachers' views on mathematical proof were at the "sometimes" level. It can be said that the pre-service mathematics teachers' views on proof were not fully formed. This result of the study is consistent with the results of the study, in which undergraduate students studying mathematics were undetermined in their views on proof and did not agree with a full opinion (Doruk et al., 2015; Doruk & Guler, 2014; Jones, 2000; Kayagil, 2012; Moralı et al., 2006). When the level differences in the view scores in the sub-scales were examined, it was determined that the scores of the pre-service mathematics teachers in the confidence and attitude-belief sub-scales were lower than the others. Accordingly, it can be said that the pre-service teachers had less confidence in the proof and positive feelings for proof. When the scores on

the confidence and attitude-belief sub-scales were compared, it was revealed that the scores obtained by the pre-service teachers from the sub-scale of confidence were lower. Accordingly, it could be said that the pre-service teachers had less confidence in themselves in mathematical proof than others. This result from the current study is consistent with the results of the past studies, where the confidence of the pre-service mathematics teachers for proof is low (Doruk et al., 2015; Doruk & Guler, 2014; Doruk & Kaplan, 2013; Moralı et al., 2006). Discussions can be held on the meaning, purpose and necessity of proof with pre-service teachers. The activities related to properties of proofs and determination of valid and invalid proofs can be carried out. With these proof activities, students can be able to have self-confidence by breaking their prejudices about proof.

As a result of examining the relationship between the pre-service mathematics teachers' views on proof with the areas of multiple intelligence, a moderate and positive relationship between the views on proof and the logical intelligence was determined, while the weaker level of other intelligence relationship was identified. Accordingly, it could be said that the relationship between the views on proof with logical intelligence was significant and its relationship with other areas of intelligence was negligible. Logical intelligence emerges effectively in reasoning about the occurrence and functioning of events through establishing cause and effect relationships (Baki, 2014). As the definition suggests, there is no doubt that logical intelligence is the type of intelligence most commonly used in the activities of proof. Therefore, a higher level of relation to proof-related views and logical intelligence can be considered as a natural result. Analysis was carried out to determine the direction of this relationship and to determine whether the logical intelligence was a meaningful predictive to the views on proof. As a result of data analysis, it was found that logical intelligence is a meaningful predictor of the views on proof and that approximately 19% of the variance in the opinions about the proof could be explained by logical intelligence. Accordingly, it can be stated that approximately one-fifth of the views on proof can be explained by the variable of logical intelligence. Accordingly, it can be deducted that the developments in the logical intelligence of the pre-service teachers will increase their views of proof and therefore their success in the activities of proof. For this reason, activities based on cause and effect can be used in order to improve the logical intelligence of the teacher candidates. For this purpose, argumentative-based teaching methods can be used where pre-service teachers can present and discuss their claims.

In this study, the relationship between the multiple areas of intelligence and the views of the pre-service mathematics teachers on proof was examined. As a result of the study, it was found that logical

intelligence was a meaningful predictive of the views on proof. In previous studies, it was determined that the views on the proof were related to the perception of mathematical self-efficacy and that the rate of explaining the views on the proof was 39% (Doruk et al., 2015). It may be suggested that other researchers investigate other affective features that may be related to the views of the pre-service teachers regarding the proof.

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CHAPTER VII

THE SIGNIFICANCE OF SCIENCE CENTERS IN SCIENCE EDUCATION

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1. INTRODUCTION

The national and international analysis of the science course curricula would demonstrate that they mainly aim to train science literate individuals. Thus, students are expected to approach problems as a scientist using their scientific process skills and reach solutions to these problems (NRC, 2009; Türkmen, 2010). In this context, out-of-school learning environments that provide significant opportunities such as acquisition of expert knowledge, scientific inferences through on-site observations, and gaining experience by doing/living, which lead to a serious learning potential (Kelly, 2000; Rivkin, 2000; Türkmen, 2010). Technological societies who live in the current urban environments have distanced themselves from traditional farming experiences and their opportunity to explore the nature has decreased when compared to their farmer ancestors. To provide this opportunity, out-of-school learning environments such as natural history museums and science centers were developed during the last two centuries and played a key role in science education.

1.1. Out-of-School Environments in Science Education

"Training Science Literate Individuals' vision, which was the foundation of Science Curricula developed and implemented after 2000, and the fact that the curricula required the use of non-formal education environments increased the interest of both teachers and researchers in out-of-school learning environments (The Ministry of National Education (MONE), 2006; 2013; 2018; Sarıoğlan & Küçüközer, 2017; Yurtkulu, Akkuş & Şimşek, 2017). Çiçek and Saraç (2017) reported that activities in out-of-school learning environments allow the application of science subjects, contribute to the training of science literate individuals, and have the potential to create a learning environment suitable for personal differences based on the views of science teachers. Several studies argued that out-of-school learning environments offer one-to-one interaction

opportunities in real-life and the application of the basic conceptual principles and generalizations included in science curricula, stimulate the main sources of learning such as curiosity and motivation, and lay the ground for permanent and meaningful learning (Ramey-Gassert, 1997; Salmi, 1993). These environments also contribute significantly to the development of higher-order thinking skills, skills to cooperate towards common goals, and career awareness among students (Kuh, 1995; Pascarella & Terenzini, 1991; Strauss & Terenzini, 2007; Westfall, 1999). Thus, out-of-school learning activities provide opportunities to acquire cognitive (memory, comprehension, analysis and synthesis) and affective (curiosity, excitement, attitude and motivation) skills, self-confidence, socialization, awareness of individual traits, and development of scientific process skills (Braund & Reiss, 2006; Öztürk & Başbay, 2017; Rickinson, Dillon, Teamey et al.2004).

The review of the domestic literature revealed that the number of studies on the contribution of out-of-school learning activities to the comprehension of scientific concepts at school and association of these concepts with daily life events (Balkan-Kıyıcı & Atabek-Yiğit 2010; Ertaş, Şen & Parmaksızoğlu, 2011; Şahin & Yazgan 2013; Tatar & Bağrıyanık, 2012), scientific process skills (Erten & Taşçı, 2016; Öztürk, 2017), student views on socio-scientific and environmental issues (Akçadağ-Karakaya & Çobanoğlu, 2018; Yavuz-Topaloğlu & Balkan-Kıyıcı, 2017; 2018), and affective factors such as interest, curiosity, attitude and motivation (Ateş, Ural & Başbay, 2011; Bozdoğan & Yalçın, 2006; Göloğlu-Demir & Yılmaz, 2018; Kelly, 2000; Öztürk, 2017; Sontay, Tutar & Karamustafaoğlu, 2016) has increased in recent years. Similarly, in a content analysis conducted by Saraç (2017), the studies conducted in Turkey between 2007 and 2016 on out-of-school learning environments were reviewed and it was concluded that the studies conducted in recent years have increased regularly. Saraç (2017) also found that the studies were mostly focused on science education, conducted with teachers and middle school students, about travel/nature activities and museums/science centers, and the effects of these environments on student interest, attitudes and learning products were generally analyzed.

Out-of-school learning environments could be described as natural or built environments that provide educational excursions and activities associated with the course objectives, and include surprises and curiosities in learning when compared to the formal education conducted at school environment (Laçin-Şimşek, 2011; Öztürk, 2009). Literature review revealed that out-of-school learning environments in science instruction included science, nature or natural history museums, zoos, aquariums, botanical gardens, science centers, planetariums, industrial institutions, natural monuments and parks (Laçin-Şimşek, 2011; Yurtkulu, et al., 2017).

Eshach (2007), on the other hand, categorized out-of-school learning environments as non-formal and informal learning, and then listed the environments in each category (Table 1).

Table 1. Out-of-School Learning Environments

Out-of-school learning environments	**Non Formal Learning**	**Zoo**
		Botanical garden
		Muzeum/Science Centers
		Planetarium
		Excursions / Nature activities
		Industry associations
		National parks
		Interactive Exhibitions
		Aquariums
	Formal Learning	Streets / Playgrounds
		Mobile Devices
		House environment
		Independent activities in schools
		Web 2.0 applications
		e-learning

As seen in Table 1, non-formal learning environments refer to non-school institutional spaces that could be visited within business hours, and informal learning environments refer to non-institutional spaces that could be visited at any time (Tal & Morag, 2009). In non-formal environments, expert guides and/or trainers are available; and thus, they aim to create a more effective learning environment (Fidan, 2012). Science centers, which are considered as non-formal learning environments, are prominent in the curricula, especially in science education (Çığrık & Özkan, 2016; Yurtkulu, et al.2017). In fact, it was demonstrated that there was a significant increase in the learning levels of students with low science achievement and their interest in science after a visit to a science center (Bozdoğan & Yalçın 2010; Brooke & Solomon, 2010). Thus, when the potential of science centers is coordinated with school programs, they are expected to improve both school achievements and positive attitudes towards science (Yurtkulu, et al.2017).

1.2. Science Centers as Non-Formal Learning Environments

Science centers are experimental and applied institutions designed to introduce science to individuals with diverse backgrounds, allow them to learn about science at the source, and to trigger scientific curiosity (Kırgız, 2018). In science centers, active participation of the visitor is encouraged in the activities. Unlike museums, visitors are encouraged to touch and try everything in science centers.

Science centers were initially described as application-oriented museums; however, they were defined as multi-sensory or multimedia museums with the inclusion of additional elements in the environment over time. Silent museums, where the objects are viewed behind a glass, could not be touched, and allow interaction through short identification tags, were transformed into active noisy spaces that allow dynamic interaction (Koster, 1999). Koster (199) suggested that science centers should have seven missions:

1. Science centers should adopt a mission that focuses on the relationships between science, technology, and society and present the mission with a multidimensional approach on how science should be in the future rather than how it was in the past.
2. Science centers should be committed to access by visitors of all ages, learning styles, or cultures.
3. Science centers should assist the visitors to learn, provide unique experiences, and build a brand identity in the market.
4. Science centers should employ current multimedia facilities completely for advanced interaction and attraction.
5. Science centers should partner with similar organizations to join forces to achieve greater impact.
6. Due to the significance of the investment, science centers should serve several stakeholders as lifelong learning centers.
7. Science centers should be impartial and develop an environment where even issues that make the society uncomfortable could be presented.

The replacement of science in public spaces for public use has valuable contributions. Science centers aim to re-socialize and democratize science by providing a fluent communication v between the public and science. However, the biggest challenge for science centers is not how to nurture the rationality of science by developing rational communication, but how to allow the rational public to properly include various population segments (Tlili, Cribb & Gewirtz, 2006).

Science centers adopt a complementary mission in education and instruction due to the technological opportunities they provide in rapid integration of scientific and technological innovations into education (Quistgaard & Hojland 2010). Çığrık and Özkan (2016) reported that the experimental apparatus and exhibitions in science centers improved the interest and motivation of the visitors in design characteristics. Furthermore, the permanence tests revealed that the increase in the interest levels of the students in scientific topics was maintained for a long time after the science center visits (Jarvis & Pell, 2005). In a study conducted with 50 students who visited the National Science Museum in Israel, Bamberger and Tal (2008) reported that the students acquired knowledge by structuring new information during their visit to the science museum, and the science center encouraged lifelong learning. Furthermore, it was determined that peer interaction and communication during the visit led to an increase in student knowledge. In a study conducted with teachers who participated in professional development program workshops organized by a science center, Ogbomo (2010) stated that workshops provided teachers with opportunities such as development of course content, experiences and discussions on course material, and collaboration with colleagues.

Several international studies were conducted to determine the impact of science centers on achievements such as career awareness, scientific attitudes, and development of creative and critical thinking skills (Bamberger & Tal, 2008; Falk & Gillespie, 2009; Falk & Needham, 2011; Wellington, 1990). Albeit late, the number of studies conducted on the employment of science centers, especially in science education, has increased in Turkey, especially after 2010 (Ateş, et al.2011; Çığrık, 2016; Çığrık & Özkan, 2016; Çolakoğlu, 2017; Karadeniz, 2009; Koyuncu, Bilici, Kırgız & Güney, 2016; Öztürk, 2017).

In addition to the research on the contribution of science centers to visitors, certain studies were also conducted to investigate the retention of the effect of the interactions initiated in science centers on visitors (Falk, Scott, Dierking, Rennie, & Cohen Jones, 2004; Stevenson, 1991; Dewitt & Osborne, 2010). In a study conducted by Falk et al. (2004) on visitors who visited a science center in four- or six-month intervals, it was determined that the impact of the visit could change over time. Stevenson (1991) applied the stimulated recall technique on science center visitors six months after the visit and reported that the stimulated recall technique was effective in promoting recall. Dewitt and Osborne (2010) determined that videos were a more effective recall technique when compared to photographs, and continuous visits by learners to science centers facilitated the acquisition of scientific terms and improve the visitors' discovery skills. In a study, Morris (2014) revealed that the academic achievement scores of the students who visited a science center decreased significantly

in a survey conducted after 2 months, while the average attitude and emotion scores of the students did not change. Dewitt and Osborne (2010) recommended that the experimental sets displayed in science centers to improve the learning potential, and short clips by public figures should be published on YouTube as a pre-visit resource in classes. Also, reminding the science center environment using photos or videos would allow students to revisit and support their interactions and reflections that would lead to more advanced science concepts. Such actions, in turn, could help maximize the learning potential of science center visits.

2. The Significance of Science Centers in Science Education

In several studies on science centers as an out-of-school learning environment, it was emphasized that these spaces stimulated excitement and curiosity, increased positive attitudes towards science and scientific topics, and developed interest and motivation through a direct participatory approach and collaboration (Ateş, et al. 2011; Bozdoğan & Yalçın, 2006; Faria & Chagas, 2012). Thus, unlike museums that offer visitors an inactive environment where they cannot touch anything, science centers offer interactive environments where they can move actively, touch and experiment, and they contribute to cognitive, affective and psychomotor skill acquirement. Therefore, science centers provide opportunities to approach natural phenomena with a scientific perspective, collaborate on problems, produce creative solutions via queries and discussions, and enjoy the discovery through scientific process skills starting from the primary school age (Bozdoğan, 2008; Çığrık, & Özkan, 2016; Çolakoğlu, 2017; Karadeniz, 2009; Koyuncu, et al.2016). Thus, the participation of the students who are deprived of the opportunity to conduct experimental activities at schools in activities and experiments available at science centers, allow them to develop critical skills and approaches such as understanding the nature of science, acquisition of scientific thinking skills, establishment of connections between science, education and industry (Öztürk, 2017; Tlili et al.2006). Science centers allow students to interact with real objects. Thus, they provide students with a positive attitude towards science course (Tenenbaum, Rappolt-Schlichtmann & Zanger, 2004; Martin, 2004). Science centers, one of the informal learning environments that allow students to learn scientific achievements meaningfully and permanently, are among the institutions that entail science, technology and education at the same time (Hannu, 1993). It could be suggested that science centers that arouse interest and excitement in visitors, offer the opportunity to experience by doing, and where knowledge is structured based on concrete experiences, are important out-of-school learning environments in preschool science education and for the development of scientific process skills (Uludağ, 2017).

In a study by Erçetin and Görgülü (2018) that aimed to determine the views of the students who visited science centers on the science course, it was reported that students developed a positive attitude towards the science course after the science center visit. Furthermore, students considered the experimental sets, etc. in the science center adequate for science course achievements, and they mostly liked the exhibitions in the categories of natural events and human body. In an empirical study, Rennie, and Williams (2002) reported that visitors had positive experiences after visiting the science center, most noticed a change in their approach to science, and this change represented not only novel information, but a step towards a change in their relationship with science.

The approach where a comprehension, meaning, and models are produced about scientific concepts and principles by working on experimental sets and exhibition material in science centers, is among the main objectives of science curricula in Turkey (Öztürk, 2017). Thus, it could be suggested that science centers have significant contributions to the improvement of learning at school through out-of-school learning spaces, facilitate the meaning and permanency of abstract concepts (Çığrık, 2016; Çığrık & Özkan, 2016; Markowitz, 2004). Therefore, it is of great importance to raise knowledge and awareness of school administrators and teachers by educational trips to science centers, the target audience of which mostly includes students and teachers (Çolakoğlu, 2017).

Science museums are structures where the visitors can touch the articles, conduct various experiments, have fun and understand natural events around them. Science topics are intertwined with daily life. Thus, science centers and science museums especially help learning abstract scientific daily life concepts while having fun (Kubat, 2018).

Especially the science curricula developed since 2000s recommended to include out-of-school learning activities as well as classroom activities in instruction (Yurtkulu et al., 2017). Literature review on these studies revealed that teachers were generally aware of the positive effects of out-of-school learning activities on permanent and meaningful learning; however, they have some reservations about the organization of these activities (Carrier, 2009; Güven, Gazel & Sever, 2004; Moseley, Reinke & Bookout, 2002; Simmons, 1998; Tatar & Bağrıyanık, 2012). The teachers did not want to deal with issues such as costs, transportation, responsibility and bureaucratic procedures (permissions, correspondence, etc.) (Bozdoğan, 2008; Dillon et al., 2006), they also did not have adequate knowledge and self-efficacy in organizing field trips (Güler, 2009), It was determined that they did not know what to do before and during the field trips (Thomas, 2010). Furthermore, it was reported that teachers experienced difficulties in sparing time for out-of-school activities due to

their anxiety about not completing the curriculum achievements (Bozdoğan, 2007).

Another reason why teachers could not adequately associate out-of-school learning opportunities with the school program was the idea that out-of-school activities would not contribute to the course outcome (Stern, Wright & Powell, 2012). However, several studies reported that when out-of-school learning activities are associated with school programs, they would be very effective on the course outcome (Bell et al., 2009; Tamir, 1991). Çığrık and Özkan (2016) emphasized that cognitive, affective and psychomotor achievements that serve the vision of training science literate individuals in science curricula would only be possible by including out-of-school learning activities in school curricula.

Several studies revealed that curricula, the activities and exhibitions available in science centers should be effectively associated for these achievements (Çığrık, 2016), and out-of-school activities that are not associated with course outcomes did not significantly contribute to and even challenge the acquisition of science achievements (Bozdoğan & Yalçın, 2006; Çalıkoğlu, 2014; Rennie et al., 2010).

2.1 Konya Science Center

Science center investments have accelerated in Turkey since 2015 under the leadership of TÜBİTAK and the support of local governments, and 12 active science centers were planned for 2023 (Çolakoğlu, 2017; Koyuncu & Kırgız, 2016). These included the largest and most comprehensive science center in Konya, which was established in 2014 with the sponsorhip of TUBITAK and Konya Metropolitan, and educational trips started during the 2015-2016 academic year based on the protocol signed with the Konya Provincial Directorate of National Education (Koyuncu, et al.2016).

Figure 1. Konya Science Center

The Konya Science Center, which includes two main sections for exhibition and education, provides science center visits designed for middle and high school students. Each student group is accompanied by an exhibition guide and an education guide, and the visits last about an hour, and are based on the touch-and-discover approach, during which the students visit the exhibition areas and attend workshops. The visiting students have the opportunity to learn by directly experiencing scientific events in exhibition areas and educational workshops. Workshops designed for science center visits were developed based on the school curricula and factors such as age group and school type (Koyuncu, et al.2016). The museum store at Konya Science Center offers interesting products such as intelligence games, educational experiment sets, popular science books for both children and adults, and special interest products such as robot kits and astrolabe telescopes.

In Konya Science Center, there are about 150 exhibitions in eight galleries (Sultans of Science, Our Body, Our World, Our Universe, New Horizons, Basic Steps, Miniature-Seljuk, Open Air Exhibitions).

> The ***Sultans of Science*** gallery includes eight main themes and 35 exhibitions. In the gallery, Muslim scholars' principles of flight, numerical systems, trigonometry, and medical instruments are exhibited.
>
> The ***Our body*** gallery includes three main themes (Vital Systems, Cells: Building blocks of the body, Genetic,

Clinical and Biomedical Laboratory). There are 31 exhibition setups under these three themes. Content about the systems and organs in human body is presented. The main objective of the gallery is to allow the visitors to learn the systems in human body and to familiarize them with the specific tasks that the organs perform in these systems for healthy survival. Participants also learn about habits and preferences that reduce risk of disease and ensure a healthy life.

The ***Our World*** gallery includes 34 exhibitions in three mains, including Ever-Changing World (Earthquakes, Earth's strata, continental movements, volcanism), Our Energy Resources (Wind, Coal, Water and Sun) Anatolian Geography (Living creatures and plant species) exhibitions.

The ***Our Universe*** gallery includes 21 exhibitions in Our Place in the Universe, Observation and Discovery, and Our Journey to Space categories.

The ***New Horizons*** gallery includes the foundations of technology and current developments exhibitions.

The ***Basic Steps*** gallery includes three main themes (observation, comprehension and physical applications). There are 27 exhibitions under these three main themes. The main purpose of the gallery is to allow the participant to observe natural events and to understand the scientific principles behind these events. Entertainment and educational areas, where the visitors could explore all basic sciences including mathematics, biology, physics and chemistry, are available.

In the ***Miniature-Seljuk*** gallery, Anatolian Seljuk and Great Seljuk artwork are presented to the visitors.

In the ***outdoor gallery***, activities such as measuring the shadow are offered for the visitors.

The compliance of the exhibitions available at Konya science center with science curriculum achievements was determined in a study by Açar and Bozdoğan (2017). In the study, it was reported that the exhibitions in the science center met only 106 out of the 248 acquisitions in the Science

course curriculum (5th-8th grades). The fact that the science center met 42% of the achievements demonstrated that it had a good potential for the science course achievements. Furthermore, it was revealed that the exhibitions at Konya science center were mostly associated with the "Living-beings and Life" and "Earth and the Universe" learning areas in science course curriculum.

Our body, the basic steps and our world galleries in Konya Science Center were selected as they are related to science education, and the associations between these exhibitions and the science course curriculum were analyzed. The exhibition titles and their associations with science course curriculum achievements are presented in Table 2.

Table 2. The exhibition titles and their associations with science course curriculum achievements

Our Body Galleries		**Our World Galleries**		**Basic Steps Galleries**	
Exhibition Names	Achievements	Exhibition Names	Achievements	Exhibition Names	Achievements
Sensory Map	F.6.6.1.1	Layers of the Earth	F.3.1.1.1.	Leverages	F.8.5.1.1
Brain Health	F.6.6.1.1	Plate Tectonics	F.5.6.3.1.	Soap Shapes	-
Brain Map	F.6.6.1.1	Fault Lines	F.5.6.3.1.	Light Waves	F.7.5.3.1
Muscles and Bones	F.6.2.1.1	Earthquake Question Test	F.5.6.3.1.	Reels	F.8.5.1.1
Bones	F.6.2.1.1	Earthquake Platform	F.5.6.3.1	Galton Box Probability	-
Bone Health	F.6.6.3.1	Real-time Seismograph	F.5.6.3.2	Circuits	F.4.7.1.1
Immune system	-	Jumping Seismograph	F.5.6.3.2	Sound Waves	F.6.5.2.1/
Immune Cell Attack	-	Mosasaur	-	Smart mushrooms	-
Immune System Weapons	-	History of Life	-	Elements	F.7.4.1.3
Seeing with Sound	F.7.6.1.2	Water cycle	F.8.6.3.1	Hydrogen Energy	F.8.7.3.5
Prenatal	F.7.6.1.2	Arid and semi-arid lands	-	Momentum	F.3.3.2.2?
Bone Tension	F.6.2.1.1	Forest ecosystem	F.5.6.1.1.	Gears	F.8.5.1.1
Cells and Organelles	F.7.2.1.1	Coastal regions	-	Simple Machines	F.8.5.1.2

Cells of Our Body	F.7.2.1.1	Helicopter Eco-tour	-	Electromagnetism / Induction	F.8.7.3.2
Atomic Family	f.6.2.1/2/	Karst Caves	-	Number Systems	-
DNA	F.8.2.1.1	Potholes	-	Prism Laser	F.7.5.3.1.
Human body	F.6.2.4.1	Resources and Recycling	F.4.6.1.1.	Motor / Motor	F.8.7.3.1
Skeleton	F.6.2.1.1	Powering a City	F.8.7.3.3.	Generator / Engine	F.8.7.3.3
Journey to the Blood Vessels	F.6.2.3.3	Coal	-	Bridges	-
Asthma	F.6.1.3.2	Personal water consumption	F.4.6.1.1.	Laboratory and Show Area	-
Healthy-Unhealthy Lungs	F.6.2.4.1.	Sky Pool	F.7.1.1.1	Air pressure	F.8.3.1.2
Heart beats	F.6.2.3.2	Astrolabe	F.4.1.2.2.	Sound Patterns	F.6.5.2.1
Digestive Health	F.6.2.2.1	Ottoman sundial	-	Organic Decay	F.8.4.2
Our Basic Needs	F.6.6.3.1	Lasers	-	Growing Crystals	-
Cardiopulmonary System	F.6.2.3.1	Records in the Rocks	F.5.6.3.1	Air Cannon	-
Gene Lottery	F.8.2.2.1	Volcanoes	F.5.6.3.1	Air pressure	F.8.3.1.2
Human Genome	F.8.2.1.1.	Rocks	F.4.1.1.1	Ball launcher	-
Lower your risk	F.6.6.3.1.	Old Konya Lake	F.3.1.2.3	Track race	-
Disease prevention	F.6.6.3.1.	Salinity	F.5.6.2.1	Ring and disc race	F.6.3.2.2
Your health	F.4.2.1.	Radioactivity	-		
Lab	-	Lava Capsules	F.4.1.1.1		

	Powers that meet electricity in the city	F.8.7.3.3
	Wildlife Areas	F.5.6.1
	Nuclear energy	F.8.7.3.3
	Wind power	F.8.7.3.3.
	Water cycle	F.8.6.3.1.
	Landslide	F.5.6.3.1
	Climate Chambers	F.8.1.2.1
	Climates in ancient times	F.8.1.2.1
	Floods	F.5.6.3.1.
	Earth energy	F.8.6.1.1
	Sustainable activities	F.8.6.3.1
	Dunes	F.4.1.1.2
	Solar Energy	F.8.7.3.3.
	Digital Globe	-

As seen in Table 2, all but 26 exhibitions were associated with an achievement in science curriculum. The high association rate between the exhibitions and the achievements indicated that Konya Science Center could contribute to the instruction of the science curriculum in Turkey. The exhibitions and associated achievements based on the grade level are presented in Table 3.

Table 3. The exhibitions and associated achievements based on the grade level

Exhibition Galleries	3th grade	4th grade	5th grade	6th grade	7th grade	8th grade	Total
Our Body	0	1	0	19	4	3	27
Our World	2	5	13	0	1	11	32
Basic Steps	1	1	0	3	3	11	19
Total	3	7	13	22	8	25	**78**

The review of Table 3 would demonstrate that the exhibitions in our world gallery were mostly associated with the science achievements when compared to our body, and basic steps galleries. Furthermore, it was determined that the exhibitions were organized based on the 8th grade science course curriculum achievements.

A study by Yalkın Şentuna (2019) aimed to determine the contribution of science centers to lifelong learning skills in science literacy and determined the contribution of experimental sets in Kocaeli Science Center Dynamic World Gallery to lifelong learning skills in terms of acquisition of scientific concepts. The study findings demonstrated that 90 experimental sets in Kocaeli Science Center Dynamic World Gallery led to the acquisition of 57 Our World and the Universe learning area achievements. It could be suggested that the Kocaeli Science Center Dynamic World Gallery was developed based on the achievements of the science course curriculum.

In a study conducted by Bell et al. (2003), it was found that association of the education in science centers and the science course had positive effects on student awareness, commitment and interest, attitude, behavior and skills. Hakverdi-Can (2013) argued that it is important for teachers to obtain information about the suitability of the experimental sets and exhibitions in the center for the student level before a trip to the science center, and even limit access to certain experimental sets that are not suitable for the student level, to avoid confusion among students. Thus, it

could be suggested that ill-planned trips to science centers that were not associated with the curriculum content could prevent achievement-oriented, permanent and meaningful learning among students (Demir, 2007; Tal, Bamberger & Morag, 2005).

While establishing science centers, they are structured in relation to the education policy and education program of the country. The high rate of reflection of the education policy and curriculum of the science centers, which have an important place in establishing the bridge between education, science and society, will increase their influence power in the society. The encounter of the students in science centers with experiment sets that show the applicability of the acquisitions they have learned in schools in daily life will provide the need for applied education. It is very important to meet the practical training needs of courses such as science education, where practical education is much more essential, in science centers. Considering that applied education in science education has positive effects on students' cognitive, affective and psychomotor skills, science centers should be organized and designed to serve the needs of students in order to realize applied education. Existence of exhibitions that reinforce the acquisitions of students in mid-term and end-of-term trips will facilitate the work of teachers, parents and school management, and stakeholders will make more efforts to solve the elements that prevent trips to out-of-school learning environments. While the teacher provides the necessary tools and materials for the process, the school method fulfills the necessary procedures, the parents will be more enthusiastic and more excited while performing the tasks that fall on them

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CHAPTER VIII

THE EFFECT OF POSITIVIST AND POST-POSITIVIST PARADIGMS ON THE CHANGE OF VALIDITY CONCEPTUALIZATION

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In this section, we will try to look from different perspectives on validity by taking into account the studies and conceptual debates on validity from past to present in the light of positivist and post-positivistic paradigms. We will try to shape our predictions for the future on the universal knowledge that the history of science has presented to us. In other words, this section, in which we try to reach the roots rather than get lost in the branches of the tree, is the logbook of a journey on the philosophical foundations of measurement.

THE VALIDITY OF WHAT?

The term validity is an adjective. Therefore, it cannot be used alone. In this respect, we started this section with the question of "the validity of what?". In scientific literature, the validity of inferences, interpretations, or conclusions is mentioned. They are claims made by researchers based on their observations. Even if it is scientific, all claims can be questioned and discussed. The validity of inferences drawn from data; validity of interpretations based on test scores; validity of the conclusions drawn from the research results can be questioned (Taylor, 2013). Besides, expressions such as validity of predictions, validity of sources, validity of measures, or validity of measurement instruments (assessment tools) are encountered in the literature or daily life. We discussed validity as a concept related to these last two, namely, measurements and measurement instruments. In fact, although the concept of validity appears in many different ways, all of these are interrelated. In short, validity is one of the most important areas of discussion for scientific research in all scientific fields such as education, psychology, sociology, biology, etc.

The American Educational Research Association, American Psychological Association, and National Council on Measurement in Education share their views on validity as follows, *"Validity refers to the degree to which evidence and theory support the interpretations of test scores for proposed uses of tests. Validity is, therefore, the most fundamental consideration in developing tests and evaluating tests. The process of validation involves accumulating relevant evidence to provide a sound scientific basis for the proposed score interpretations. It is the interpretations of test scores for proposed uses that are evaluated, not the test itself. When test scores are interpreted in more than one way, each intended interpretation must be validated. Statements about validity should refer to particular interpretations for specified uses. It is incorrect to use the unqualified phrase 'the validity of the test."* (American Educational Research Association [AERA], American Psychological Association [APA], and National Council on Measurement in Education [NCME], 2014, p. 11).

Cronbach (2009), on the other hand, mentions very earliest discussions about test validity as follows, some early writers said that a test is valid if it measures *what it purports to measure*. Other early writers said that a test is valid if it serves the purpose for which it is used. From these definitions, it appears that there is a big difference between the old and the new conceptualization of validity.

According to Angoff (2009), this active interest in a new conception of validity pointed to a more widespread philosophical shift, from the purely pragmatic and empirical orientation that characterized psychometry in the first half of the 1900s to a new and growing interest in psychometrics and psychological theory.

The question is, are these discussions over? The answer is, no. Our students, who read the latest opinions of organizations in the USA, are confused. They ask, can't we talk about the validity of the tests? In our opinion, expressions like a *valid test* or *a test has construct validity* are absolutely false. Because no test or measurement can be completely valid and the validation process is not an ending process. But there is no harm in using an expression like this: "*An achievement test with evidence that it makes valid measurements for math ability*." or "*The test with strong validity arguments*." We think that validity can be considered not only related to test-based interpretations but also in relation to the tests themselves.

A BRIEF OVERVIEW OF THE HISTORY OF SCIENCE

According to Stacey (1969), the aim of each scientific discipline is to identify and explain the subjects within its field. Science determines phenomena only through observation and experiment. Disclosure of the

detected facts is a logical process. Science uses ways of describing and explaining facts in order to reach its goal. The most basic characteristic of science is that it is experimental, and another important feature is not only how information can be reached with the methods it has established, but also allows other scientists to repeat them. The issue that has been debated by researchers for many years is whether scientific knowledge should be obtained by quantitative or qualitative methods. It is possible to come across opinions that qualitative research methods have no place in science on the ground that they destroy objectivity. Some intellectual theories reject qualitative studies altogether. For example, the quantitative research method represents the research method of the positivist paradigm; Quantitative studies are carried out on the positivist foundations (Bryman, 1984).

Social sciences have also changed form with the influence of many movements since its emergence. In particular, different philosophical views have caused various fluctuations and trends in scientific fields. These changes affected psychology, sociology and educational sciences, sometimes directly and sometimes indirectly. Therefore, it would be appropriate to examine the differences of opinion in the field of psychometrics within the historical development process of social sciences and in the context of the effects of the trends emerging during this process. Moreover, it is need to examine which currents the psychometrics discipline are influenced by, examining not only the differences of opinion, but also the issues that have been agreed upon.

The source of information is an important problem in philosophy. Some philosophers (realists, empiricist, etc.) argue that the source of knowledge is an experiment. The human mind is innately empty (tabula rasa). In this case, all information is aposteriori. On the other hand, some philosophers (rationalists, Plato, Hegel, etc.) defend that the source of knowledge is the mind and they admit that the human mind is not empty from birth. According to these philosophers, all the correct information exists in the human mind and one can reach them using his mind. Therefore, knowledge is a priori because correct information is always and everywhere the same. Information obtained through experiments based on observation data, since the observed facts are constantly changing, such information is not correct and universal. Furthermore, some philosophers claim that the source of true knowledge is both intelligence and experiment. Kant is the most important of these thinkers. According to him, concepts without intuitions are empty, intuitions without concepts are blind. Apart from all these, some thinkers say that the source of true information is intuition such as Gazali and Berkson (Sönmez, 2010).

The strengthening of the science of sociology has had such a great impact that causes radical changes in all other scientific branches. Because according to the positivist point of view of Auguste Comte and his friends, the founder of sociology, science is the basis of all kinds of knowledge, statistical analysis should be used in social theory and causal explanations should be sought for social phenomena. According to positivists, knowledge is acquired only through experience and empirical progress (Swingewood, 1984).

Another aim of positivism is the understanding of absolute knowledge. If the facts are accepted as a result of experiments, this acceptance must be universal and of infinite duration. In other words, a physics experiment should give the same result in England and Africa. An experiment should give the same result in 1830 and 1984. If this happens, the facts become facts. Positivists are also aware of the difficulties of reaching such precise information. For this, numerous research should be done and the best result should be reached. The positivist view, which finds strong support in the scientific world, has led to intellectual and methodical changes in many scientific disciplines.

Positivism approach is not the only theory that guides social sciences. Post-positivist theories have been put forward as a critique of positivism after the positivist approach has been introduced. According to Thomas Kuhn (cited in Sönmez, 2010), one of the leading names of those who criticize positivism, there are no universal and generally valid criteria to control scientific findings. Scientific criteria are determined by scientists in every period by consensus because it is not an objective activity. There is no such thing as verification, falsification, or refutation in science. Science's goal is to understand. Understanding in science is the interpretation of situations and events. There are many interpretations of situations and events because the main factor driving science is the psychological and sociological characteristics of scientists. Perception is essential in scientific research. There can be no objective perception because the scientist examines the facts with the information he has obtained up to that time. In this context, as positivists say, there is no complete objectivity. Moreover, there is no single method in science, and the method is not everything. Therefore, it is not necessary to carry out experiments in the laboratory under strict control, said Thomas Kuhn. These philosophical debates on science also affect psychology. A technique used to measure any psychological structure can be defined as a suitable technique when evaluated in terms of some approaches that have emerged in the history of psychology until today. However, when evaluated in terms of some approaches, it can be defined as an inappropriate technique for measuring the relevant structure.

The history of psychology begins with structuralism and continues with functionalism. The basic principles of behaviorism, which was born in 1913 as a radical change movement against both schools, are simple, direct, and specific. Watson, the founder of behaviorism, called this understanding objective psychology. It deals only with observable behavioral activities that can be objectively described in terms of action and response, through objective observations. Watson strongly rejected the concept of consciousness on the grounds that it harmed objectivity. According to Watson, consciousness can never be seen, touched, smelled, tasted, or moved. This is an unprovable assumption, at least as much as the concept of the soul. Then the revolt of cognitive psychology with Gestalt psychologists against behaviorism begins. There are clear differences between Gestalt psychologists and behaviorists. Gestalt psychologists have argued that it is pointless to create psychology deprived of consciousness, as behaviorists do. It starts to talk about the concepts of consciousness and subconscious. Since psychoanalytic theorists deal with intangible structures such as the unconscious, they have taken a rather different approach from the objective psychology of behaviorism. Along with recent trends such as humanistic psychology, cognitive neuroscience, evolutionary psychology, the science of psychology has a great variety in theory. As a result, psychology today is more fragmented than at any other stage in its history. Each movement embraces its own theoretical and methodological orientation by developing and advancing itself with its own language and school of thought while approaching human nature with different techniques. (Schultz & Schultz, 2015).

During research, a social scientist has to measure as a necessity of doing scientific research, no matter what theory is under the influence. Psychometry comes into play as a scientific discipline at this stage. Whether a psychologist is a gestalt, behaviorist, or neurocognitive does not affect his measurement purpose. Regardless of the technique used, the researcher has to measure with high validity and reliability in all conditions. It is clear that the decision reached as a result of evaluations based on valid and reliable information will be an appropriate decision (Cronbach, 1988, 1990). Although almost all scientists agree on this issue, discussions about how to make valid and reliable measurements have gained a philosophical dimension today. The effect of differentiating paradigms on the proposed definitions and methods plays an important role in the evolution of the concept of validity as it is felt in the whole measurement and evaluation discipline.

THE CHANGE OF VALIDITY DEFINITION UNDER THE INFLUENCE OF DIFFERENT PARADIGMS

For scientists, during the years when the positivist approach was effective on social sciences, special observations, rules, and empirical generalizations, theoretical expressions and definitions, mathematical and statistical analyzes on data collected systematically and objectively, predictability studies based on these analyzes, as a basic research understanding stood out.

It can be argued that experimentation has an important place in measurement studies under the influence of the positivist approach. Theorists made the following definition for validity in the 1930s: Validity is the correlation between test results and the results of another test determined as its criterion (Newton, 2012). Guilford defined validity similarly, in a very general sense, a test is valid for anything with which it correlates (Guilford, 1946). When the mentioned definitions are examined carefully, the traces of the experimentalism that come to the fore in the definition made will be noticed. Lissitz and Samuelsen (2007) argue that in the late 1940s and early 1950s, authors began to look for evidence as to what they might identify as inadequate in the definition of validity, moving from empirical approaches to approaches that are more theoretical in nature. After this period, researchers influenced by post-positivist approaches have embarked on a great struggle against rigid experimental approaches in the field of psychometrics. Researchers adopting post-positivist approaches in this struggle have claimed the differentiating paradigm as the correct way to access information and accused experimentalists of being backward. The positivists, who described these attempts as an attack on their scientific discipline, accused the post-positivists of making systematic disinformation propaganda to get away from science.

When the current state of this ongoing conflict in the scientific world is examined, it is seen that the domain of post-positivist approach has spread over to important institutions and organizations. This effect caused the definition of validity to take its current form. The definition of validity made by measurement and evaluation societies in the USA can be considered in this context. Based on their definition, it is stated that the phrase “validity of tests” cannot be used, but the phrase “validity of inferences made from test scores” can be used. In this sense, it would not be wrong to say that the definition of validity is shaped by a post-positivist perspective. Because of this approach, "validity" has been transformed into a concept that changes according to different usage situations or purposes of the test. It has been removed from the functional definition.

COULD THE MEASUREMENT INSTRUMENTS HAVE FIXED PROPERTIES?

The idea that qualities such as validity and reliability, which was previously described as the quality of the measurement instrument, will change in line with the scores obtained in different ways from different groups is now a dominant opinion. However, there are also researchers such as Lissitz and Samuelsen (2007) who oppose this view. Content validity is the focus of these discussions.

Suppose that we developed a test aimed at measuring mathematics achievement of Grade 6 students in Turkey. We know that the achievements expected to be reached by grade 6 students across the country are certain in the curriculum. Therefore, when developing such a test, the behavior pattern to be sampled is also determined. When the content of the test is established in line with the table of specifications and expert opinions, this is no longer a feature that will change in different regions of the country. Therefore, can the statement "content validity of the test" be considered as a false statement? If we cannot use such an expression, by what feature can we distinguish a test that has been meticulously studied in terms of content in the development process and a test developed cursorily in terms of its content.

APA experts avoid characterizing even a validation related to the content of the test as the test's feature. So, what are we going to say about standard tests whose psychometric properties are determined by applying to large standardization samples covering all subgroups concerning the feature it aims to measure? Could the values obtained from a sample that truly represents the target group is characterized as a feature of the test rather than a feature of the particular group? If not, what will the test manual be used as a reference for all practitioners? Are we going to create different handbooks for each practitioner?

Considering all these discussions, we see that the effect of post-positivist approaches on the concept of validity makes the objectivity of all measurement instruments debatable, including standardized tests.

We do not agree with the view that it is not possible to obtain validation arguments of the test itself since the test will be used for different purposes. The test developers determine the purposes of the tests and obtain validation arguments according to this line. If another researcher wants to use the test for another purpose, he/she has to obtain new validation arguments as to whether the test will be used for that purpose. The validation process is not an ending process. However, validation arguments are not independent of the test. Because there are no unlimited usage purposes for a test. In brief, a test can have many validation arguments. If these arguments are strong, the following

statement is correct in our opinion: “The test with strong validity arguments.”

CONCLUSION

It is a fact that the efforts of Auguste Comte and his friends to make social sciences as objective and absolute scientific disciplines as natural sciences contributed greatly to the formation of new scientific disciplines such as sociology and psychology. Later, opinions claiming that positivism is out of date have become widespread.

The conflict that started between these two opinions is not yet over. The positive side of this conflict is that the philosophical roots of social sciences are discussed. This issue wasn't discussed sufficiently in the emergence process of social sciences. Roots are important and will shape the future of social sciences. The negative side of the conflict is that the paradigm against positivism has become overly dominant, and therefore we tend to move away from the principles of objectivity and generalizability of science. We think that the exacerbation of these philosophical debates will lead us to a better point. We have come a long way in producing more objective, stable and generalizable results in the field of psychometrics. We're moving forward on statistical-based and more robust approaches such as item response theory. In the future, it can be predicted that mathematical models with more solid logical foundations and more easily applicable in practice will dominate the measurement processes. Also, in the near future, these models will enable us to obtain strong validity and reliability evidence for tests.

Kuhn (1991) suggests that paradigm is the key term in the development of science and according to him, the term paradigm is intertwined with science. Scientists with a common paradigm use this paradigm to refine theories, to achieve more accurate and precise measurements over time, and finally to strive to expand the boundaries of normal science. Since social sciences are newer than other sciences, it cannot be said that any paradigm is unquestionably accepted in many subfields.

The important thing here is not to fall into the delusion that any one approach is totally superior to other approaches. All approaches have strengths and weaknesses relative to each other. In addition, scientists with different perspectives contribute to the development of the scientific fields in different ways. When the common history of all sciences is examined, it can be thought that as a result of this turbulent process, a widely accepted paradigm will be reached in the field of psychometrics as in other scientific disciplines. However, the immutability of the last paradigm will always remain a matter of debate.

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CHAPTER IX

A PSYCHOLOGICAL PERSPECTIVE ON ORGANIZATIONAL LONELINESS

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THE CONCEPT OF LONELINESS

The lexical meaning of loneliness is defined as the state of being distant from other people. Loneliness is a state of mind induced by weak interpersonal relationships and social interaction. Loneliness is a mood that also includes cognitive, affective and behavioral elements that reflect the desire to establish close relations with others. The desires of individuals regarding their relationships and the things they obtain from their current relationships are evaluated and analyzed at the cognitive level. Positive or negative (mostly negative) affections that individuals experience as a result of analyses and evaluations performed are included in the affective level. Behavioral level refers to the expression of these evaluations and affections in various ways (Ernst & Cacioppo, 1999).

According to the most commonly accepted definition, loneliness is induced by the difference between the individual's expected relationship status and acquires relationship status (Peplau & Perlman, 1982).

Loneliness is a mood that is dreadful, scary, worrisome, despairing, that worries the individual, makes the individual's life meaningless, and causes the individual to form an introverted personality, to be alienated and pessimistic, and that restrains the individual from socializing. Loneliness can also be defined as a condition where adaptation to the environment is distorted, the individual feels deserted and unexplained, and where incompatibility and unhappiness dominate (Geçtan, 1999).

The feeling of loneliness arises in cases where interpersonal relationships cannot meet social needs, fails to fill personal needs and where social awards decrease. Therefore, it is not simply a feeling induced by being physically alone (Russell, Cutrona, McRae, & Gomez, 2012). Brelim (1985 quoting from (Buluş, 1997) relates the reasons for loneliness to insufficiencies in the relationships owned, wished changes in relationships and personal characteristics and explains the reason for the incompetence experienced with alienation, nonattachment to someone,

being on one's own, compulsory or forcible isolation and losing one's place.

Lonely individuals become dissimilar to other people around them in terms of their characteristics. The characteristics of individuals who feel lonely can be listed as follows(Özodaşık, 1989) (Akgün, 2001):

- They do not feel in compliance with people around them,
- Lack of social activities,
- Avoidance from taking responsibilities,
- Having difficulties making friends,
- Being introverts,
- Being shallow in relationships,
- Evaluating events negatively,
- Taking on egocentric attitudes.

McWhirter (1997)examined loneliness in five dimensions as interpersonal, psychological, social, cultural and cosmic loneliness.

- *Interpersonal loneliness:* The individual perceives themselves as distant from others.
- *Psychological loneliness:* A state of loneliness induced by the fact that different parts of the ego do not establish relations with one another.
- *Social loneliness:* A state of distancing from the group or society.
- *Cultural loneliness:* The feeling of distancing from others due to cultural loss or serious cultural changes.
- *Cosmic loneliness:* The feeling of alienation due to the disappearance of religious connection or distancing from God.

Based on the existence of different personal relationships that meet the different needs of individuals, Weiss (1973) stated that loneliness can be divided into two categories. These are as follows:

- *Social loneliness,*
- *Emotional loneliness.*

Loneliness is defined with different names based on its reason and symptoms. Social or relational loneliness is defined as the individual's inability to feel belonging to a community or a group, and the feeling out of place in the society where they live (Yaşar, 2007). Social loneliness is the absence of social relations between individuals or not being in a

community that would accept them. Shyness, having the feeling of rejection from their friends, and states of marginalization are experienced by individuals who are in such loneliness. Individuals may be freed of these feelings when they are in social interactions (Şişman & Turan, 2004). According to Weiss (1973), Vincenzi and Grabosky (1987), who are known for their studies on this subject, there are six types of relationships for everybody. The absence of one of these might be the source of social loneliness. These are *attachment, social integration, appreciation, reliable friendships, protecting-being protected* and *guidance*.

- Attachment is for the individual to develop commitments that they can feel safe. Belonging to a partner and family or a community can be given as an example of this.
- *Social integration* expresses being included in the network relationships developed in a group. For instance, neighbors, clubs, sanctuaries, etc.
- *Appreciation* expresses the knowing, recognition and explanation of the skills and abilities of the individual by others. For instance, the recognition of the employee's achievements by their managers, and also enabling others to recognize them, too.
- *Reliable friendships* mean supporting others and being supported by others.
- *Protecting and being protected* mean wishing and actualizing the goodness that one wishes for themselves, for others.
- *Guidance* means being sensitive towards others, and confidentiality and sharing (Şişman & Turan, 2004).

On the other hand, emotional loneliness expresses the absence of close and intimate emotional relationships between people. Emotional loneliness also expresses the disappearance of very important relationships as a result of events like death and divorce. Elimination of such loneliness is possible by establishing important relationships similar to previous relationships (Weiss, 1973). Young (1982) defined three types of loneliness based on time. These are as follows:

- *Transient loneliness* is a type of loneliness that is not emphasized a lot. It continues for a minute or a couple of hours, and its symptoms are not severe. It contains the feeling of loneliness experienced by many people at times.
- *Situational loneliness* contains the feeling of loneliness experienced due to the dissatisfaction of the individual, who was satisfied with their relationships before, because of the changes in relationships, or a significant loss in the individual's network of

social relations (such as leaving home, ending some relationships, etc.).

- *Chronic loneliness* reflects the dissatisfaction experienced in relationships for at least two successive years or longer periods. Chronic loneliness contains long-term cognitive and behavioral incompetence experienced by the individual. Individuals who are chronically alone, have less deep and close relationships than individuals who are experience situational loneliness.

The basis for loneliness is constituted by the insufficiency of the individual's social relations and their dissatisfaction with these relations. Whatever the ages and social statuses of the individuals, they can experience loneliness if they are not satisfied with social relations (Yılmaz, Yılmaz, & Karaca, 2008). According to studies, the rate of satisfaction with life is lower among lonely individuals (Goodwin, Cook, & Yung, 2001). Lonely individuals experience the feeling of togetherness less and feel despair for themselves, and avoid taking action again and worry about negative consequences when things do not go well (Güloğlu & Karaırmak, 2010).

In line with the literature, the reasons for loneliness can be listed as follows (Haliloğlu, 2008):

- Lack of social support
- Low self-perception
- Weak social skills
- Personal and psychological factors
- Deficiencies in social relations
- Unrealistic subjective evaluations, cognitive factors (attributions, schemes, etc.)
- Discomforting emotions or emotional stresses
- Social and environmental factors

THE CONCEPT OF ORGANIZATIONAL LONELINESS

Loneliness in the workplace expresses the state of being left in isolation due to the social environment, being isolated and be on one's own (Yılmaz & Aslan, 2013). The results of loneliness in the workplace changes with the effect of organizational variables. Since the loneliness in the workplace negatively affects psychological well-being, it decreases the performance of the employee, the perceived organizational support, weakens organizational commitment and the perception of organizational citizenship, and damages organizational culture (E. Gumpert & Boyd,

1984) (Yılmaz & Aslan, 2013). Loneliness in the workplace results in the abovementioned organizational outcomes as well as may emerge as a result of one of a few of these organizational variables (Wright, Burt, & Strongman, 2006).

Loneliness in professional life is different from general loneliness and may only be effective in the work environment. In other words, an individual who has satisfying and healthy relationships in their daily lives and who do not experience the feeling of loneliness may have difficulties in establishing social relations and receiving social support in the workplace. This may cause the individual to experience feelings of loneliness and exclusion in professional life.

The feeling of loneliness in the workplace causes the weakening of the balance between personal and organizational goals as well as resulting in a decrease in the employees' productivity and job satisfaction, the feeling of failure experienced by employees' who do not display sufficient performance in the workplace, competitive attitude, support of colleagues, out-of-job support, manager's support, workload, the climate of fear, the community spirit, job satisfaction, perceived work stress, organizational commitment, and life satisfaction (Wright, 2005). In addition to organizational results, loneliness in the workplace also has some personal results. It is known that individuals who experience loneliness encounter results such as a shocking loss of trust, high level of worry, powerlessness, high level of stress, indecision and leaving the environment that they are in (Gierveld, 1998).

All jobs have specific working conditions. If these conditions do not meet the expectations of employees, it may cause employees to feel lonely and not consider themselves a part of the organization they are in. It is acknowledged that employees, who do not get the feeling of loneliness in the workplace and who consider themselves a part of the organization they are in, may work more efficiently and healthy. It can be possible to reach the intended level by ensuring trust, which is one of the most important elements in actualizing personal relations at the expected level, and cooperation between employees, eliminating hierarchy, keeping communication channels open, developing the team spirit, re-designing the work methods, putting emphasis on the development of the employees' knowledge and skills, and meeting the employees' expectations and needs. It can be stated that the employees may experience the feeling of loneliness less in an environment where they trust the management, their superiors and colleagues and that the working environment will be more functional (Kaplan, 2011).

THE DIMENSIONS OF ORGANIZATIONAL LONELINESS

Based on the existence of different personal relationships that meet the different needs of individuals Weiss (1973) stated that loneliness can be divided into two categories as social and emotional loneliness. Similarly, Wright, Burt and Strongman, who developed a valid and reliable measurement tool that can measure loneliness experienced in the workplace in a distinguishing way from daily loneliness, measure the loneliness in the workplace in two subdimensions (2006). These are as follows:

- **Social Friendship**

The social friendship dimension of loneliness in the workplace can be defined as the perception of the quantity of relations in the workplace (Doğan, Çetin, & Sungur, 2009). The social friendship dimension mentions the employee's inability to participate in the social network in the workplace and to consider themselves a part of the social network in the workplace. It can be stated that employees who do not easily communicate with other employees, participate in social activities such as picnics, parties and dinners, who are not interested in different events like weddings, births and funerals, experience loneliness in the social friendship dimension. It can also be stated that those who experience loneliness in the social friendship dimension in the workplace have difficulties in sharing their daily problems about work and personal thoughts, in finding someone to spend time together during the breaks in the workplace, and do not feel like they are a part of the friend group in the workplace (Doğan, Çetin, & Sungur, 2009) (Mercan, Oyur, Alamur, Gül, & Bengül, 2012).

The social friendship dimension mentions the employee's inability to participate in the social network in the workplace and to consider themselves a part of the social network (Çakıcı, 2008). Communication is of great importance for organizations. According to theories developed by sociologists and economists, it is predicted that there is generally a positive relationship between trust and transfer of information. The coordination of employees can only be realized with communication. It will not be possible to cooperate when individuals are not informed about each other's needs and feelings. Every action related to communication may affect organizations (Demir, 2000).

Lack of communication in the social friendship dimension is an important factor for loneliness experienced in the workplace. Because the employees of the organization live and produce together in the social relations system. This production being efficient and effective will mainly be possible with the provision of a complete communication possibility to the members of the organization. Thus, individuals who are supported with a high level of information will move away from the feelings of loneliness

and deficiency to the extent they can express themselves and greatly trust themselves and other employees. Communication enables establishing accurate relationships at the proper time and enables group members to know and trust one another (Asunakutlu, 2002).

• **Emotional Deprivation**

It is the state of experiencing feelings of anxiety and emptiness due to the absence of close relationships with different people in the workplace (Weiss, 1973).

The emotional deprivation dimension of loneliness in the workplace includes the quality of the employee's relationships with their colleagues. This subdimension can be defined as the perception of the emotional quality of the relationships in the workplace (Doğan, Çetin, & Sungur, 2009). Emotional deprivation that emerges in professional life can be defined as closing oneself off other employees, avoidance from one's emotions and thoughts with other employees, and thinking that their colleagues cannot understand them. Additionally, it can be stated that employees who do not feel comfortable and peaceful in the workplace, who experience feelings of anxiety and emptiness in the working environment, and who cannot establish close relationships with their colleagues experience emotional deprivation in the workplace. Individuals who experience emotional deprivation in the workplace give the impression that they are distant from their colleagues, they feel excluded from the group and they experience a general feeling of emptiness.

Weiss (1973)explains emotional loneliness as the state where there is no closeness to another person, and where the feelings of anxiety and emptiness are observed. Emotional loneliness is a definition used for those who are deprived of close and intimate relationships and whose mental needs are not met in normal environments (Peplau & Perlman, 1982). After this definition is addressed, it will be understood that emotional deprivation is not related to the number of people around the individual. Because the individual may sometimes feel alone in crowds and feel like a stranger among familiar people. In this respect, loneliness is not quite related to the number and frequency of social relations experienced. In fact, the members of the same family may sometimes feel sad because they are lonely (Yaşar, 2007). Considering the emotional deprivation dimension of loneliness in the workplace from this perspective, even if the individual works in a crowded workplace, they may withdraw themselves and not want to communicate with them.

Yalom (2000)defines loneliness as that the individual considers people around them as threatening, experiences a high level of anxiety and isolates themselves from others due to interpersonal obstacles and lack of communication. Emotional deprivation can be experienced as a result of

the occurrence of the features that are mentioned in the definition of loneliness such as the obstacles between the individuals, miscommunication, the fact that the individual sees people around them as threats, high level of anxiety and isolation from people among employees or in the workplace. The effects of the feelings of loneliness on the individual and its reflections on the environment may affect some features due to the interaction between the employee and organization (Yılmaz E. , 2008). In places where employees do not trust the other employees enough, individuals will perceive each other as threats. This will cause the communication environment in the workplace to be damaged and the employees to feel a high level of anxiety and drift away from other employees. This negative environment in the workplace will affect employees so that they will experience emotional deprivation.

Personal characteristics of the employee should also be considered in the emotional deprivation dimension of loneliness in the workplace. Because employees will want to see certain behavioral patterns outside the work as well as in the workplace. The employees' behaviors are sometimes responded positively in the workplace, but this behavior of the employee will sometimes be criticized by their friends. For example, an employee who is aggressive and has a high level of boldness may not comply with an institution where kindness, respect and compatibility values are dominant (Yaman, 2001). This incompatibility between the self and values of the organization (person-environment incompatibility) may arise the feeling of loneliness among the employees (Wright, 2005).

It can be stated that disappointments, misunderstandings, offense, the fear of not being understood and the feeling of incompetence experienced in the relationships with other people have a share in the loneliness the individual feels in the emotional deprivation dimension. Individuals who have experienced the psychological distress of such an insufficient communication environment may prefer avoiding intimate social relationships in order not to experience similar disappointments and misunderstandings again and to stay alone. In fact, they may not hesitate to make a special effort to stay alone. Because individuals generally put thorns around them and turn in on themselves to cope with suspicion and distrust in a place where relationships have become barren like cactuses that collect water to live. Defeats that lonely people face in their social relations cause them to feel rejection, worthlessness, incompetence and disappointment, and these feelings are among the important reasons for loneliness. Thus, Kuiper et al. determined that individuals prefer loneliness as a coping method as a result of negative life events experienced (Yaşar, 2007). Additionally, those who experience the feeling of loneliness feel weak, abandoned and desolate in time; thus, drift apart from society. In this case, they may see people as unfaithful and unreliable, and they may

sometimes act distant, reckless and cruel towards them (Yaşar, 2007). Such negative life experiences and prejudices may cause individuals to experience feelings of deprivation intensely.

THE RESULTS OF LONELINESS IN WORKPLACE

Loneliness in the workplace is a mood induced by insufficient relations in the workplace (Wright, Burt, & Strongman, 2006). According to Gumbert and Boyd (1984), loneliness in the workplace negatively affects individuals' psychological well-being. Loneliness also negatively affects the performance in work. Moreover, loneliness in the workplace is also affected by the lack of social support and working alone. This effect is so much more than the lack of social activities. The relationships between people in the workplace are associated with loneliness rather than factors like organizational citizenship and teamwork (Wright, Burt, & Strongman, 2006). The effects of the feelings of loneliness on the individual and its reflections on the environment may affect some features due to the interaction between the employee and organization (Yılmaz E. , 2008).

One of the significant consequences of loneliness in the workplace is the decrease in productivity and job satisfaction. The employees who cannot display sufficient performance at work due to loneliness may get the feeling of failure and self-insufficiency, and this will cause them to have decreased job satisfaction. When an employee cannot feel belong to a group, their feelings of loneliness will increase and productivity will decrease.

Another consequence of loneliness in the workplace is stress. Considering that loneliness is a condition that may affect the psychological, physical and social integrity of an individual, it can be stated that those who experience loneliness in the workplace, have a high level of stress. Studies have revealed that stress has different effects on people and decreases productivity.

Wright (2005) stated that loneliness in the workplace is significantly associated with mental features such as the competitive attitude, support of colleagues, receiving support outside the work, managers' support, workload, the climate of fear, job satisfaction, perceived work stress, organizational commitment, satisfaction with life.

Other consequences of loneliness in the workplace can be summarized as a high level of concern, self-masking, worry, increased anxiety, impatience, emotional withdrawal and burst of anger (Adamson & Axmith, 2003). In addition to these consequences, it was stated that individuals who experience loneliness in the workplace complain about having no colleague whom they can share their experiences, search their

ideas and consult to and that they have no confidence to share their worries about their job (E. Gumpert & Boyd, 1984).

METHODS OF COPING WITH LONELINESS IN WORKPLACE

It must be accepted that loneliness in the workplace is an inevitable condition or an unsolvable case. Loneliness in the workplace is sometimes displayed as a "burst of anger" and sometimes as "emotional withdrawal" by employees. Just how the occurrence reasons for loneliness in the workplace and its effects on the employees vary, the methods of coping with the loneliness in the workplace also vary (Kaplan, 2011).

Expecting the feeling of loneliness that already exists or will later emerge in the workplace, to be eliminated in an instant with some improvement actions is not accurate. How long an individual stays in a negative social environment or is exposed to negative and destructive interpersonal relationships, the feelings of loneliness and isolation get that much deeper (Ernst & Cacioppo, 1999).

One must pay attention to three things to cope with loneliness in the workplace (Kaplan, 2011). These are as follows:

- **Interpersonal Relationships in the Workplace**

Establishing sincere relationships that may actualize the operating of the organization is up to the employees (Wright, 2005). The employees' relationships with one another, the ability to discuss problems and gather around a common understanding affect the achievement performance of the organization. Social networks formed in the workplace may develop daily styles of interaction outside the work. Fine (1986) took the relationship between organizational and organizational sincerity into account and determined a few factors that increase the interpersonal relationships among colleagues. These factors are humor, ceremonies and celebrations, activities shared outside the work and common tasks.

Aronson and Patnoe (1997) determined that school-age children attach more importance to trust and friendship when theoretical classes, which are normally taught in the classroom, are taught outside in nature in cooperation. Researchers have emphasized that positive social improvement can be achieved without harming academic achievement. Environments that promote working together, shared goals and employees who can gather around the goals of the organization may experience feelings of friendship without decreasing work performance, and social isolation in the workplace will, thus, decrease.

Generally, people tend to establish interpersonal relationships in the easiest way in social environments which enable sharing common values and similar backgrounds (Fine, 1986). The working environment and

organizational climate have the potential of affecting the quality of interpersonal relationships in the workplace. For instance, some working environments actively promote cooperation, friendship and socialization among employees. On the other hand, some working environments encourage individualism, distrust and competitiveness. The quality of interpersonal relationships among people in these two workplaces cannot be the same. Thus, the quality of relationships in the organization is expected to increase when positive values are supported in the workplace. It can be considered that employees with quality and satisfying relationships in the workplace will feel loneliness less.

- **Social Support in the Workplace**

Dignam and West (1988) report that support received from friends, family and colleagues provides a powerful and natural force that protects the individual from the harmful effects of stress. In the literature on social support, two important models for reducing stress draw attention. These models can be classified as the "direct effect" model and the "buffering" model that decreases the effect. The direct effect model advocates that social support directly affects the psychological and physiological health of the individual regardless of the severity of stressors experienced. In other words, social support and stressors act independently on the employee (ChockalingamViswesvaran, Sanchez, & Fisher, 1999). The second model, which is stated as the moderator model, buffers the harmful outcomes of stress from the individuals. Because individuals who have a low level of support are reported to experience the relationship between stressors and tension more severely (Beehr, Farmer, Glazer, & Nair, 2003).

Wright (2005) reveals the effect of social support provided for the individual by other employees and managers in the workplace on loneliness. According to his study, job satisfaction of the employee who has sufficient social support will increase, the feeling of success will increase, the employee will be able to share their work-related problems and will see themselves as a part of the organization with the increasing feeling of trust toward the organization. It is an expected result for the level of loneliness of the individual with these positive values to directly or indirectly decrease. Additionally, if an individual does not value establishing high-quality relationships, then social support may not affect that person's loneliness in the workplace.

- **Friendship in the Workplace**

Workplace friendships are defined as relationships that are established with mutual commitment, trust and love, which include not only acquaintance but also romantic commitments, and which are realized with mutual interests and values (Berman, West, & Richter, 2002). It is stated that workplace friendships decrease the stress in the workplace by

increasing support and information that help people to do their work, increase communication by supporting formal and nonformal horizontal and vertical interactions in communication, help employees and managers to achieve their tasks and support the acceptance process for organizational change. Workplace friendships may also make the work more lovable and increase personal creativity (Yager, 1997). In the perspective of the organization, workplace friendships may increase organizational commitment (Rawlins, 1992), morale, and decrease the workload (Kram & Isabella, 1985).

Workplace friendships may differ in certain aspects compared to friendships established in other environments. Workplace friendships can be tested and limited around events unlike other environments where friendship can be experienced (Winstead, Derlega, Montgomery, & Pilkington, 1995). For instance, a work-based friendship between two people who work together in the organization and are at similar levels might regress with the promotion of one of them to the management level. Studies show that it is generally easier to establish friendships in the workplace based on equivalence in terms of status. Considering subordinate-superordinate friendships, maintaining such friendships is more difficult since work-related tension and stress may reflect on friendship. Friendships between peers and individuals with the same status tend to support a more balanced friendship (Fine, 1986).

Some studies show that the quality of friendship in the workplace is associated with job satisfaction (Hackman & Greg R, 1975).

Despite the abovementioned benefits of workplace friendship, many organizations may pose a negative attitude towards workplace friendship. There are also study results that validate these attitudes of organizations with this negative perspective. Gutek (1985) reported that workplace friendships may cause a conflict of interest, turn into a romantic commitment, and the problems of the friendships may damage the trust within the organization, and workplace friendships may even cause sexual discomfort allegations and criminal behaviors. Berman, West and Richter (2002) stated that workplace friendships may cause unstoppable office gossips, divert the employees' focus from work-related activities, and threaten the authority of the managers due to the formation of alliances between employees that may harm the mission of the organization. Additionally, recent studies, current news and literature based on the statistical data have documented the positive outcomes of significant and close relationships among individuals in the workplace. It is seen that worries and the feeling of membership are often shared, community awareness is provided or the individual may experience a sense of belonging in workplace friendships (Fine, 1986).

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CHAPTER X

EXPECTATIONS AND FACTS FROM PROBLEM SOLVING IN MATHEMATICS: AN APPLICATION EXAMPLE

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INTRODUCTION

The increasing role of science and technology in our lives has in turn increased the need for mathematical thinking and problem-solving skills. The Council of National Mathematics Teachers stresses that the goals of school mathematics for all students are increasingly and willingly dealing with problems and solving the problems. It is important to educate students who can use mathematics in their daily lives and who can catch up with real life while solving mathematical problems (NCTM, 2000). The increase in science and technology as 21st century skills in our daily lives also highlights mathematical competence. Mathematical competence, along with literacy, brings out the need to raise individuals with mathematical thinking and problem solving skills. In order to develop mathematical competence, problem solving, association, communication, modeling, reasoning have been emphasized in secondary school mathematics programs since 2005. The general aims of the Mathematics Curriculum related to the subject are stated as; "3. Will be able to express their thoughts and reasoning easily in the problem solving process and will be able to see the gaps or deficiencies in the mathematical reasoning of others. 9. Will be able to develop a positive attitude for mathematics through his / her experiences in learning mathematics and develop a self-confident approach to mathematical problems." (MoNE, 2019).

Mathematics is a living subject which seeks to understand patterns that permeate both the world around us and the mind within us. Although the language of mathematics is based on rules that must be learned, it is

important for motivation that students move beyond rules to be able to express things in the language of mathematics. This transformation suggests changes both in curricular content and instructional style. It involves renewed effort to focus on seeking solutions, not just memorizing procedures; exploring patterns, not just memorizing formulas; formulating conjectures, not just doing exercises (Schoenfeld, 2016).

Mathematics, which is "a system consisting of ideas (structures) and connections developed as a result of sequential abstraction and generalization processes" (Baki, 2008, p. 84). It is also a study of patterns and relationships and a way of thinking, carefully using defined terms and symbols (Reys, Suydam, Lindquist & Smith 1995: cited in Gökkurt, Soylu & Gökkurt, 2012). It can be expressed as a science that includes cognitive learning such as theory, rule, problem solving methods. Mathematics is abstract in nature, and the development of mathematical thinking is possible when the situations in daily life are approached from a mathematical perspective. Mathematical language, which is considered as a meta language formed by the combination of mathematical concepts or objects, references based on dialogue and logic, and everyday words, ensures that the focus of communication processes in which it acts as a message element is mathematics.

Among the professional development standards of mathematics teachers determined by NCTM (1991); expose students' thoughts, conflict with them and question them creating tasks and questions; carefully listening to students' ideas; asking students to clarify and validate their ideas verbally and in writing; the responsibilities of deciding when and how to add mathematical representation and language to students' ideas are included. Therefore, teachers are obliged to use various methods to enable students to communicate about mathematics and to evaluate their development (Thompson & Chappell, 2007).

It is also known that there are difficulties in transition to the algebra world at the secondary school level where arithmetic comprehension is dominant. It is known that the variables that form the basis of algebra are not structured correctly in the students' minds, although one of the strategies that students use most while solving problems is "establishing equations or inequality". Unfortunately, the expected level of performance cannot be achieved in this strategy, in which our students can use the language of mathematics effectively. At the core of this strategy is writing

the relationships specified in the problem as equality or inequality. Algebra topics consist of two basic concepts, namely variable and equation (Knuth et al., 2005). Although the concept of variable constitutes the basis of algebra, only the conceptual aspect is neglected and the operational aspect is emphasized while the course is being taught (Ersoy & Erbaş, 2002). In the studies conducted, it was observed that students in different age groups could not conceptualize the relational meaning by seeing the equals sign only as a symbol and have misconceptions (Falkner, Levi & Carpenter, 1999; Kieran, 1992; Yaman, Toluk & Olkun, 2003). At this point, the situations (just memorizing procedures or formulas, just doing exercises) stated by Schoenfeld (2016) come to the fore. In this context, problem solving skills can validate all these efforts but first of all it is useful to examine other strategies that make it possible to solve problems without equation.

Tertemiz, Çelik and Doğan (2014) revealed that the most preferred strategy of prospective classroom teachers was "write an equation or inequality" strategy, and "look for a pattern" and "make a drawing or diagram" strategies were among the mostly preferred strategies. There are studies in the literature showing that similar situations are valid for students. The strategies they use most are make a drawing figures or diagrams, look for a pattern, establishing equations or inequalities, simplifying the problem, and guess and check, act it out. As an example, the strategies used in Altun and Arslan's (2006) study are "simplify the problem, "guess and check", "look for a pattern", "drawing a figure", "make a systematic list" and "work backward", and these were chosen based on the 7th and 8th grades. Thus, studies show that students use some problem-solving strategies informally, although they have not received any training on this subject (for example, Yazgan & Bintaş, 2005; Altun & Arslan, 2006).

There are studies showing that problem solving skills can be learned (Anzai & Yokoyama, 1984; Çelik & Güler, 2013; Artut & Tarım, 2006; Ersoy &Güner, 2014; Gökkurt, Örnek, Hayat & Soylu, 2015; Verschaffel, De Corte, Lasure, Van Vaerenbergh, Bogaerts & Ratinckx (1999). Studies have revealed necessity to provide different experiences and environments in which teachers will deepen, develop, and share their knowledge and advance their mathematical knowledge like the features requested from the students. Teachers can fulfill what is expected from them but if they are competent in this subject since their undergraduate

education. In fact, problem solving provides problem situations for teachers at each grade level where they can use pedagogy and field knowledge together.

Teachers who are not aware of the problem-solving strategies cannot help students explore the various ways in which a maths problem can be solved. In many cases, students think that they can solve a mathematical problem in only one way, based on the nature of the problem being taught (e.g. age problems, profit-loss problems, mixing problems, etc.) or that some computational processes or formulas are the only approaches that can work. Morover, international examinations such as PISA (2015) report reveal that our students do not perform as expected. In this context, problem-solving activities for both current and future mathematics teachers offer an opportunity to effectively develop and teach and for students to become mathematically literate.

It is believed that prospective teachers' views on the integration of problem solving into mathematics teaching will directly affect or shape their experiences in professional life. In this direction, the main aim of the research is to determine the prospective teachers' views on problem solving in mathematics education. As a result, it is important to explore prospective teachers' thinking on the integration of problem solving into mathematics education.

METHOD

The study adopted a qualitative research design, and participants were asked to provide written answers to open-ended questions. The participants in the study were prospective fourth-grade teachers studying in the Mathematics Education Department at the Faculty of Necatibey Education at Balıkesir University. They were selected by criterion sampling. The criteria were that prospective teachers had successfully completed mathematics field education courses and had an idea about problem solving strategies. The study was conducted in the spring semester of 2018-2019 academic year.

In this study, 30 prospective teachers were asked to apply one or more problems chosen by them for a maximum of 1 lesson hour. Books written by Posamentier and Krulik, translated to Turkish by Akgün, Kar and Öçal, Problem solving in Mathematics (for 3-6 grades), written by Altun (2015), Efemat (5-6, 7-8) Mathematical Applications, Non-rutin

Problems, Mathematical Literacy Questions, written by Yazgan and Arslan (2017),
Mathematical Non-rutin Problem Solving Strategies and Examples and textbooks used in mathematics curriculum were used as sources. While some prospective teachers decided on which grade level would be appropriate for the problems, others used the book they cited. Some prospective teachers chose the same problems but wanted to compare the results by applying them at different grade levels. Prospective teachers were asked to explain, in writing, their views on on problem solving. For this reason semi-constructed interview form was developed by the researcher. Form includes the following questions:

1. *How many problems did you address to which grade level? Which problem solving strategies are you expecting your students to use while they are solving problems?*
2. *Why did you choose these problems?*
3. *What are your views on problem solving applications?*

These questions are the research problems too. The qualitative data were analyzed using descriptive analysis technique. The views were separately analyzed by the researcher and an expert in assesment and evaluation. The reliability of the study was tested on the basis of the reliability formula proposed by Miles & Huberman (1994), namely "reliability = number of agreements / (number of agreements + number of disagreements). The reliability, as calculated with the formula, was 98%. Since the value was higher than 70%, the reliability was confirmed (Miles & Huberman, 1994). PT1, PT2, PT3, ... , PT30 was used for the abbreviation of prospective teachers.

FINDINGS

Findings for the first research problem

30 prospective teachers participated in the study. Prospective teachers addressed 95 problems, ranging from 1 to 6, to students in grades 5-8. Prospective teachers applied the practice in schools where they have their internship. In this study, 650 students from 11 practice schools were studied. A second application was not made to the same students. 57% of prospective teachers chose 2 or 3 problems for the application and applied the problems in 6th and 7th grades.

Table 1. Number of problems and application grades chosen by prospective teachers

Problems	**f**	**Grades**	**f**
1	2	5	5
2	8	6	12
3	9	7	8
4	5	8	5
5	5	**Total**	**30**
6	1		
Total	**30**		

Table 2. Frequency and percentage values of strategies to be used in solving problems

Problem solving strategies	**Descriptive statistics**	
	f	%
Make a systematic list	18	13
Make a drawing or diagram, draw a picture	24	17
Look for a pattern	18	13
Work backward	7	5
Guess and check	18	13
Write an equation or inequality	14	10
Make a table	-	0
Reasoning	19	13
Act it out	14	10
Simplify the problem /benefit from similar simple problems	9	6
Total	**141**	**100**

In the literature, there are the six most common problem-solving strategies which are to guess and check, make a drawing or diagram, draw a picture, look for a pattern, simplify the problem, make a systematic list and work backward that used by 5-8 th grade students. Similarly, prospective teachers mostly preferred strategies that are to make a drawing or diagram, make a systematic list, look for a pattern, guess and check. According to the table 2, it is noteworthy that the problems to be solved with making a table strategy are not included at all. Prospective teachers

explained that they do not prefer these problems because they too find this problems the most difficult type of all. Making a table strategy requires using parameters given in a problem to write an equation or a mathematical model or a formula, etc. This strategy also requires abstraction and minimum high school grade level.

Prospective teachers preferred problems related to the use of almost all problem-solving strategies but make a drawing or diagram strategy is higher than others. In particular, the students could not display the expected performance in making a drawing or diagrams. Similarly, they did not tend to act it out. These strategies, which are expected to be used especially by 5th grade students, have never been used in the solutions. After the application, prospective teachers' resolving strategies with the acting it out or making a drawing, attracted the attention of the students and made it possible for them to see that the problems they had difficulty could be solved easily. It is thought to provide permanent learning by prospective teachers.

More than one strategy is used in order to solve some problems. For example in the ‘’If there are 20 people in a party, how many handshakes would have occurred’’ problem, making a drawing shapes or diagrams, simplifying the problem and looking for pattern strategies are used. Some problems can be solved with different strategies. For example, while the problem presented in the figure can be solved by guess and check strategy at grade 5 and 6, the result is reached by the strategy of writing an equation at grade 7 and 8.

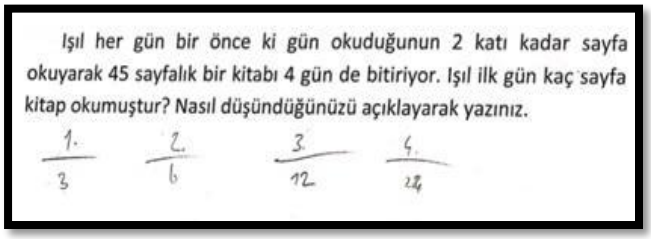

Figure 1. “Işıl reads twice as many pages as the previous day and finishes a 45-page book in 4 days. How many pages did Işıl read on the first day? Explain how you think.”

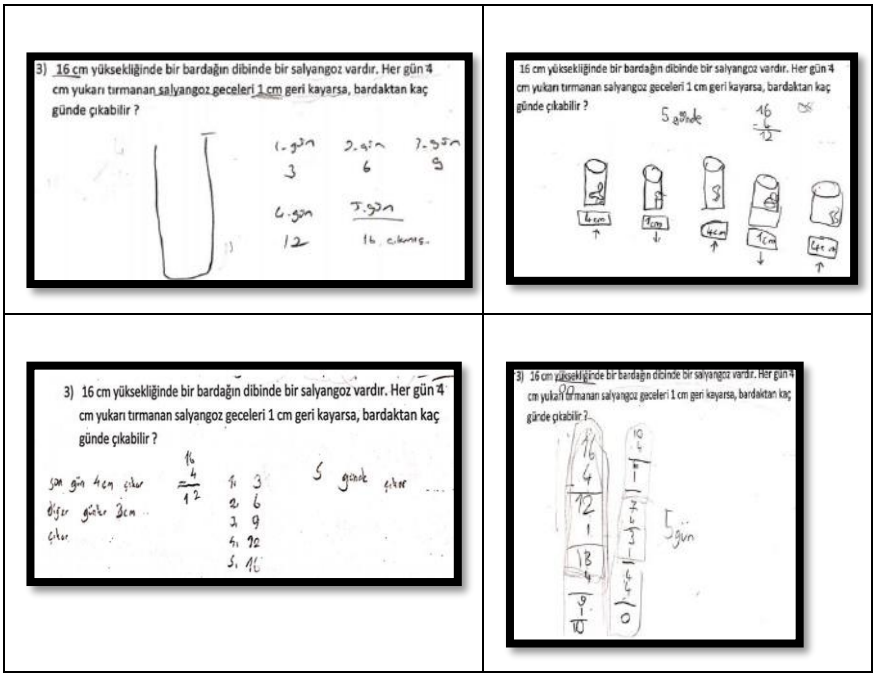

Figure 2. Example of snail problem that can be solved using different strategies ("There is a snail at the bottom of a 16 cm long glass. If it climbs up to 4 cm during the day and slides back 1 cm at night, how many days can the snail leave the cup?")

It has been observed that the problems that require reasoning have attracted the attention of the students rather than the other types of problems and they have spent more effort and time to solve them. Prospective teachers were asked to solve these problems especially. (eg. egg cooking problem [We have two cooking machines. One is set to 4 minutes and the other is set to 7 minutes, and the time can neither extend nor shorten. We do not have any other cooking tools. You are asked to cook an egg for two minutes, how do you do it?])

Reasoning strategy is often preferred in solving real life problems. Students liked to see the applications of mathematics in daily life and through these problems, they were able to relate their mathematical knowledge to daily life. As a matter of fact, after the application, students have the opinion that they do not solve such problems in the lessons and that they want them to be included more.

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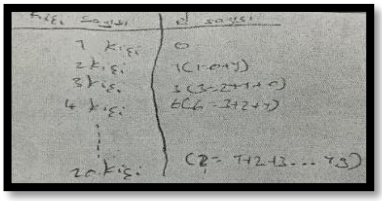
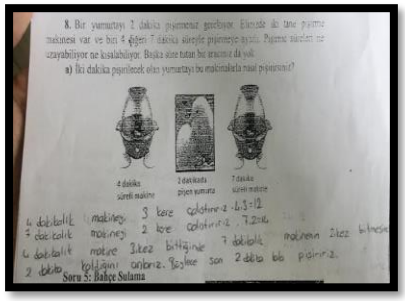
<td> 
Look for a pattern (handshake problem)</td>
<td> 
Reasoning (egg cooking problem)</td>
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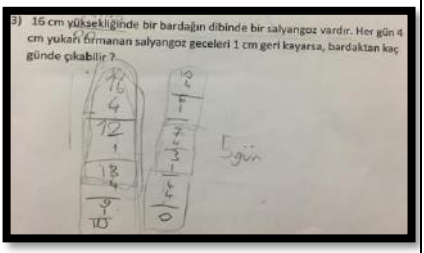
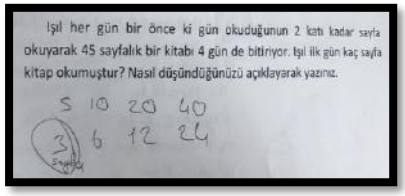
<td> 
Work backward (snail problem)</td>
<td> 
Guess and check (reading problem)</td>
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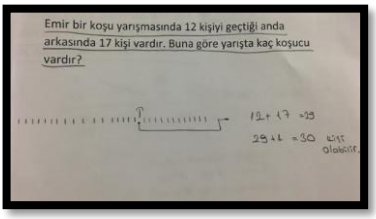
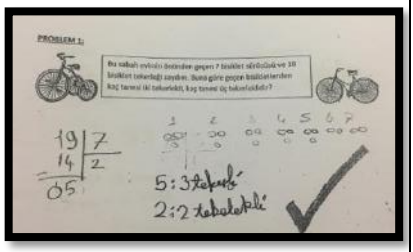
<td> 
“a problem with thinking about the passing of someone in a run and determining how many people are running”

Make a drawing or diagram, draw a Picture</td>
<td> 
“a problem with determining the number of wheels”

Make a drawing or diagram, draw a Picture</td>
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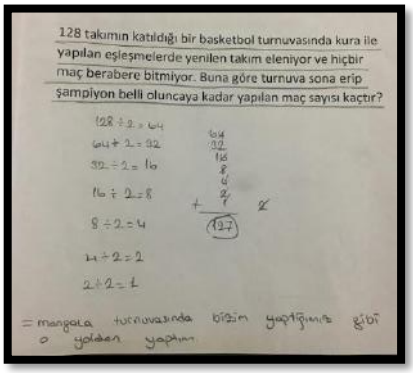
Figure3. Problem solving strategies and Sample problems



"How to determine the champion in a basketball tournament?"
Simplify the problem /benefit from similar simple problems

Figure3-continued. Problem solving strategies and Sample problems

Findings for the second research problem

When reasons for prospective teachers to choose problems were examined, 6 categories emerged. Table 3 presents the findings. Expectation of students to find a solution using a strategy and The suitability of the problems to the students' grade level stand out in line with the expressions stated by almost all of the prospective teachers

Table 3. Reasons for choosing the problems, frequency values and sample views

Reasons for Choosing Problems	**f**	**Sample views**
Expectation of students to find a solution using a strategy	30	"Since the problem had more than one solution, I would expect them to use a systematic list-making strategy. They also learned to solve equations that year, so they could have used an equation-building strategy." (PT28)
The suitability of the problems to the students' grade level	23	"Problems were appropriate to their grade level and if they have read it thoroughly, they could have answer easily." (PT12) "The problem is feasible for most students because I have seen lower grade levels solve this problem." (PT18)
Wondering how will students solve the problems	4	"I want to examine the approaches of the students to these problems and how they find the solutions." (PT2) ''My application class was grade 6 and I chose this problem because they have not took equations yet. I wondered how they will proceed without equations." (PT1)
A problem that attracts students' interest	3	"The class is generally indifferent to mathematics and the level of the class is not very good. So I chose problems that would interest them." (PT18) "I wondered whether the problems that would interest me, would interest them too." (PT1)
Examining their attitudes towards problems	2	"My aim in the application was to examine students' attitudes towards non-routine problems." (PT3)
The possibility of applying a method they have memorized	2	"Most of the students chose ratio-proportion without thinking and found the wrong answer. This problem showed how much our students used to recite." (PT12)

		"This problem was the one that I thought they would get it wrong the most, and it was." (PT21) (iron cutting problem)

Findings for the third research problem

When the prospective teachers' views about problem solving were examined, it was found out that the views were gathered under the themes of "The situations encountered on the application" and "Students' problem solving approaches" and sub-themes related to them.

Table 4. The findings concerning the opinion on problem solving

Theme	**Sub-Theme**
The situations encountered on application	The revision of the problem
	Contributing to professional development
	Outputs
	Attitudes
	Problems
Students' problem solving approaches	Learning barriers
	Outputs

In the sub-theme of the students' problem solving approaches, it was concluded that the prospective teachers emphasized the learning barriers of the students. Numerous categories of learning barriers and 67 views have emerged, so rich data on this sub-theme has been obtained. It is clear that prospective teachers gave views to more than one category. It was concluded that students' learning barriers are the factors that affect problem solving success. Prospective teachers also expressed their views on the outputs.

Table 4.1. Findings related to the situations encountered on application

The situations encountered on application		**f**	**Sample views**
Sub theme	**Category**		
The revision of the problem	Reducing/ increasing the number of problems/ keeping it the same	10	"I did not wish that I had asked more problems because students barely solved two problems." (PT5) "If I could do it again, I would like to choose more problems for the students." (PT9) "If I could do it again I would choose the same questions, and I would not reduce the number of them. Because easier questions would not be suitable for 7th grade level." (PT30)
	Sorting the problems from easy to difficult	3	"I should have sort the problems from easy to difficult. The first problem exhausted the students and they started on other problems with little motivation, they had difficulty focusing and more students could have solved the last problem." (PT4) "I wish that I started with simpler problems." (PT9)
	Offering options	1	"If I apply the study again, I would have ask 3 problems and say answer whichever you would prefer." (PT17)
Total		**14**	

Contributing to professional development	Giving more space to real life problems in the lessons	11	"When I become a teacher I believe I should give more space to non-routine problems in my lessons." (PT2) "I saw that students have too much prejudices against mathematics and its applications. In order to fix that, at the beginning of each class, we can give a daily life problem and argue on it for 5 minutes." (PT5) "It concerned me that out of 22 students only 1 gave the right answer. It is necessary that students encounter with these type of problems more often."(PT11) "Students see mathematics as taking notes, passing the course instead of as life. These problems will answer where will we use mathematics in our daily life question." (PT25) "I think if there were more problems like these ones about the daily life, students can learn easier. I saw that these problems gain students attention and interest more than practices and routine problems." (PT29)
	The effect of gaining self-confidence in students	2	"The misconception that they will always get it wrong should be eliminated. They should be confident in themselves and their solutions." (PT28) "The fact that the problems were removed from test logic and that there were shapes and pictures and also with a little effort they could solve the problems easily increased the possibility of leaving them empty." (PT30)

	Group work	1	"If I could apply it again I would make the students study in groups." (PT17)
Total		**14**	
Outputs	Differentiation of expectations and solution reaching rates	12	"There were less correct answers than my prediction." (PT1) "The ratio of reaching the correct results was lower than I expected." (PT4) "I thought the students can easily form equations but they did not meet my expectations." (PT6) "Students failed to show the performance expected from them. This was due to the fact that they had not done these practices before and were not accustomed to such problems." (PT9) "I could not get the results I wanted because students were not that eager, did not want bother and had lack of explanations." (PT18)
	Meeting the expectations	3	"The result of the application was as I expected. The amount of correct answers were as I expected." (PT27) "I saw that students first decided on a strategy then tried to solve the problem when solving the problem." (PT30) "I got the results I expected from class in all three problems." (PT3)
Total		**15**	
Attitudes	Being satisfied by students' interest	13	"Our application process was very enjoyable and I was very happy with the students who really tried to solve the problem. I have seen that students find it difficult to solve these problems but had fun trying to solve them." (PT9) "It attracted the attention of the students and the application

			process was enjoyable for me as well." (PT10) "I really enjoyed the application. And most of the students solved the problems fondly and willingly." (PT29)
	Being pleased with students finding different solutions	6	"They surprised me by finding a way to the solution even I did not know of." (PT1) "They made creative solutions to the problems that require reasoning, and I enjoyed the ideas that were produced." (PT13) "Students are overly interested in problems where there is no single solution. It was a really good experience to watch them find a different result from their friends and say that I solved it like that, and they could produce solutions themselves." (PT30)
Total		**19**	
Problems	Explaining more than necessary so that students would understand	6	"In general, they asked me a lot of questions to understand the problem, and I explained it in detail each time." (Pt7) "I explained the problem in the class again and again. But no one gave the correct answer." (PT13)
	Inability to determine the degree of difficulty of problems	5	"I would have included a problem that uses the same strategy but is easier level wise. I can not say that I have had efficiency from this problem. "(PT3) "I would have wanted to do the same application with different and easier problems"(PT9)
	Inability to determine the time correctly	5	"The students completed the practice in a longer time than I expected when solving the problems." (PT21)

			"Even half of a lesson hour was not enough for some students. I should have given them more time.'' (PT30)
	Feeling the need to edit the expressions in the problem	2	"I think the students had difficulties understanding the problem. The reason for this is the expression of stopwatch in the problem. The problem would have been more easily understood if it had been asked in the form of an hourglass instead of a stopwatch."(PT7)
	The problem being not appropriate to the class level	2	"I concluded that the problems were not suitable with the level of 5th grade.'' (PT4)
Total		**20**	

Table 4.2. Findings related to students' problem solving approaches theme

The situations encountered on application		**f**	**Sample views**
Sub theme	**Category**		
Learning barriers	The fact that students have never encountered such problems before	11	"Thanks to this application, I realized that the students never encountered real life problems." (PT5) "Lessons are focused on exercises and routine problems. They solve problems that tell students what to do and don't need any thinking about." (PT6) "They commented that they were not accustomed to such problems, that they were not very familiar with them, and that they had difficulty perceiving them." (PT9)

	The fact that students have never encountered such problems before	10	“Although there were more than one correct answers to the problem, the students who answered correctly always reached the same conclusion.’’ (PT7) ‘’The students wrote a single case instead of writing all possible cases. They did not think that the problem could have more than one solution.” (PT16)
	The fact that students have never encountered such problems before	8	“Most students could not solve the problem because they ignored the concept of day and night in the snail problem, but they took the progress of a day into account. (PT26) “The common situation among students was that the effects of day and night on the problem was not understood.” (PT3)
	The fact that students have never encountered such problems before	7	“I noticed that some students did not want to write down their train of thought. They voiced their ideas of solution aloud, and I had difficulties getting them to write it on paper.” (PT6) “I had to have a talk with the students because they couldn't or didn't want to write their solution on paper. Most students have this problem, they have difficulty expressing themselves.” (PT26)
	Lack of knowledge of concept/To have misconceptions	7	‘I realized that the students did not know the concepts of profit and loss.’’ (PT7) “I noticed that they could not distinguish between discount and coupon applications in shopping problems and they thought both of them as discounts.” (PT19) “I have seen that the students find the solution as if they were asked about the

			circumference when they needed to find the area." (PT25)
	The fact that students tend to make process-oriented solutions	7	"They tried to reach the result by adding, subtracting, multiplying and dividing the numerical values in the problem.'' (PT7) "In the statement, the student said that I had added two numbers. This indicates that they tend to add the given values. Because they did not use a convincing drawing or expression." (PT23)
	The fact that students have negative attitudes	6	"They decide whether to do the problems according to their length or shortness without reading. The students had too much prejudice and fears about mathematics and problems." (PT5) "The students did not want to solve the problems." (PT17) "As soon as I gave them the problems they asked if they were going to be graded." (PT25)
	Failing to applying the correct strategy	5	"1 or 2 students who started the equation correct, left the problem incomplete when they could not reach the correct result" (PT6) "Students do not know how to move in their working backwards strategy." (PT11) "Some students used the guess and check strategy, but gave complex, incomprehensible answers.'' (PT15) They used the systematic list strategy, but instead of all the cases, they wrote half." (PT29)
	Making mistakes	3	"If they did not make a mistake in the process, they would have reached the right solution. (PT23) "Other mistakes were related to inability to perform multiple classifications and to reverse them. They used the systematic list strategy,

			but instead of all the cases, they wrote half, thinking unilaterally." (PT29)
	Trying to solve problems by giving special values	2	''They had a hard time solving the problem. Nearly half of the students tried to solve the problem by valuing the angles and sides of the triangles." (PT6)
	The idea that the result should be an integer	1	"The students had difficulty in the last step because the result was not an integer. I have no regrets about this problem, I got really good answers." (PT3)
Total		**67**	
Outputs	Increased class interaction (between students and teacher, among students)	7	''They kept asking if they were doing it right, what was the right answer.'' (PT2) "These interactions sometimes helped them to find the right answer through exchange of ideas, and sometimes a common mistake spread to the whole class." (PT23) "The effort of the students to give the right answer increased and a competitive environment emerged. They've always tried to get me to confirm their answer." (PT15)
	Developing positive attitude towards problem solving	6	"They were happy to face and deal with these problems. After making the solutions, they asked me to ask for another problem." (PT15) "The students were satisfied with the study and asked for the study to be repeated." (PT16) "The feedback after the application was really nice. They were pleased with the study.'' (PT17)
	Student tendency to make a drawing	3	"I observed that the 5th grade students were trying to solve the problems by drawing more shapes and making them tangible." (PT4)

	Positive effect of in-class educational games	2	"It was very good to hear some students explain the solution and say that we did it in the mangala tournament." (PT23) "The students were very eager because they resembled the problem to sudoku, and tried hard to solve it." (PT27)
	Students solving the problem with a different strategy	2	"There was a situation that caught my attention in this problem, a student worked backwards and reached a solution. If I do it again, I would gladly include this problem." (PT4) "Some students used the guess and check strategy, while others solved the problem using the systematic list method." (PT14)
Total		**20**	

DISCUSSION AND CONCLUSIONS

When the domestic literature on problem solving is examined, there are studies on the problem solving strategies, approaches and process choices of elementary school students and prospective teachers (İskenderoğlu, Akbaba-Altun & Olkun, 2004; Yazgan and Bintaş, 2005; Artut and Tarım, 2006; Altun, Memnun and Yazgan, 2007; Altun and Memnun, 2008; Avcu and Avcu, 2010; Tertemiz, Çelik and Doğan, 2014), the effect of problem solving education on the choice of problem solving strategies (Arslan & Altun, 2007; Ramirez, Chang, Maloney, Levine & Beilock, 2016). When the foreign literature is examined, there are studies on the problem solving strategies of students and prospective teachers (Cai, 2003; Van Dooren, Verschaffel & Onghena, 2003; Elwan, 2016), the effect of the field knowledge of prospective teachers on the evaluation of students' problem solving strategies (Van Dooren, Verschaffel and Onghena, 2003).

With this study, prospective teachers who are free to choose the problems gained experience on; how many problems can be solved in the given time, fine adjustment of difficulty levels of problems, sorting the problems correctly (easy to difficult), not including expressions that can create confusion during problem solving, instead of evaluating their

solvability according to the source they cite, it is necessary to consider the current class levels.

In the last few years, in our country, high school student placement exam has included more non-routine problems. But they are still in the form of multiple choice test. In this context, this has been a study that reveals the current situation of students' problem solving behaviors in mathematics at 5-8 level.

The following results were reached in this study and these results are similar to the findings of the mentioned studies.

- Most of the students did not use the expected problem solving strategies. It was confirmed that most of the students who used the right strategy could solve the problem and reach the right answer. There were those who started with the right strategy and made an operation error, as well as those who could not complete the solution.
- Most of the students had difficulty in understanding the problem. At this point, the prospective taechers stated that they had given sufficient explanations and even gave hints. This situation increased the students' desire to solve the problems and had positive results.
- In addition, it was found that instead of explaining the problem solving process, they made numerical calculations to reach the correct answer. In these calculations, there were also students who made meaningless operations in order to give an answer by using only numerical values in the problem. In addition, most of the students who reached the correct answer did not question whether there is a different solution. Although the problem solving steps (a. write the given and requested, b. summarize the problem, c. draw the appropriate shape or schema for the problem, d. specify which operations to perform respectively, e. estimate the result, f. perform operations, g. check the accuracy of the solutions) were given to them, they could not make the expected explanations about problem solving process.
- Most of the students have a tendency to make a method that they memorize in problem solving. When the solutions were examined, it was revealed that students could not relate

mathematics to daily life. This is especially the case with snails falling into the well problem. While the distinction between day and night can be easily seen by drawing figures or diagrams, the students thought about the progress of a day and made the wrong solution by establishing the right proportion. At this point, it was ensured that the students were able to see the solution and learn meaningfully with the strategy of drawing the figure or diagram or acting it out. Another reason is that there are rarely non-routine problems in mathematics classes. Routine problems and exercises are frequently mentioned in the textbooks.

- In many cases, students think that they can solve a mathematical problem in only one way based on the nature of the problem being taught (e.g. age problems, profit-loss problems, mixing problems, etc.). Students often think that some computational processes or formulas are the only approaches that can work. It is common for students to have the correct answer as an integer and only one solution to the problem.
- It was also observed that the students did not want to explain how they solved the problems, stated the solutions verbally or just wrote the result in the explanation section. Most of the students who could not solve the problem made arithmetic operations with numerical values in the problem and gave meaningless answers. There are those who only wrote “I did not understand”. Prospective teachers' knowledge about problem solving approaches of students in practice schools contributed to their professional development. Prospective teachers have reached the conclusion that non-routine problems should be included in mathematics teaching and emphasized the importance of educating future problem solving individuals.

SUGGESTIONS

As mentioned by the prospective teachers, students should encounter non-routine problem situations more frequently and it can be ensured that they associate mathematics with daily life and gain a

multifaceted perspective. In the literature, it is emphasized that students are not taught problem solving strategies. Thus, they are expected to provide creative solutions or develop original solutions. In this study, students use some problem-solving strategies informally even though they have not received any education on this subject. In this study, it is concluded that expected performance was not exhibited At this point, it can be examined by another study whether students' awareness of problem solving strategies will change the results of this application.

Non-routine problems should be included in textbooks which are an effective resource in mathematics teaching. In this way, students can gain problem solving skills. Thus, students will be able to develop solutions to situations encountered in daily life from a mathematical perspective. In order to increase mathematics literacy and success in international exams, mathematical applications courses were added to elementry school programs. In this course, problem solving practices should be emphasized and problem writing skills should be gained in addition to problem solving individuals.

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CHAPTER XI

STUDIES ON COGNITIVE LOAD THEORY IN TURKEY: A LITERATURE SURVEY

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"Necessity is the mother of innovation." –Plato.

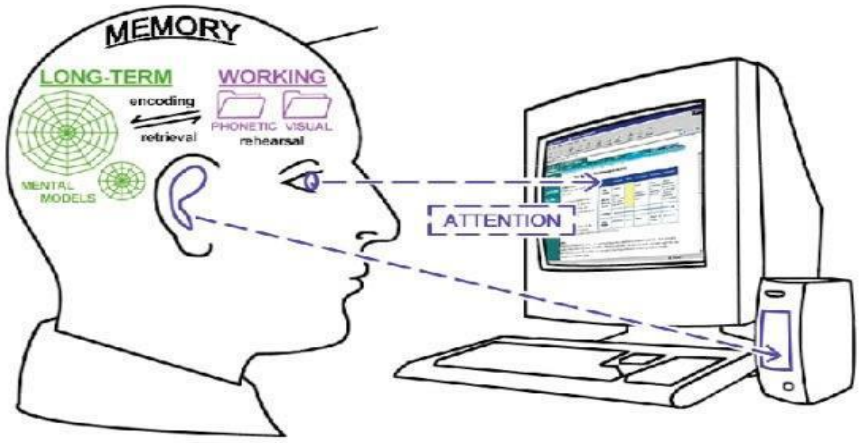
1. INTRODUCTION

The world has been drastically reshaped by the COVID-19 pandemic, as well as the education system. Humanistic psychology's core values seem to struggle with the conditions under which students worldwide receive education since they burst out of the pandemic. Wellness and fairness principles are hardly implemented (Duff et al., 2016), yet it has been the primary concern of educators and administrators. The ultimate aim is to provide instruction to as many students as possible, regardless of the quality of content or teaching methods. This aim is described as "Education in an Emergency," and everything related to education underwent four stages of reaction; rapid adaptation, improvement, consolidation, and restoration (Crawford, 2020). As a result, we had to leave half of our hearts in theory and focus on practice.

To begin with, institutions radically revised to suit means of distance, online, and digital forms of delivery (Murphy, 2020) and adjusted their teaching-learning strategies or curriculum approaches that are only applicable in a classroom environment. The transitions and cessation of formal education towards distance education platforms were not easy, in any case. Soon it was understood that it was not only about having an online session with the students and that we did not have challenges only in assessment, evaluation, learning, and teaching approaches and strategies but also in responses and behaviors of our students. While discerning the necessary aspects

or instruction to transfer into digital education, we had to consider the students with or without technological resources residing in remote geographic areas (Seale, 2020). Notwithstanding, time, the learners' psychological well-being, motivation, interaction with each other and their instructors, their level of readiness to such an instruction, and support received to be successful in a distance learning model should all be considered. Instead of translating the readily-made content, the contents that consider both cognitive and affective dimensions should be launched in our instructional designs (Chen, 2014).

At this point, we need to start thinking about how many individual differences in learner characteristics are being neglected or how cognitively loaded the students become in such learning environments. By being introduced to verbal or pictorial presentation formats or auditory and visual modalities, we sure deliver the content; yet, increasing the learners' cognitive load. So it seems that an online learning environment would offer an excellent opportunity for the continuity of the lessons during the time crisis; however, there might be handicaps that negatively affect the working memory capacity of the students studying under different learning conditions when compared to traditional learning environments (Carroll, 1993; Jonassen & Grabowski, 1993). In other words, what we experience in the distance education process would end up with lessons that contain unnecessary units and components for that learner. As a result, working memory cannot hold the load or easily send the information to long term memory (Sweller, 2017); schemes are not built, leading to a total failure of instruction. Instructional designers should be aware of the designs' cognitive requirements, whether an online lesson is being designed or not, and ensure that our learners can meet those requirements, both cognitively and affectively. Also, all aspects of the instructional design should add value to the learning experience instead of saving the day through online delivery.



2. LITERATURE REVIEW

To explore the ways our brains process information and generates the models of thinking and learning has been widely studied in the field. The background information about cognitive science comes from mid-20th century psychologists' attempts to create a model. What cognitive load emphasizes is how human beings interact with the world while learning. This approach determines which part of the information is processed and interacted with by analyzing cognitive load theory (CLT) and background information. The analysis results can help us create a more effective learning environment, especially when considering the online learning and teaching and teaching environment.

2.1 What is Cognitive Load?

According to Sweller (2017), effective learning is enhanced when the learners' cognitive capacity in a particular domain is not exceeded. When it is exceeded, it creates an overload in the student's working memory capacity, which prevents learning (Paas, Renkl, and Sweller, 2004), and therefore should be controlled by the instructors.

In that sense, Cognitive Load Theory (CLT) focuses on controlling the overload of our working memory. Thus, it is an instructional theory and a learning theory because human beings have limited working memory and unlimited long-term memory. The theory indicates that learning best ensues under circumstances where

working memory creates prevailing structures in the long-term memory by regulating its overload. In other words, the limited capacity of working memory load should be kept under control during operations and in learning environments by distributing the capacity of memory in a way that makes learning (Sweller and Chandler, 1994). Subject areas that we need to know to vary with regards to the elements included. Some areas might comprise highly interacting elements that produce a high cognitive load, while some other areas have low degrees of interactivity, leading to limited cognitive load. As Sweller and Chandler, (1994) claim, the difficulty here is that it is hard to learn such elements in isolation since, when considered, none of them can make a mathematical sense on their own.

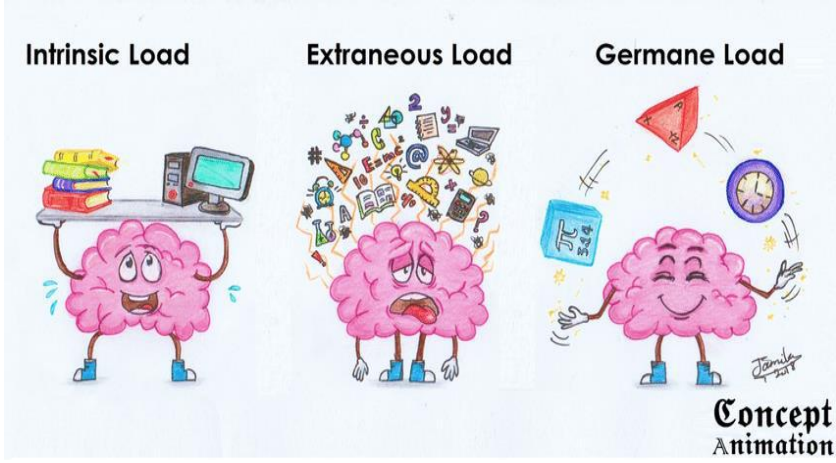
For that reason, CLT focuses on the possibility of decreasing cognitive load that stems from external and secondary knowledge. According to Sweller (2017), "learning at school requires explicit instruction that accelerates the acquisition of information. If human beings internalize knowledge using all available cognitive forces and capacity, our brains' cognitive load can be reduced, and our learning capacity can increase. But how about online teaching and learning environment?

It is seen that the relationship between the learning environment and learning task arises the causal factors for the cognitive load. While coping with higher mental tasks, our cognitive structure comprises a robust long term memory, a limited working memory, the learning methods, schema storage, and automation that utilize information kept in long term memory to decrease the load on working memory. At this point, as to Sweller (2017), it is of high importance to realize that through the direct introduction of instruction, learners could better gain the domain-specific knowledge to improve the impact of the borrowing principle. During the learning process of reading in a specific area, examples of particular textual knowledge are required. Thus, cognitive load theory principles are invaluable in showing the program designers how that leads the learners to the desired outcomes of the learning processes (Yılmaz-Virlan, 2020).

"Natural information processing systems such as biological evolution and human cognition organize information used to manage the activities of natural entities" (Sweller and Sweller, 2006). According to these researchers, those five principles underlie natural information processing systems:

1. The information store principle (a large store of information that
   must be learned over time)
2. The borrowing and reorganizing principle (borrowing information
   from other fields to build our schema)
3. The randomness as genesis principle (generating problem-solving
   methods randomly)
4. Narrow limits of change principle (the capacity of the working
   memory)
5. The environmental organizing and linking principle (to perform in
   our environment through the schema systematized previously)

As a consequence, CLT is an instructional theory that has instructional applications. According to this theory, the instruction's primary focus is to construct a general knowledge store efficiently in the long term memory. However, as Sweller (2017) suggested, when we have limited working memory because of the change principle's narrow limits, we have an obstacle to achieving our aims. To prevent this, the borrowing and reorganizing principle provide the best way. Therefore, the information should be transferred to a learner directly. All applications of the theory include some ways to help reduce the load of working memory.



DOI: https://doi.org/10.15694/mep.2018.0000153.1

2.2. Types of Cognitive Load

CLT is one of the significant theories centered on the relationship between short-term and long-term memories. Working memory has limited capacity and can be overloaded easily, which, in turn, inhibits learning. Overloading must be prevented, first for actual learning. If the instructional strategy is more effective than the load, learning performance increases more than expected. Bearing in mind the theory's significant magnitudes, which are mental load and effort, we can classify cognitive load types under three main categories; intrinsic, extrinsic, and germane cognitive load.

Intrinsic cognitive load: It refers to a learner's requirements when the complexity of the task that stems from the information delivery method is met. Korbach, Brünken, and Park (2017) explain that the intrinsic cognitive load is determined by “the complication of the learning task and element interactivity." Besides, “the number of interacting elements of knowledge of a learning task characterizes the element interactivity, and when the learning task is more complex, the intrinsic load will be higher" (Korbach, Brünken, and Park, 2017). So we can reduce the high cognitive load that results from the task complexity by breaking it into small pieces as step-by-step tasks and focus on small segments each time.

Extraneous cognitive load refers to the cognitive load type from the outer environment rather than the learners themselves**.** According to Van Merrienboer and Sweller (2005), "redundant details, deficient guidance, inappropriate requests of conveyance and utilization of media bits of help would all be able to add to extraneous cognitive load." Besides, as Chandler and Sweller (1992) claim, there might be a "split-attention effect over cognitive load that occurs if cross-referencing sources are sent from different places." Some presentation methods might misdirect students as they can unintentionally create complexity for the task or distract the learners' attention.

Germane cognitive load: It is how much load we spare to process the information while learning activities (Sweller, Van Merrienboer, and Paas, 1998). In other words, it is the deep processing of the new information by adjusting it with the existing knowledge. It is hard to comprehend materials that contain high element interactivity; therefore, establishing cognitive schemata that represent the interacting elements is the best way to encourage comprehension (Yılmaz-Virlan, 2020). We can do this by

reorganizing, integrating, or linking it with previously coded information.

2.3. Aim of the Study

The research aimed to identify studies in a Turkish context and characterize their features that focused on Cognitive Load Theory, which is highly important in current educational settings and designs. In so doing, it would provide researchers with the strengths and weaknesses of the implementation of cognitive load theory in the literature on a nation-wide scale and contribute to the design of future studies. With this in mind, the following research questions were addressed:

1. What are the characteristics of the studies conducted in Turkey on cognitive load theory?
2. What kinds of strategies, techniques, or procedures were used in those studies?
3. What is the quality of the studies with regards to today's educational preferences?

3. METHOD

The quantitative studies that were carried out between 2000 and 2020 were examined in this survey study. Search terminology was determined, and academic articles, theses, and dissertations were reviewed online accordingly to collect data. The research was examined using a content analysis approach that identified the study material utilizing categorical and frequency analysis techniques. First, inclusionary and exclusionary criteria were determined to identify studies' features out of the search terminology. Second, studies were screened for relevance using the defined inclusionary criteria, and irrelevant studies and duplicates were excluded from the

research.

A clear and detailed coding form was also prepared to identify the characteristics of the studies. These characteristics also constituted the independent variables of the study. The coding form that was developed, composed of five sections:

1. Type of the study (M.A. or Doctoral thesis, article)
2. Publication years
3. Educational level (university; high school, secondary school, or primary school)
4. Subject matters of the study (such as Language, Science, Social Sciences)
5. Sample size (small, medium, large)

Finally, the research findings were presented through frequency tables according to the content analysis results obtained via the coding form.

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1.1. Data Collection Procedures

A comprehensive search strategy was employed using several data collection methods to find as many articles as possible (Figure 1). The search strategy had four steps: identification, screening, eligibility, and inclusion. First, the research focused on the studies centered on cognitive load and the related theory. Search terms and concepts were identified and constituted the search terminology. Publications were scanned using the keywords “cognitive load," "bilişsel yük" "cognitive load theory," bilişsel yük teorisi," "education," "curriculum," and "experimental study." The databases' search engines were adjusted to show studies conducted between 2000 and 2020, as the first studies on cognitive load theory in Turkey dated back to the year 2004.

First, the eligibility criteria for inclusion were created. The thesis catalog of YÖK (Council of Higher Education), electronic university libraries in Turkey catalogs, conference presentations, digital dissertations, and international databases were searched for relevant, accessible published and unpublished doctoral theses, M.A. theses, articles published in refereed and non-refereed journals using specific keywords. The research launched with 646 studies at the very beginning.

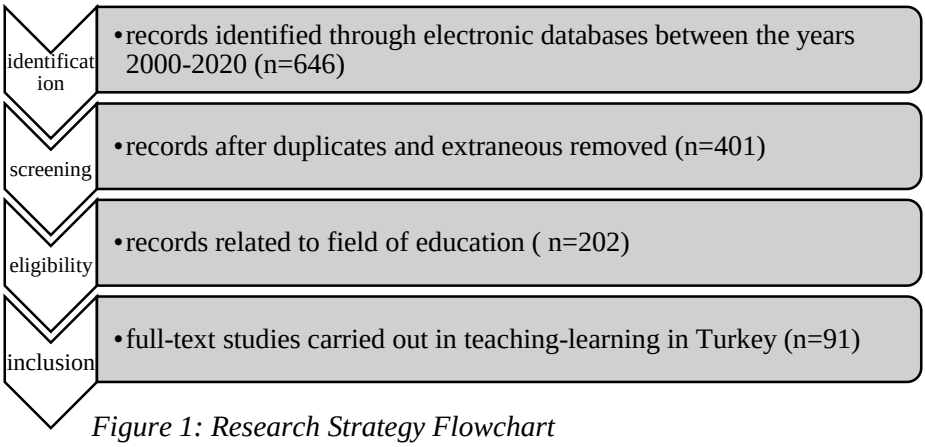

Figure 1: Research Strategy Flowchart

Second, for inclusion in the literature database, studies were screened for relevance. Studies reflecting descriptions of general practice, conceptual or theoretical papers and reviews, reports or presentations, publications included in books, chapters, surveys, and meta-analysis studies were also left out. When the studies read thoroughly, it was also identified that some studies were not relating to the theory of cognitive load but just revisiting the theory in their reviews; hence they were also excluded. Additionally, studies in both English and Turkish were included in the study providing that the setting belonged to a Turkish context.

Following the removal of extraneous and duplicate articles, 401 articles were retained. Third, the studies not conducted in education but were defined so on the databases were excluded through a detailed analysis. So, the number of eligible studies decreased to 202. Finally, full-text experimental studies (n=92) conducted concerning cognitive load theory in the field of education in Turkey between the years 2000 and 2020 were defined as eligible to be included in the current research.

4. RESULTS

After the study sample (n=91) was determined, a clear and detailed coding form was developed. Data from the investigated studies were obtained with regards to the type of the study (M.A. or Doctoral thesis, article); publication years of the study; the educational level (university; high school, secondary school or primary school) that the study was carried on; subject matters of the study (such as Language, Science, Social Sciences) as well as the sample size.

4.1. Types of Studies

Three different sources were used to reach the studies to be examined. Since the research focused on studies carried out in a Turkish context, national servers that enable catalog search was preferred in the first place. The first one was the national database of theses and dissertations of the Council of Higher Education (YÖK); the second one was the open-access database of Turkish Journals, namely, Dergipark/Ulakbim. Table 1 displays the sources that the studies were retrieved from, types of publications included in the study, the number of screened studies, and the number of maintained studies after the eligibility criteria are applied.

Table 1. Distribution of retained studies

SOURCES	Type of Publication	# of screened studies	# of retained studies
YÖK	MA & Ph.D. Dissertations	101	55
Google Academic	Articles	488	27
Dergipark & Ulakbim	Articles	57	9
Total		646	91

As displayed in Table 1, 101 MA and doctoral dissertations on cognitive load theory were accessed through the YÖK database. After screening the studies and employing the eligibility criteria, the number of retained studies decreased to 55. Out of 55 theses and dissertations, 26 were M.A. theses. Twenty-nine of the studies were conducted as a doctoral dissertation. Besides, Google academic was used to access as many published studies as possible via the keywords defined for the current research. In total, 488 studies were retrieved from the system. After the studies' detailed investigation, duplicates and extraneous studies were excluded according to the current study's coding form. Surprisingly the number of retained studies significantly reduced to 27, constituting 5% of all the studies that reached the first stage. Also, the national catalogs of Turkish Academic Journals were screened, and 57 studies were found eligible to be included in the study. However, when the studies were screened, the number decreased to 9 in total. Overall, the research included 36 articles and 55 M.A. and doctoral thesis to be further investigated.

4.2. Years of Publications of Studies

According to the coding form, the study's second criterion is the publication years of the retained studies (n=91). Figure 2 displays the distribution of the studies to years.

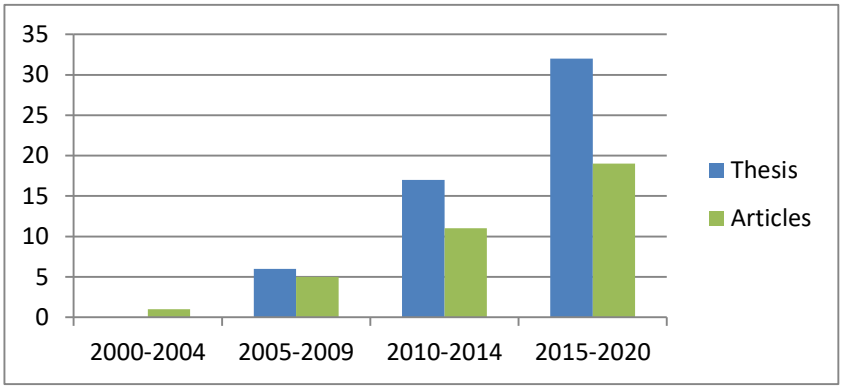

Figure 2. Distribution of studies to years

When Figure 2 is examined, it is observed that studies centered on cognitive load in Turkey start with an article published in 2004. Out of the 55 theses and 36 articles, five articles and six theses were published during 2005-2009. Only one of these theses is a doctoral dissertation that was conducted in 2005. The number of published articles (n=11) doubled in the years between 2010 and 2014. Likewise, the number of theses and dissertations almost tripled (n=17), as ten studies were conducted as doctoral dissertations. 60% (n=33) of the theses and dissertations carried out between 2005 and 2020 in the defined area were conducted after 2015. It should not be disregarded that more than half of the articles (n=19) in total were produced in this period.

4.3. Educational Levels of Studies

The retained studies' educational levels were further reviewed with regards to primary, secondary, and tertiary education contexts to answer the research questions of this study. Table 2 below reveals the results.

Table 2. Distribution of Educational Levels of Studies

	Theses		Articles		Total	
Educational levels	n	%	n	%	n	%
University	35	63	24	66	59	65
High School	5	9	3	8	8	9
Secondary School	8	15	7	19	15	16
Primary	7	13	2	5	9	10
Total	55	100	36	100	91	100

As Table 2 reveals, it is notable that %65 (n=59) of all the studies were conducted at the university level with university students—the studies carried at secondary schools (n=16) and primary schools (n=9). The results also show that studies conducted at high schools constitute 9% (n= 8) of all studies examined within this particular research scope. It should also be noted that except for two studies, all the instructions where the studies were conducted were from state universities and schools. The two studies were conducted as an M.A. thesis under the supervision of two different foundation universities.

4.4. Subject Levels of Studies

To better understand the characteristics of the studies focused on the framework of this literature survey, the studies' subject levels were also investigated within the scope of the research. In total, nine subject areas were spotted when the studies were reviewed. Out of nine subject areas, five were undergraduate courses, and four were subject matters in primary or secondary schools.

Table 3. Distribution of Subject Level of Studies

	Theses		Articles		Total	
Subject matters	n	%	n	%	n	%
Computer Education and Instructional Technology	19	35	19	53	38	42
Language Teaching	11	20	1	3	12	13
Teaching (Pre-school, Classroom)	8	15	7	19	15	16
Science	8	15	3	8	11	12
Computer and Software	4	7.5	3	8	7	8

Mathematics	2	3.5	1	3	3	3
Social Sciences	1	1	1	3	2	2
Engineering	1	1	1	3	2	2
Medicine	1	1			1	1
Total	55	100	36	100	91	100

According to Table 3, 42% (n=38) of the studies were conducted in the Computer Education and International Technology department at universities. There were 12 studies carried on in the Language Teaching department, and a further examination of the studies revealed that all these studies were done with English Language Teaching undergraduates except for one study, which worked with students from the Turkish Language Teaching department. Moreover, it was also found that Preschool Teaching and Classroom Teaching departments (n=15) also provided research settings for the studies under investigation. There are two more subject areas, which involved Engineering (n=2) and Medicine (n=1) courses at universities as a part of the study.

Apart from these universities' departments, some studies were conducted in a school other than tertiary education. Science lessons (n=11) as well as Computer and Software (n=7), Mathematics (n=3), and Social Sciences (n=2) lessons were the subject matters of studies that were conducted in primary or secondary schools in Turkey.

4.5. Sample Sizes of Studies

Within the scope of this literature survey, studies were further investigated in terms of their sampling procedures and sample sizes. As the sampling methods, it was found out that random sampling methods such as convenience and voluntary sampling methods were preferred by the studies most. Besides, while all the studies reported their sample sizes, only three studies explained that they calculated their sampling size out of their population. The results are displayed in Table 4 below.

Table 4. Distribution of Sample Sizes of the Studies

	Theses		Articles		Total	
Sample size	n	%	n	%	n	%
< 29	14	25	13	36	27	30
30-99	24	44	15	2	39	43
100<	17	31	8	22	25	27
Total	55	100	36	100	91	100

As can be observed from table 4, the sample sizes of the studies

were examined under three groups: small scale (1-29), medium-scale (30-99), and large scale (100<). The results showed that 30% (n=27) of the studies had less than 29 participants as their samples, while 43% (n=39) of the studies were medium-scale studies with a sample size ranging between 30 and 99. Furthermore, 27% (n=25) of the studies were identified as large scale studies with more than 100 participants. Additionally, four studies reported to have a sample size larger than 200, 3 studies reported a sample of more than 300, and there is one study with a sample size of more than 500. As the analysis shows, the study with the largest sample size (n=724) is an M.A. study conducted in 201.

In addition to the results presented above, 12 of these studies had participants as mixed staff, thereby employing students or undergraduates and teachers, academicians, administrators, and instructors. Data in these studies were collected through pre-post tests are questionnaires. In 17 of the studies, the cognitive load scale developed by Paas & Marrienboer was utilized to measure the subjects' cognitive load. There were both quantitative (n=38), qualitative (12), and mixed-method (n=41) studies identified when the designs of the studies were explored.

All things considered, when we examine the studies focusing on cognitive load and the related theory, we can access 91 experimental studies conducted in a Turkish context between the years 2000-2020. As the results indicate, there are few studies on this field, and there is diversity in the educational levels and the subject areas of the studies conducted.

5. DISCUSSION AND CONCLUSION

The purpose of this survey was to characterize the research literature related to cognitive load theory in the educational field. By documenting the studies' strengths and weaknesses, it aimed to fill the gap in the literature and provide the necessary detail for researchers to find the needed research or develop their research strategies.

The first research question aimed to analyze the characteristics of Turkey's studies on cognitive load theory. Considering the results, we can conclude that among the few studies published, most were conducted as doctoral dissertations, which were produced only in the last five years. Even though there has been an increase in the number of studies conducted in Turkey in the last decades, it still seems insufficient when compared to the studies conducted in the same research field around the world. The literature

review showed that the studies conducted focused more on the theoretical aspect of CLT instead of the implementation of the theory or practicing its implications in the learning and teaching environments. In this sense, this research provides a valuable aspect by emphasizing the gap in the field.

When the studies were analyzed to answer the second research question, it was found out that the research techniques and strategies were mostly about measuring the students' cognitive load. Only a few studies offered alternative ways or instructional designs that could employ a cognitive load design. Seen in this light, by presenting the necessities in the literature, this research also tries to draw attention to the *pandemic distance learning settings*, where most students ignore their cognitive processes while trying to catch up with what is happening in their artificial learning environments. Thus, this research aims to bring to the forefront the importance of studies designed more effectively providing implementations as well as solutions to the possible increase in the students' cognitive load in such settings.

The third research question pursued the quality of the studies with regards to today's educational preferences. Today's educational preferences' principal doctrines stem from the implications of *wellness* and *fairness* in humanistic psychology. When we consider the studies reviewed, we can see that by dealing with overloaded learners, the researchers of these studies pay attention to the students' well-being. However, the limited number of studies makes it difficult to generalize the results to a larger scale. Furthermore, as was implied by the results, most studies were conducted at universities, but we also need to learn more about the students' conditions at the tertiary level to provide them with fair means of education.

In short, as this research implies, there are not many studies conducted on the cognitive load theory in Turkey. However, considering today's educational preferences and the conditions that arose after the pandemic, the cognitive load of the learners and individual differences among learners gained more importance. More studies should reflect on this issue by emphasizing creating appropriate instructional designs for distance education settings that aim to decrease the cognitive load of the learners.

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CHAPTER XII

NANOSCIENCE EDUCATION

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Nanoscience is the study of structures on the scale of nanometers ranging between 1 and 100 nm. Nanotechnology is defined as "a science, engineering, and technology conducted at the nanoscale, where unique phenomena enable novel applications in a wide range of fields, from chemistry, physics and biology, to medicine, engineering and electronics" by National Nanotechnology Initiative in U.S. (Bayda, Adeel, Tuccinardi, Cordani and Rizzolio, 2019). Prior to introduction to nanoscience education, it is necessary to recognize the emergence of nanoscience in the history of science and its differences from other scientific fields. Therefore, this chapter consists of 3 main parts. The first part covers the historical emergence and development of nanoscience for a wide range of uses from lenses to chemiscopes; thus, it will make it easier to appreciate Richard Feynman's speech which is regarded as the beginning of nanotechnology, as well as the scientific developments in that period, afterwards and today. In the second part, the features that distinguish nanoscience from other sciences are mentioned. The last part aims to give information about the studies on nanoscience education.

1. FROM LENSES TO CHEMISCOPES

"The light microscope opened the first gate to microcosm. The electron microscope opened the second gate to microcosm. What will we find opening the third gate?" Ernst Ruska (1906-1988)

The scientists mentioned in the time line from lenses to chemiscopes in this chapter are shown in Fig.1. Although glass has been known to exist since 5500 BC, the first lenses were developed in 1st century AD by filling a spherical glass container with water. Seneca, the Roman writer and philosopher, noticed that the glass sphere filled with water made things look bigger. The first real lenses began to be made only in the 13th century (Bardell, 2004). 2500 years ago, the Greek philosopher Democritus thought that when a substance is divided continously, an

invisible particle would be obtained, and he called this particle as atomos in the sense that it can not be divided.

With the development of lenses and advances in optics, it can be said that many steps were taken into the world of small things. The invention of the microscope is credited to Zaccharias Janssen (1587–1638) and his son Hans Janssen (1534– 1592) (Masters, 2008). Antonie van Leeuwenhoek is the first person to make and use a single lens microscope in the late 17th century. Leeuwenhoek achieved a magnification power of 270 times with the single-lens microscope, and this magnification was fantastic at that time. He studied many living species such as bacteria, yeasts, spermatozoids and fleas. To increase the power of a single-lens microscope, the focal length had to be reduced. In the 17th century, British scientist Robert Hook produced compound microscopes containing 2-3 lenses (History of the Microscope, n.d.). Although Hook's microscope was more advanced and larger, the image could not be obtained as clear as Leeuwenhoek's single-lens microscope due to chromatic aberration. Numerous studies have been conducted on small things for 300 years. That magnificent world of tiny creatures called as microorganisms has been discovered. Our thinking about life has fundamentally changed. However, it was realized that it is not possible to see everything with light microscopes, just as there is a lower limit that our eyes can see. Ernst Abbe showed (1873) that light diffraction limits the resolution of a light microscope to approximately one-half the wavelength of light or approximately 200–300 nm. With a light microscope, it was possible to see the structures as big as 0.2 micrometer. However the light did not work well for smaller structures (Coşkun, 2010).

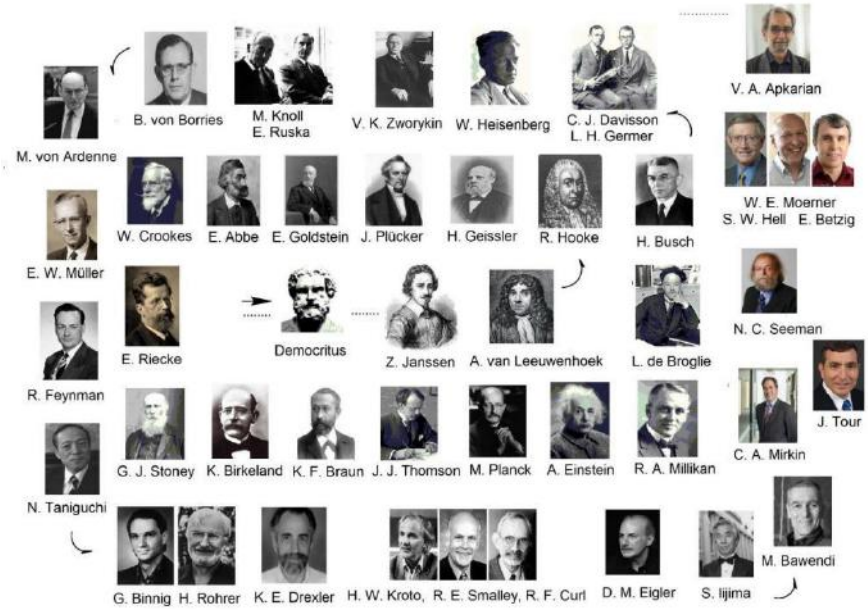

Fig. 1: The scientists mentioned in the time line from lenses to chemiscopes

Heinrich Geissler invented (1855) the first vacuum tube that was later called the Geissler tube. Julius Plücker showed (1858) that cathode rays could be deflected by the magnetic field. Eugen Goldstein observed (1870) that the particles that make up the cathode rays were always the same, no matter which element was used as cathode. Sir William Crookes modified (1878) the Geissler tube and confirmed the existence of cathode rays by displaying them in his Crookes tube (Masters, 2009). Crookes carried out many experiments using more reliable equipment to confirm earlier finding about the properties of cathode rays. He concluded (1881) that that the cathode ray was made of particles which must have mass (Cathod ray tube, n.d.). Eduard Riecke showed (1881) that a good account of the deviation of the cathode rays by magnetic field could be deduced, investigating the equations of motion for such charged molecules of a given mass (Nola, 2008). George Johnstone Stoney proposed (1891) that the unit of electricity that atoms gain or lose when they forms ions was called an electron. Kristian Birkeland focused (1896) electrons with a magnetic field. Karl Ferdinand Braun developed (1897) the cathode ray tube as the Braun tube which is the ancestor of the oscilloscope and the television picture tube (Masters, 2009). Joseph John Thomson found (1897) the ratio of charge/mass of electrons by applying electric and magnetic fields to electrons in cathode ray tube. Max Planck explained

(1900) the relationship between the frequency and energy of blackbody radiation by introducing the theory of "quanta", that is, that radiation consists of quanta with specific energies determined by a new fundamental constant, thereafter called Planck's constant (Max Planck – Facts, 2020). Albert Einstein proposed (1905) the existence of discrete energy packets during the transmission of light, consistent with Planck's theory (1905). These energy packets were later called photons. Robert Andrews Millikan determined (1910) the electric charge of a single electron via his famous oil-drop experiment. Louis de Broglie introduced (1924) the idea that particles, such as electrons, could be described not only as particles but also as waves. By the end of the 1920s, the ideas required for the lens to be used in the electron microscope had matured. Hans Busch theoretically demonstrated (1926) a short coil generating a magnetic field would result in electrons behaving like light does when passed through a converging lens: the electrons could be focused into a beam (Ruhge, 2017). Clinton J. Davisson and Lester H. Germer investigated (1927) the reflection of electron beams on the surface of nickel crytals and measured the wavelengths of electrons which are the same as the the value predicted by Louis de Broglie (Weinert, 2009). Werner K. Heisenberg discovered (1925) a way to formulate quantum mechanics in terms of matrices and published his uncertainty principle in 1927 (Beyler, 2020). Vladimir Kosma Zworykin invented (1929) the kinescope, which is a type of cathode ray tube for his television system (Masters, 2009).

Max Knoll and Ernst Ruska developed (1931) a two-stage transmission electron microscope (TEM) with magnetic lenses with a magnification of 13x by the use of the electron optic equations of Hans Busch between 1929 and 1931. The resolution of the first microscope was poor compared to light microscopes. However, Ruska had opened the way and it was necesssary to proceed on this road. Bodo von Borries and Ernst Ruska applied for (1932) a patent on a magnetic pole lens electron microscope. E. Ruska described (1933) a new type of magnetic lens with a short focal length and published the work in his doctoral thesis. Manfred von Ardenne invented (1937) the scanning electron microscope with great depth of focus and a high resolution. Manfred von Ardenne constructed (1938) the first scanning electron microscope (SEM) and the first scanning transmission electron microscope (STEM). Hans Mahl constructed (1939) the first transmission electron microscope with two electrostatic lenses. Manfred von Ardenne constructed (1940) an electron microscope with a resolution of 3 nm. Erwin Wilhelm Müller developed (1951) the field emission electron microscope (FEM) and obtained images of the arrangement of atoms on the surface of the electrode tip (atomic resolution) (Masters, 2009).

Richard Feynman's speech, "There's Plenty of Room at the Bottom" at the American Physical Society on December 29, 1959, was accepted as the beginning of nanotechnology, accompanied by the above-mentioned scientific studies. Feynman devoted a significant part of 'Plenty of room' to electron microscopy, stressing the breakthroughs that would be possible in many areas of science if it were possible to "just look at the thing!" (Plenty of room revisited, 2009). He outlined a vision of what would later be called nanotechnology, imagining 'that we could arrange atoms one by one, just as we want them'. At the time, Feymann's ideas were received as science fiction.

Norio Taniguchi coined (1974) the term nanotechnology. Heinrich Rohrer and Gerd Binnig tested (1981) scanning tunnelling microscope (STM) capable of imaging and manipulating individual atoms and molecules. STM was suitable for imaging in 0.1 nm planar, 0.01 nm depth resolutions. The fact that efficient results can be obtained from only conductive samples using tunneling microscopy led to the need to develop a different system. This idea came to life in a device called the atomic force microscope (AFM) by taking an atomic resolution image by measuring the vertical distance of the tip from the surface. AFM is a combination of the principles of the scanning tunneling microscope and the stylus profilometer (Binnig, Quate, Gerber, 1986). In 1981, K. Eric Drexler published a paper entitled "Molecular engineering: an approach to the development of general capabilities for molecular manipulation". Drexler later developed in his 1986 book Engines of creation, which became the point of entry to nanotechnology for many lay readers (Ball, 2009). Harold W. Kroto, Richard E. Smalley and Robert F. Curl discovered (1985) fullerenes, nanoparticles consisting entirely of carbon atoms. Their work on fullerenes eventually led to the discovery and synthesis of carbon nanotubes by Sumio Iijima (1991). Donald M. Eigler and Erhard K. Schweizer (1989) at IBM's Almaden Research Center manipulated 35 individual xenon atoms to spell out the IBM logo. C.T. Kresge and colleagues (1992) at Mobil Oil discovered the nanostructured catalytic materials MCM-41 and MCM-48. Moungi Bawendi of MIT (1993) invented a method for controlled synthesis of quantum dots. Chad A. Mirkin (1999) invented dip-pen nanolithography. James Tour and colleagues (2006) at Rice University built a nanoscale car made of oligo(phenylene ethynylene) with alkynyl axles and four spherical C60 fullerene wheels. Nadrian C. Seeman and colleagues (2009-2010) at New York University created several DNA-like robotic nanoscale assembly devices (Nanotechnology Timeline, n.d.).

Eric Betzig, Stefan W. Hell, and William E. Moerner were awarded the 2014 Nobel Prize in Chemistry for succeeding in overcoming the scientifically accepted constraint that a light microscope cannot have a resolution higher than 0.2 micrometers. The STED (stimulated emission

depletion) technology developed by Hell is a far-field flourescence imaging technique that fundamentally breaks the diffraction barrier (Harke, Bianchini, Vicidomini, Galiani, and Diaspro, 2013). This was a necessary step for the microscope that Vartkess A. Apkarian and his group called Chemiscope. V. A. Apkarian explains, "chemiscope is a microscope that operates where chemistry happens – at the 0.1nm scale and on the femtosecond timescale". In the Center for Chemistry at the Space-Time Limit, launched in 2010, the researchers have been working on three different variations of the 'chemiscope': i) STM+Surface Enhanced Raman spectroscopy (SERS), ii) STM+Electroluminescence spectroscopy and iii) Photo-induced force microscopy (PiFM). They have already succeeded in recording the motion of single electrons, single orbitals, and chemical bonds in single molecules (Gross, 2015).

2. WHAT'S SO DIFFERENT ABOUT THE NANOSCALE?

"I have estimated how many letters there are in the Encyclopaedia, and I have assumed that each of my 24 million books is as big as an Encyclopaedia volume, and have calculated, then, how many bits of information there are (10^{15}). For each bit I allow 100 atoms. And it turns out that all of the information that man has carefully accumulated in all the books in the world can be written in this form in a cube of material one two-hundredth of an inch wide—which is the barest piece of dust that can be made out by the human eye. So there is plenty of room at the bottom! "

Richard Feynman (1918-1988)

Nanoscience deals with the properties of systems at the nanoscale (1-100 nm) and the facts occurring at that scale. Bulk materials and micron-sized materials possess continous physical properties which are described by the principles of classical pyhsics. However, quantum mechanics is necessary to explain their properties when particles assume nano-scale dimensions. Due to the presence of electromagnetic force, quantum mechanical phenomena, high ratio of surface area/volume and the importance of random kinetic motion at nanoscale, materials have different properties from the macroscale at the nanoscale (Lesson 3: Unique Properties at the Nanoscale, n.d.). However, the properties of the materials at nanoscale change depending on their sizes and geometries. When gold (Au) nanoparticles with a diameter of 10 to 30 nm are suspended in solution, they will give rise to a red color, and, as the diameter increases to 100 nm, the color shifts toward violet (Haiss, Thanh, Aveyard, Fernig,

2007; Link and El-Sayed, 1999). Some materials that are conductors in bulk form may become semiconductors or poor conductors at the nanoscale, while some materials that were semiconductors may become conductors or superconductors. The confinement of electrons results in the electrical properties that occur at the nanoscale. Au metal will no longer conduct electricity when it becomes less than 10 nm (Mott, n.d.). Nanospherical polypropylene particles have higher elastic modulus compared to the bulk one (Paik, Kar, Deva, and Sharma IITK, 2007). Particles of copper smaller than 50 nanometers lose their malleability and ductility (Hughes and Hansen, 2003). The hardness of silicon nanoparticles with 40 nm diameter is four times more than that of the macro-sized silicon (Gerberich et al., 2003).

NANOSCIENCE EDUCATION

With the reflections of the developments in the field of nanotechnology on the economy, the need for trained manpower in this field is increasing. During 2006 and 2007, a series of national workshops was held to help define and to clarify a set of big ideas and learning goals in nanoscale science and engineering at the K-12 and 13±16 levels. They are core concepts that are critical for basic competency in a nanoscience because these concepts are the building blocks for the development of a deep understanding of other concepts in that field (Wansom et al., 2009). Sample studies under the headings of Big Ideas (13±16 levels) will be given below.

Big Idea 1-Size and Scale

This idea involves factors relating to size and scale which help describe matter and predict its behavior. In the review study of Bryan, Magana and Sederberg (2015) including the studies on nanoscience education between 2003 and 2014 years, twenty-six experimental studies involving pre-university students and teachers were summarized. It has been stated that the most striking big idea in these studies is 'size and scale' since 15 of 26 articles examined belong to it. Two reasons for this may be that size and scale is a prerequisite for learning nanoscience, and it can understand more easily than other Big ideas by those who want to study on nanoscience education. The studies on size and scale has focused particularly on the different conceptualizations of individuals and how these conceptualizations change in STEM disciplines according to age, grade level, daily experience, culture and expertise.

Castellini, Walejko, Holladay, Theim, Petersen and Crone (2007) investigated the public's baseline knowledge of nanotechnology with a seven-question survey. Survey results showed that people do not have enough understanding of concepts associated with atoms and the size of the nanoscale. In addition, it was observed that the accuracy of the ordering

of the objects depending upon their sizes increased with the increase in the education level of the participants. The participants identified microscopic objects, atomic and subatomic particles in the category of smallest things that could be identified.

Akdeniz and Benlikaya (2015a) aimed to examine pre-service science teachers' understanding of size and scale in their study. The sample of the study consists of 150 pre-service teachers of Biology, Physics and Chemistry. Conceptual understanding test consisting of 4 open-ended questions was used as data collection tool in the study. As a result of the study, it was observed that they had difficulty in sorting micro and nano-scale objects and applying unit transitions other than length. Tretter, Jones, Andre, Negishi, and Minogue (2006) determined that in the question of the order of magnitudes, students generally regard the wavelength of red light as the largest or the smallest. However, it was observed in many studies (Waldron, Spencer and Batt, 2006; Jones, Taylor, Minogue, Broadwell, Wiebe and Carter, 2007; Stavrou, Michailidi, Sgouros and Dimitriadi, 2015) that students had difficulties in ordering invisible objects (such as molecules, viruses ...).

Big Idea 2- Structure of Matter

Stevens, Delgado and Krajcik (2010) conducted interviews with students at various levels such as middle school, high school, undergraduate to measure their conceptual understanding of the structure, properties and behavior of matter, in order to test aspects of hypothetical progression. They found that the students do not hold robust ideas about the characteristics of the particles that make up solids until they make the connection that the particles are atoms.

Hadenfeldt, Neumann, Bernholt, Liu and Parchmann (2016) aimed to unveil students' progression in understanding matter by investigating their progression in developing understanding of four big ideas about matter (structure and composition, physical properties and change, chemical reaction, and conservation). The analyses confirmed that the four big ideas represent distinct ideas although their examination of students' progression in understanding these ideas suggests that three of them develop in parallel. A detailed comparison of students' progression suggests that the hypothesized levels mark a hierarchical series of levels through which all of them progress in the same order although not necessarily at the same pace.

Big Idea 3- Forces and Interactions

In the study of Sockman, Ristvey ve Jones (2012), it was aimed to enable students (n=100) to identify the factors affecting the strength of the forces between interactive surfaces. The researchers have developed a

course called NanoLeap, where students need to make observations and comments on how Gecko's foot interacts with surfaces and the factors affecting the strength of the forces between interacting surfaces. In the activity prepared for the NanoLeap unit to determine the factors affecting the strength of the forces between interacting surfaces, the students were evaluated with a composition they wrote about the underlying reasons for the Gecko's adhesion to the surface. It was determined that the greatest misunderstanding of the students in the compositions was related to the knowledge of electrical forces and their role in the adhesion of Gecko.

Benlikaya, Erol, Yıldırır and Korkusuz (2019) examined the effect of using argumentation and/or 3D printed models on the conceptual understanding of pre-service teachers in teaching the subject of surface area and interactions within the scope of nanoscience. The activities involve the change in the surface properties from hydrophilic/hydrophobic to superhydrophilic/superhydrophobic, and the skin surface properties of various creatures such as shark, Gecko and lotus flower. According to the statistical analysis of the pre-test and the post-test, it was observed that there was no significant difference in learning among the groups (argumentation, 3D models and argumentation+3D models). In addition, misconceptions such as "Roughness change does not change the property of the surface" and "The presence of water in the form of drops on a surface is caused by the surface tension of water" were determined.

Big Idea 4-Quantum Effects

Learning quantum mechanics is challenging, even for upper-level undergraduate and graduate students. Ingerman (2009) investigated senior physics students' perceptions and understanding on quantum scattering in general and on quantum tunnelling in particular using a phenomenographic approach. Key concepts in understanding quantum scattering were determined as probability, energy, and the wave function according to the resulting set of four qualitatively distinct categories.

Sayer, Maries, and Singh (2017) discussed the development and evaluation of a research-validated Quantum Interactive Learning Tutorial (QuILT). An interactive simulation was used to improve student understanding of the double-slit experiment in the tutorial which strives to help students develop a good grasp of foundational issues in quantum mechanics. The obtained data from the pre-test and post-test showed that on average, the QuILT was effective in helping students develop a more robust understanding of foundational concepts in quantum mechanics that defy classical intuition using the context of the double-slit experiment.

Big Idea 5-Size Dependent Properties

In the study of Bryan, Sedeberg, Daly, Sears and Giordano (2012), teachers examined the change of size-dependent properties with numerous laboratory activities (synthesis of ferrofluid, generation of gold biosensor and synthesis of quantum dots). At the end of the program, most of the teachers were less successful in explaining how and why these differences arose, while giving examples of properties on the nanoscale that differ as a function of size.

Akdeniz and Benlikaya (2015b) examined pre-service chemistry teachers' understanding about size-dependent properties. This study was conducted with 60 pre-service chemistry teachers by performing two tests (A and B) one by one which involve open-ended questions. It was found that the teachers had difficulty mostly in explaining the causes of the colors of gold nanoparticles and quantum dots and the differences between semiconductor and conductor. They also struggled with imagining the changes in the interactions and in the surface area at nanoscale. Some alternative conceptions on these topics were found. Some suggestions for teacher education were given based on the results obtained in this study.

The most common theme among the studies on size-dependent properties is the relationship between surface area and volume (surface area/volume) since the concept of "surface area / volume ratio" was defined as a prerequisite for students to understand the size-dependent properties. In the study conducted by Taylor and Jones (2009), it was aimed to investigate the relationship between proportional reasoning ability and understanding surface area/volume relationships. The sample of the study consisted of 19 middle school students. A study was conducted on the surface area/volume ratio as a limiting factor on physical and biological systems for one week. As a result of the study, the researchers revealed that there is a significant relationship between them.

Big Idea 6-Self-Assembly

Some materials can spontaneously assemble into organized structures without any intervention. This process facilitates nanofabrication. Larsson, Höst, Anderson and Tibell (2011) aimed to investigate students' learning of self-assembly in an authentic learning environment: a teaching-learning sequence (TLS) including a tutorial exercise with a physical model of a poliovirus capsid. Twenty third-year biochemistry students in South Africa participated in the study. The data was obtained from interviews and written pre- and post-tests in the context of a mixed-methods approach. The fact of that a significant improvement in test scores was found showed the TLS could support students' understanding of self-assembly.

Höst, Larsson, Olson, and Tibell (2013) investigated the impact of using two external representations of virus self-assembly on student learning about the process of self-assembly. The representations were an interactive tangible three-dimensional model and a static two-dimensional image. Students in the tangible model condition used the facets of self-assembly in their open-ended posttest responses more frequently than those in the image condition. In particular, it was seen that the dynamic properties of the tangible model may support student understanding of self-assembly in terms of the random and reversible nature of molecular interactions.

Bagara, Dean, Nichol and Wong (2011) presented two hands-on experiments which are visual and interactive demonstrations of self-assembly as a synthesis tool and nanotechnology (in which nanomaterial can be made to perform useful functions), and build on the concepts of acid-base chemistry and electrostatic interactions.

Big Idea 7- Tools and Instrumentation

The study of Blonder (2010) aimed to learn how the AFM teaching model influenced science teachers' (n=14) understanding of the AFM, and how they felt about using the teaching model with their students. The results showed that the teaching model improved the teachers' knowledge and positively affected their attitudes towards using it in school and towards teaching nanochemistry.

Ristvey and Pacheco (2013) provided 21 high school teachers with hands-on experiences with a mobile AFM and a STM to image various samples (such as a microchip, Staphylococcus aureus, a polymer thin film etc.) during an intensive 2-week summer course as well as pedagogical training on nanoscience and nanotechnology, which lasted for one year. From the pretest to posttest assessments, mean average score improved from 61% to 68%. As a result of the study, the researchers determined that the teachers successfully learned the concepts of nanoscience and nanotechnology in school curricula, gained content knowledge of nanoscience and nanotechnology applications, and also mastered the function and processing of these devices.

Big Idea 8- Models and Simulations

Models and simulations are needed to understand and visualize nanoscale objects and phenomena. Daly and Bryan (2010) investigated the designing and the use of models of 18 secondary science teachers on nanoscience teaching. The study was carried out in two weeks in an intensive teaching framework, and then the teachers' work was followed for a year. An achievement test consisting of open-ended questions and lesson plans were used as data collection tools. As a result of the study, it

was observed that modeling is effective in concretizing ideas by visualizing them and facilitating inquiry.

Xie and Lee (2012) presented a systematic visual approach to teaching concepts in nanotechnology. They used five types of mathematical models to generate visual, interactive simulations providing a powerful software environment for virtual experimentation. A variety of instructional strategies were discussed in order to use these simulations effectively. Preliminary results from a pilot study at the college level demonstrated the approach used in this study may able to improve nanotechnology learning.

Big Idea 9- Science, Technology, and Society

The nanotechnology applications continue to expand day by day. In addition to its use in fields such as physics, chemistry, biology, computer, material science and electronics, it has also started to provide quite striking developments in the fields of medicine, environmental problems, energy production, defense industry, agriculture, aviation and space studies (Aizenberg and Fratzl, 2013).

Menon and Devadas (2019) presented the application of an energy lesson conducted by using nanoscience approach in a secondary education for pre-service science teachers. Firstly, the teachers were included in discussions about alternative energy sources. This was followed by a case-study approach to illustrate a real-world problem of energy deficiency which could be solved by solar energy based on nanoparticles. It was stated that the course provides opportunities for the teachers to develop an understanding of green energy.

In the study of Menthe and Heller (2015), high school students (n=190) were asked to investigate a current socio-scientific problem involving nanoscience on their own in a new science course jointly developed by Department of Chemistry Education of and Department of Chemistry, Hamburg University. As part of the course, the students spent two days at the university, conducting experiments, researching information and, finally, evaluating whether or not the silver nanoparticles designed to sanitize laundry are likely to have a negative environmental impact. After the course, students were asked to give feedback. These reports showed that the students found both the subject and the laboratory studies they participated in interesting.

Gardner, Jones, Taylor, Forrester and Robertson (2010) focused on the perceptions of undergraduate engineering students on the risks and benefits of nanotechnology. It was found that the perceptions of risks and benefits of nanotechnology tended to be closely tied to specific groups of applications including common consumer products, health-related products, and advanced technological applications. The intersection of

scientific application and perception was discussed in the context of science education curriculum considerations.

The Studies Involving More than one Big ideas

Blonder and Sakhnini (2012) aimed to develop a nanotechnology teaching module that will help students understand the issues of size-scale and surface area/volume ratio by using various teaching techniques. The sample of the study consists of 60 ninth grade students. The study lasted twelve weeks, with a 45-minute class hour per week. At the end of the lessons, the students were provided to create and present a final project. Conceptual understanding test, structured bilateral interview forms and students' final project presentation activities were used as data collection tools. As a result of the study, it was determined that the teaching module positively affected the learning of the students who were below the average, providing them to discover the concepts.

Bryan, Sederberg, Daly, Sears and Giordano (2012) reported the findings from a recent study conducted as part of a 5-year initiative by the National Center for Learning and Teaching Nanoscale Science and Engineering to facilitate secondary science teachers' development of nanoscale science, engineering, and technology content knowledge. They examined the pedagogical development of secondary science teachers in general nanoscience content knowledge on the subjects of "size-dependent properties, size and scale, tools and instrumentation, models and simulations". For this purpose, the teachers attended a 2-weeks pedagogy course. The conceptual achievement test, the retention test and the lesson plans were used as pre-test and post-test as data collection tools in the study. As a result of the study, it was observed that the academic achievement of the teachers on the subjects increased in favor of the post-test, but there was no significant difference in the retention test results.

Benlikaya, Kabaca, Yılmaz, Balcı, Korkusuz, and Erol (2018) presented four activities including size and scale, surface area/volume ratio (Activity-1), microscopes (Activity-2), nanostructures in nature (Activity-3) and nanotechnology applications (Activity-4) developed for teaching nanoscience at the secondary education in order to form the basis for higher education. Some photos taken during the activites were given in Fig.2. These activities were applied to two groups of 11 and 15 students from 9th, 10th and 11th grades in three hour periods. Pre-test and post-test results were compared in order to determine how effective these activities had been. In addition, each activity was assessed by the students via the rubric given in the end of activity. An increase in post-test averages of each group was seen. According to the results of the activity assessment Activity-3 and Activity-4 had the highest scores, with Activity-1 having lowest. The

suggestions made on the activities underlined the importance of improving students' attentiveness and achievement.

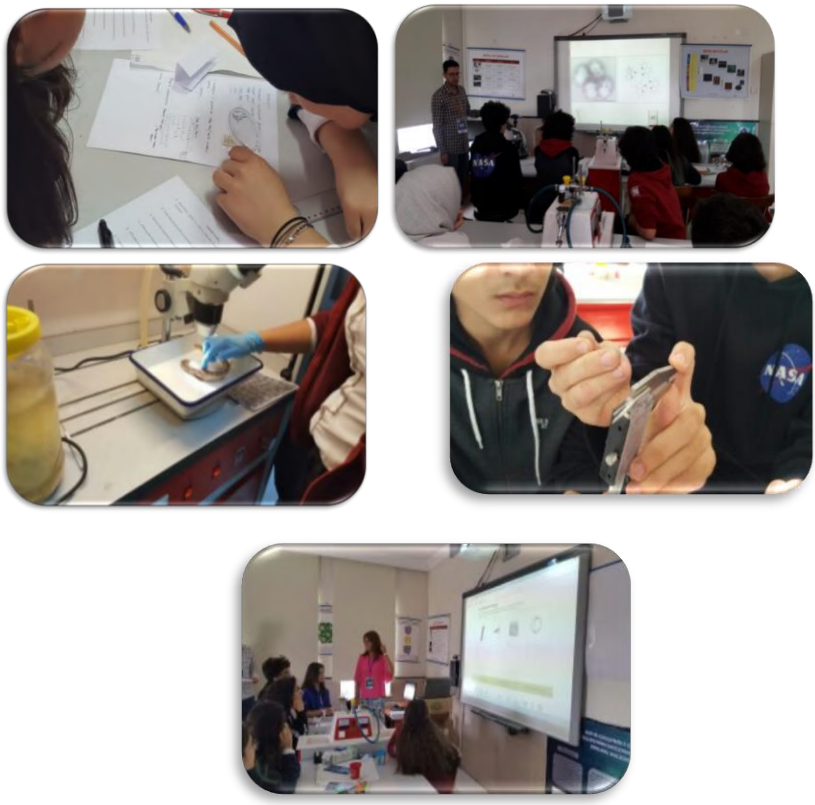

Fig. 2: Sample photos taken during the activities

Why is it Difficult to Teach/Learn Nanoscience?

Nanoscience-nanotechnology literacy requires understanding the interactions, the structure and properties of matter at nanoscale, and evaluating the advantages and disadvantages of nanoscale materials (Feather, 2011). Achieving this literacy is not easy because it is inevitable that you will have conflict with your prior knowledge when learning nanoscience topics. The fact that all properties change with scale is at odds with the traditional concept of "intensive properties," which are defined as being independent of the amount of material (e.g., melting point, color, reactivity, hardness, conductivity, malleability). The traditional conception of chemical and physical properties applies only for macroscale amounts of a material, for as the size of the material gets smaller towards to the nanoscale, some of those intensive properties do, indeed, begin to change.

For example, you have learned until now that gold is a yellow-colored and less reactive than other transition metals, but at the nanoscale you will encounter many colors of gold and learn that it behaves as catalyst. You will see that the melting point, which you think to be constant at constant pressure, varies at the nanoscale for the same substance depending on its size and shape. You've talked about macroscopic and microscopic properties until now and you will come across nanoscopic properties that you have not heard before. It is possible to increase the number of these examples.

Another of the conceptual difficulties in learning nanoscience is the limited ability of students to understand the real size and scale of objects. Xie and Pallant (2011) stated that it was not possible for students to see and manipulate nanoscale objects, so that students could not have a real experience from the nanoscale or do hands-on experiments to examine nanoscale events.

The probe microscopes will have a positive impact on students' understanding of nanoscale due to providing opportunity to see atoms, move them and make the new structures at nanoscale. Not every school can afford to buy such expensive equipment, especially in the short term. This means that only a small number of students will benefit from using them. Consequently, if the purpose of introducing nanoscience to schools is to form a nano-literate population, other strategies and other tools also needs developing.

Some difficulties and misconceptions of the students in their prerequisite knowledge, for which samples are given below, could have affect negatively on learning/teaching nanoscience as other sciences. As Stevens, Sutherland and Krajcik (2009) suggested in their books, students may believe that

- Relative and absolute sizes of two objects are linked (Delgado, Stevens, Shin, Yunker and Krajcik, 2007).
- Electrons move around the nucleus in orbitals like planets around the solar system (Griffiths and Preston, 1992).
- It is possible to see atoms and molecules with a light microscope (Griffiths and Preston, 1992).
- There is a lack of tools small enough to work with things that are too small to see.
- Science is a linear process; all experiments work (Smith, 2000).
- When technologies and new products are developed to solve problems, there are no side effects or negatives.

- Bond polarity is a secondary property of covalent bonds instead of thinking about a continuum between ionic and covalent bonding (Pallant and Tinker, 2004).

Students often have conceptual difficulties with decimals (Cohen, Corel, and Johnson, 2002), ratios and proportions (Misailidou and Williams, 2003), and measurement (Kenney and Kouba, 1997). In addition, new misconceptions may be also formed after learning the topics on nanoscience. For example, students may believe that scanning probe microscopes work similarly to optical microscopes and images produced with the probe microcopes are the same as "seeing" something through an optical one (Harrison and Treagust, 2002, as stated Stevens et al., 2009).

As seen in the literature mentioned above, there is a need for more experimental studies involving inquiry-based learning, case-based instruction, problem-based learning, project-based learning and discovery learning on different subjects specified in "Big Ideas" in nanoscience teaching. Although the use of some of the 3D printing technology applications has only just begun, it is clear that 3D printing will soon become the main technology (Jafari, Cloutier, Allahdini and Momen, 2019). The models produced with this technology can be used to eliminate the difficulty on conceptualization of small imperceptible objects and processes. The interactive simulations on the probe microscopes may enable students to explore actively nanostructures, tools and instrumentation. The suggestions above can also help students/teachers to remediate or overcome the misconceptions about nanoscience.

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