ITALL

INSTRUCTIONAL TECHNOLOGIES AND LIFELONG LEARNING

Volume 5, Issue 2, December 2024

e-ISSN: 2717-8307

INSTRUCTIONAL TECHNOLOGY AND LIFELONG LEARNING

e-ISSN: 2717-8307

International Refereed Journal/Uluslararası Hakemli Dergi

Volume: 5, Issue: 2, December 2024
Cilt: 5, Sayı: 2, Aralık 2024

Contact Information
Web: https://dergipark.org.tr/itall
E-Mail: itall.journal@gmail.com
Address: Eregli Faculty of Education/ Ereğli/KONYA

İletişim Bilgileri
İnternet Adresi: https://dergipark.org.tr/itall
E-Posta: itall.journal@gmail.com
Adres: Ereğli Eğitim Fakültesi/ Ereğli/KONYA

Instructional Technology and Lifelong Learning (ITALL) is a free, international academic journal with open access in which original scientific research on instructional technologies and lifelong learning is published in English. ITALL is published electronically in two issues, June and December.

Öğretim Teknolojisi ve Hayat Boyu Öğrenme Dergisi (ITALL), öğretim teknolojileri ve hayat boyu öğrenme ile ilgili alanlarda yapılan bilimsel araştırma ve derleme çalışmaların İngilizce dilinde yayımlandığı açık erişime sahip, ücretsiz, uluslararası akademik bir dergidir. ITALL, Haziran ve Aralık olmak üzere iki sayı olarak elektronik ortamda yayınlanmaktadır.

Abstracting & Indexing / Taranan Dizinler
EBSCO Education Full Text, Education Source Ultimate, EBSCO - Central & Eastern European Academic Source, Index Copernicus ICI Journals Master List, Directory of Research Journal Indexing (DRJI), Crossref, ASOS Index

Instructional Technology and Lifelong Learning, Volume 5, Issue 2, 2024, TÜRKİYE

CONTENT / İÇİNDEKİLER

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 192-213 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Academics' Scientific Attitude Levels

Halil GÜÇER *[1], Necla ŞAHİN FIRAT [2]

* *Corresponding Author, halil.gucer@deu.edu.tr*
[1]*Dokuz Eylül University, Türkiye*
[2]*Dokuz Eylül University, Türkiye*

Abstract

This descriptive study is aimed to determine the scientific attitude levels of academics who are working in different fields at universities. The Scale of Instructors' Scientific Attitudes was used in order to obtain data. The research population is 6807 academics working at four public universities and two foundation universities in Izmir/Türkiye. The research sample includes 678 in total, 341 women, 337 men at these universities. The SPSS Statistics 23 program was used for analysis. The data has been analyzed by using arithmetic mean, standard deviation, t- Test, and One-Way ANOVA hen the difference was found significant, and LSD Test of Significance were used in order to determine which groups create differences. Scientific attitude levels of academics vary according to titles, university type and their fields. Accordingly, while academic titles progress, the level of scientific attitude also increases. Regarding levels of scientific attitudes, the findings were discussed in favor of instructors working at state universities and in the fields of communication technology, natural sciences and mathematics.

Keywords: Academics, Science, Scientific attitude levels, Knowledge production

Citation: Güçer, H. & Fırat, N. (2024) "Academics' Scientific Attitude Levels". *Instructional Technology and Lifelong Learning, 5*(1), 192 – 213. https://doi.org/ 10.52911/itall.1410506

Öğretim Elemanlarının Bilimsel Tutum Düzeyleri

Özet

Bu betimsel çalışmada üniversitelerde farklı alanlarda çalışmakta olan öğretim elemanlarının bilimsel tutum düzeylerinin belirlenmesi amaçlanmaktadır. Araştırmada verilerin elde edilme sürecinde Öğretim Elemanlarının Bilimsel Tutum Ölçeği kullanılmıştır. Araştırmanın evrenini İzmir'deki dört devlet üniversitesi ve iki vakıf üniversitesinde görev yapmakta olan öğretim elemanları oluşturmaktadır. Araştırma örneklemi 341'i kadın 337'si erkek olmak üzere toplam 678 öğretim elemanından oluşmaktadır. Veriler SPSS 23 istatistik paket programı kullanılarak analiz edilmiştir. Verilerin analizinde aritmetik ortalama, standart sapma, t- Test ile One Way ANOVA Testi yapılmıştır. Anlamlı farklar bulunduğu zaman, farklılığın hangi gruplar arasında olduğunu saptamak için LSD Anlamlılık Testi kullanılmıştır. Araştırmada öğretim elemanlarının bilimsel tutum düzeylerinin unvanlarına, çalıştıkları üniversitenin türüne ve alanlarına göre farklılık gösterdiği bulunmuştur. Buna göre öğretim elemanları akademik unvanlarda ilerledikçe bilimsel tutum düzeyleri de yükselmektedir. Bilimsel tutum düzeyi bakımından devlet üniversitelerinde görev yapmakta olan öğretim elemanları ile iletişim teknolojileri, doğa bilimleri ve matematik alanlarında çalışan öğretim elemanlarının lehine bir bulgu ele edilmiştir.

Anahtar Kelimeler: Öğretim elemanları, Bilim, Bilimsel tutum düzeyleri, Bilgi üretimi

Date of Submission	26.12.2023
Date of Acceptance	01.03.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	This article is extracted from my doctorate dissertation entitled " Scientific Attitude Levels of Academic Staff ", supervised by Necla Şahin Fırat (Ph.D. Dissertation, Dokuz Eylul University University, Izmir, 2021).
Author(s) Contribution	**Güçer:** Conceptualization, Writing- Original draft preparation, Data curation **Fırat:** Reviewing and Editing, Methodology, Supervision, Validation.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	itall.journal@gmail.com
Grant Support	The author(s) acknowledge that they received no external funding in support of this research.
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

The world has been experiencing the scientific and technological revolution that took place in the mid-1980s and is called the third technological revolution and third industrial revolution. With this revolution, which has become evident mainly as the application of microelectronics and computers to production, almost all countries are trying to transform into an information economy/society. In this environment where the importance and value of knowledge are increasing, nations have been struggling to make a difference in the fields of research and development (R&D). Innovation and creativity have become the most important competitive element on the international platform (Kalkınma Bakanlığı, 2013). All of these processes are parallel with science and scientific developments. Science is not a concept that human beings have collided with recently. It is thought that since the beginning of history, mankind has tried to solve the problems encountered in nature by trial-and-error method. The purpose of controlling the power of nature and survival has resulted in the emergence of science. In other words, the need to control nature and the purpose of survival combined with the curiosity of human beings. As a result of this, people have entered a process that they have been asking and seeking answers to these questions. Science is the intellectual and practical process of seeking reliable and valid knowledge through systematic methodology including testing of hypotheses, observation, and experiment (Lewins, 1992).

Scientific knowledge is subject to change by new observations and experiments or new comments on current observations (Schwartz, Lederman & Crawford, 2004). Depending on a certain type of methodology and changing over time, science casts aside all mystical and supernatural definitions and acceptances. Just as science is not only a process of obtaining knowledge, but also a process of discovery, it is connected with the natural way of discovering in a systematic way (Setiawaty, 2017). In this discovery process, the developments in R&D have made the role of universities stronger in public life. Because there is no any doubt that universities play a crucial role in the production of knowledge (Godin and Gingras, 2000). Therefore, academics' ideas, thoughts, feelings, and attitudes about science also have a crucial importance in generating new scientific knowledge at universities. As it is known, universities aim to enable their students to understand science and gain a scientific perspective.

It seems that producing new scientific and academic knowledge and transferring it to the new generations are the main roles of academic at tertiary institutions. Jung (2020, p. 135) states the same point that "the role of higher education is particularly crucial as a core actor of knowledge production". Välimaa and Hoffman (2008) got a global point of view and pointed out that the role of higher education institutions in a global knowledge economy is more crucial than ever. In higher education knowledge is produced through research programmes which also contribute efficiency of higher education. Cortese (2003) also emphasized the responsibility of higher education and stated that universities have a profound responsibility to create just and sustainable future by increasing awareness, knowledge, skills, and values. Therefore, research programmes and knowledge production are inseparable components of university education (Metcalfe and Fenwick, 2009).

It has been possible to create science and technology in today's known level as a result of human beings' innate ability of questioning. Because of the ability of questioning, people can ask questions before they acquire scientific knowledge. Therefore, in all scientific fields, scientists can start any study by forming a question at the first stage of the research process. Everybody conducting research finally presents their findings depending on their initial questions and research process. Emergence of scientific research, R&D, and creativity may require a type of attitude towards science. Such an attitude is based on an intellectual basis that every opinion may change and scientific knowledge cannot be accepted as dogmatic views. An opposite approach brings to mind that scientific knowledge is static or does not change. If scientific findings were considered not to be changed, there would not be any necessity to do further research to create new knowledge. It also means that the efficiency of higher education declines.

Since the academic staff are responsible for doing scientific research and training future doctors, engineers, teachers, lawyers, and so on, their scientific attitude levels have a crucial impact on society. Thus, this study is aimed to find out the scientific attitude levels of academics. As it is understood that this paper approaches scientific attitude from the perspectives of academic staff and tries to answer the following research questions.

Research Questions

1. What is the scientific attitude level of academic staff?

2. Do the scientific attitude levels of academic staff vary significantly in terms of their academic titles?
3. Do the scientific attitude levels of academic staff vary significantly in terms of the type of universities in which they are working?
4. Do the scientific attitude levels of academic staff vary significantly in terms of their fields of study?

1.1. Literature Review

It is understood that the emergence of R&D, innovation and creativity may require an attitude that does not accept all information as true, discusses discuss it or an attitude which is open to change current knowledge. This type of attitude can be called as "scientific attitude" that does not have a single definition in the relevant literature. The studies including scientific attitude make a list of some characteristics of this concept. For instance, Byrne and Johnstone (1987) indicate curiosity, open-mindedness, critical-mindedness, objectivity, caution in concluding weighing evidence, loyalty to truth, and existence of cause-and-effect relationships as components of scientific attitude. Gardner (1995, p.284) thinks "curiosity", "rationality" and "open-mindedness" are scientific attitudes. In other words, scientific attitudes are an intricate blend of a want to know and understand, a critical eye toward all claims, a look for data and their significance, a demand for proof, a respect for logic, a study of premises, and a consideration of consequences (Osborne, Simon & Collins, 2003). Another description of scientific attitude is "the motivation needed to convert knowledge and skills into scientific procedures and engagement" (Fives, Huebner, Binbaum & Nicolich, 2014, p.555). People with a scientific mindset are open-minded, focused on doing experiments, and methodical in their approach. (Wildan, Hakim, Siahaan and Anwar, 2019). Pitafi and Farooq (2012, p.383) indicated "curiosity, rationality, willingness to suspend judgment, open-mindedness, critical mindedness, objectivity, honesty and humility" as the components of scientific attitudes. Suryawati, Osman and Meerah (2010, p.1720) stated that seven important aspects which build scientific attitude are "responsibility, curiosity, cooperation, punctuality and accuracy, discipline, tolerance, and self-confidence".

Due to the vital role of academics in the production of knowledge, the importance of their scientific qualifications is increasing. In this study, the reason why the academics are included

in this research is based on the assumption that their main task is to carry out scientific research, R&D and innovation and to teach young generations. In addition to conducting individual research projects, academics also provide master's and doctoral thesis consultancy in postgraduate education programmes. They make invaluable contributions to knowledge production in the thesis advisory process (Baptista, 2011; Denicolo, 2004). Therefore, the level of scientific attitude can be considered as one of the leading qualifications of academics.

The success of any higher education system means that more qualified graduates join economic, social, and professional life. The quality and efficiency of university education depend on scientific and academic characteristics of lecturers. The academic staff whose scientific attitude level is higher can contribute both to the quality of university education and its graduates (Lee & Kuzhabekova,2019). As a result of more qualified university education, the scientific attitude levels of all occupations such as doctors, teachers, judge and so on will increase, which is going to help to develop the scientific attitude level of all society.

Covid-19 global pandemic has revealed the significance of science and scientific studies. Individuals who obey doctors' and scientists' warnings to avoid Coronavirus are successful in not to getting infected. However, the ones ignoring all warnings or precautions get infected or even pass away. So, it can also be stated that every member of society needs a certain level of scientific attitude to live healthily.

An important reason for this study is that a study on scientific attitude levels of academic staff in literature cannot be found. It is thought that this study may contribute to researches to improve the qualifications and efficiency of academics in Turkey. Some studies which are not related to academics on scientific attitude can be found in the literature. For example, Flegg and Hukins (1973) conducted a study to measure the scientific attitude-curiosity level of high school students. Jones and Butts (1983) conducted a study called to measure the level of 7–10-year-old students in New South Wales Secondary School to have scientific attitudes specified in the affective goals of the science curriculum. Moore and Foy (1997) conducted a study in which they studied the scientific attitudes of middle and high school students. Pitafi and Farooq (2012) aimed to measure the scientific attitude levels of high school students in Pakistan. The common aspect of those studies is that they were conducted with high school or secondary school

students and they focused on the scientific attitudes in science courses. Studying the concept of scientific attitude only with students can be considered a deficiency in the literature.

2. Method

This paper is a descriptive study with a survey model. Descriptive survey research aims to reveal a large group of people's opinions, perceptions, or beliefs about an issue; therefore, it is more suitable for exploratory or explanatory purposes and it enables the researcher to describe a large population which would be impossible to do directly (Rubin and Babbie, 2011). This paper is based on quantitative study conducted in Izmir/Türkiye. Data was collected from 6 universities located in Izmir. These universities are the state universities which are Dokuz Eylul University, Ege University, Izmir Katip Celebi University, Izmir Institute of Technology, and two foundation universities which are Izmir University of Economics and Yasar University.

2.1. Population

The research population consists of 6807 academics working at the aforementioned universities in Izmir.

2.2. Sample

The sample was determined with stratified sampling which "involves dividing the population into homogenous groups, each group containing subjects with similar characteristics" (Cohen, Manion & Morrison, 2005: 101). First, faculty members from both state and foundation universities are represented by 10% in the sample of this study. As it was impossible to reach all the instructors in these universities, the researchers tried to include the academic staff in the sample according to their gender, study fields and academic titles. The sample was formed according to the type of university in which they were working, their gender, academic titles, and their fields of study. Table 1 provides the information about distribution of academic staff according to their gender in the study sample.

Table 1.

Distribution of academic staff according to their gender in the study sample.

Gender	Population*	%	Sample	%
Woman	3347	49	341	51
Man	3460	51	337	49
Total	6807	100	678	100

Source: Higher Education Information System (https://istatistik.yok.gov.tr/)

According to the data in Table 1, the population included 6807 instructors in total. 49% of them were women and 51% were men. The sample is consisting of 678 academic staff in total, 51% of them were women and 49% were men. Table 2 shows the distribution of academic staff according to their academic titles.

Table 2.

The distribution of academic staff according to their academic titles.

Titles	**Population**	**%**	**Sample**	**%**
Prof. Dr.	1792	26,4	163	24,1
Associate Prof	1082	15,8	117	17,3
Assistant Prof	1119	16,4	104	15,4
Instructor	1235	18,2	94	13,8
Research Assist.	1579	23,2	200	29,4
Total	6807	100,0	678	100,0

As can be seen in Table 2, the aim was to ensure that the academics were represented in the research sample by preserving their proportions in the population. For instance, the rate of assistant professors is 16% in the population and similarly the rate of assistant professors is 15% in the study sample.

Table 3 indicates the distribution of academic staff according to type of universities in which they are working.

Table 3.

The distribution of academic staff according to their type of universities

Type of university	Population	%	Sample	%
State	6092	89	609	%89
Foundation	715	11	69	%11
Total	6807	100	678	%100

Table 3 represents the rate of academic staff in the population according to the type of universities in the sample. The rate of academic staff working in state universities is the same in population and sample. The rate of academics working in state universities and foundation universities is so close in the population and sample.

The study fields of academic staff are also examined. Table 4 presents the distribution of academic staff according to their fields.

Table 4.

The distribution of academic staff according to their study fields

Type of Field	Population	%	Sample	%
Information and Communication Technologies Natural Sciences, Mathematics and Statistics	543	8,0	55	8,1
Education, Services	963	14,1	100	14,7
Business, Administration and Law Arts and Humanities Social Sciences	1455	21,4	146	21,5
Engineering; Manufacturing and Construction Agriculture	1767	26	184	27,1
Health	2079	30,5	193	28,4
Total	6807	100	678	100

As it is seen in Table 4, approximately 28% of the teaching staff participating in the research sample are in the field of health; 27% in engineering, manufacturing, construction, and agriculture, about 22% in social science, arts and humanities; about 15% of them work in education and 8% in the fields of information and communication technologies, natural sciences, mathematics and statistics.

2.3. Data Collection Instrument

The Scale of Instructors' Scientific Attitudes developed by the author (2021) was used to obtain data for the research. The scale is a five-point Likert-type scale and there are 23 items ranging as "I completely agree; I mostly agree, I am neutral; I mostly disagree, I totally disagree". This scale has two subscales; The Attitude about Scientific Principles including 19 items and The Attitude about Scientific Details and Differences including 4 items. The validation of scale was provided by construct validity and criterion validity. The Kaiser-Meier-Orkin (KMO) coefficient for the scale used in this study was .92 (>0.60) and the results of the Barlett sphericity test (X^2 = .6658 $p<0.01$) were found to be significant (Büyüköztürk, 2011). Cronbach's alpha reliability coefficient was also calculated for both the total of The Scale of Instructors' Scientific Attitudes of and its subscales. According to the results of reliability of analysis, the total Cronbach's alpha coefficient is .92. The Attitude about Scientific Principles subscale's

Cronbach's alpha coefficient is .91 and The Attitude about Scientific Details and Differences' is .63 (Güçer, 2021).

2.4. Data Collection Process and Data Analysis

The scales were delivered to the academics and collected by the researchers themselves. During the data collection process, the units of all universities in Izmir were visited regularly on certain days of every week. In these visits, the answered scales were taken, and in each visit, it was tried to reach the academics individually as much as possible. For this purpose, appointments were arranged in advance in order to reach as many academics as possible on the day of the visit. In order to make a statistically significant analysis, reaching 10% of the population was achieved in a period exceeding one and a half years. The reasons for this situation were that some academics could not be reached despite all of the efforts, the majority of the academics answered the scales late and although some scales were answered in a short time, the delivery was delayed or not delivered at all, and some scales were answered without being read incompletely or randomly. At the end of the data collection process, 10% of the research population was reached and data was obtained from the intended sample group.

The research sample is sufficiently large (n=678) that the skewness values are within the range (± 1) and can be interpreted as normally distributed (Büyüköztürk, 2011). For these reasons, the t-test from parametric statistics, one-way ANOVA, LSD test in multiple comparisons, and arithmetic mean and standard deviation were used to analyze the data in the SPSS Statistics 23.

2.5. Research Ethics

This research was carried out with the approval of Dokuz Eylul University, Institute of Education Ethics Committee for Researches on Educational Sciences with the decision numbered "02" in the session dated 22.02.2018.

3. Findings

3.1. Findings related to the first research question

Table 5 indicates the distribution of scientific attitude levels of academic's according to subscales.

Table 5.

Distribution of scientific attitude levels of academics' according to subscales (arithmetic mean and standard deviation)

Subscale	$\bar{x}$	SD
The attitude about scientific principles	3,84	1,09
The attitude about scientific details and differences	4,55	0,66
Scientific Attitude Levels in General	3,96	1,02

The first research question of this study was "What is the scientific attitude level of academic staff?". Depending on the analysis of data, the level of scientific attitude levels of academics can be accepted at higher level ($\bar{x}$=3,96). The mean scores of "the attitude about scientific details and differences subscale" ($\bar{x}$=4,55) is higher than the mean scores of "the attitude about scientific principles subscale" ($\bar{x}$=3,84) The academics scored the 16th item "I support different points of views to emerge" at the highest level (totally agree, $\bar{x}$=4,66) generally and in "the attitude about scientific principles subscale" The academics also scored the 7th item "Problems can be solved in different ways" (totally agree, $\bar{x}$=4,63) and 10th item "It is reasonable to evaluate different point of views before making a decision" (totally agree, $\bar{x}$=4,63) in "the attitude about scientific details and differences subscale".

3.2. Findings related to the second research question

The second research question of this study was stated as follows; "Do the scientific attitude levels of academics vary significantly in terms of their academic titles?" To analyze this question, mean scores and standard deviations of academics' scientific attitude levels were calculated in terms of their academic titles. Whether the scientific attitude levels differ significantly or not according to the titles, one-way analysis of variance (one-way ANOVA) was

carried out. LSD Test of Significance is used in order to determine which groups differ significantly The results of one-way ANOVA and LSD test are presented in Table 6.

Table 6.

Results for one-way ANOVA and LSD tests carried out to reveal the academic staff's scores for scientific attitude levels in terms of their academic titles.

Subscales	Titles	n	$\bar{x}$	SD	df	F	P	Difference
The attitude about scientific principles	1.Res. Assist.	200	69,77	12,42	4	20,26	0,00*	4-1
	2.Instructor	94	69,71	10,95	673			4-2
	3.Assist.Prof.	104	71,13	12,25				5-1
	4.Assoc.Prof.	117	74,22	13,29				5-2
	5.Prof.	163	80,09	11,14				5-3
								5-4
	Total	678	73,22	12,73	677			
The attitude about scientific details and differences	1.Res. Assist.	200	17,90	2,27	673	4,29	0,00*	4-1
	2.Instructor	94	18,22	1,91				4-3
	3.Assist.Prof.	104	17,93	2,03				5-1
	4.Assoc.Prof.	117	18,45	1,38				5-3
	5.Prof.	163	18,58	1,23				
	Total	678	18,21	1,85	677			
Scientific Attitude Levels in General	1.Res. Assist.	200	91,18	14,12	673	21,61	0,00*	4-1
	2.Instructor	94	91,65	12,17				4-2
	3.Assist.Prof.	104	91,87	13,99				4-3
	4.Assoc.Prof.	117	96,13	15,02				5-1
	5. Prof.	163	103,11	12,10				5-2
								5-3
								5-4
	Total	678	95,07	14,35	677			

*P<.05

As can be seen in Table 6 the academic staffs' scientific attitude level scores vary significantly in terms of their academic titles (p=0,00) in both two dimensions and scale in general. The scientific attitude level scores of professors and associate professors are higher than research assistants, instructors, and assistant professors.

3.3. Findings related to the third research question

The third research question of this study was stated as follows; "Do the scientific attitude levels of academic staff vary significantly in terms of type of their universities in which they are working?" In order to analyse this question, mean scores and standard deviations of academics' scientific attitude levels were calculated in terms of type of their universities in which they are working. To find out the scientific attitude levels are significant or not according to the university type, t test was carried out. Table 7 shows the results -t test results.

Table 7.

Results for -t test carried out to reveal the academic staff's scores for scientific attitude levels in terms of type of their universities in which they are working

Subscales	Uni. Type	n	$\bar{x}$	SD	df	-t	P
The attitude about scientific principles	State	582	73,81	12,52	676	0,03	0,00*
	Foundation	96	69,64	13,45			
The attitude about scientific details and differences	State	582	18,19	1,88	676	-0,59	0,55
	Foundation	96	18,31	1,64			
Scientific Attitude Levels in General	State	582	95,70	14,12	676	0,05	0,00*
	Foundation	96	91,25	15,17			

* P<.05

It can be observed in Table 7 the academic staff's scientific attitude level scores vary significantly in terms of the type of their universities in which they are working in one dimension and scale in general (t=0,05; p<0,05) according to -t test carried out to understand whether the scientific attitude levels are significant or not. The scientific attitude level ($\bar{x}$ = 95,70) of academics working at state universities is higher than the scientific attitude level ($\bar{x}$ =91,25) of the ones working at foundation universities.

The academic staff's scientific attitude level scores vary significantly (t=0,03; p<,05) in terms of type of their universities in which they are working in the dimension called as the attitude about scientific principles. In this dimension it is calculated that the scientific attitude level ($\bar{x}$=73,81) of academics working at state universities is higher than the scientific attitude level ($\bar{x}$=69,64) of the ones working at foundation universities.

According to the findings of Table 7, the academic staff's scientific attitude level scores do not vary significantly in terms of type of their universities in which they are working in the subscale about the attitude about scientific details and differences.

3.4. Findings related to the fourth research question.

The fourth research question of this study was stated as follows; "Do the scientific attitude levels of academic staff differ significantly in terms of their field of study" In order to analyze this question, mean scores and standard deviations of academics' scientific attitude levels are

calculated in terms of their scientific fields. To decide the scientific attitude levels differ significantly or not according to the scientific fields, one-way analysis of variance (One-way ANOVA) is carried out. LSD Test of Significance is used in order to determine which groups create differences. The results of one-way ANOVA and LSD tests are given in Table 8.

Table 8.

Results for one-way ANOVA and LSD tests carried out to reveal the academic staff's scores for scientific attitude levels in terms of their scientific attitude levels.

Subscales	Scientific Fields	n	$\bar{x}$	SD	df	F	P	Difference
The attitude about scientific principles	(1) Info.Com.Tech. Natural Sciences Math. Stats.	55	83,11	4,00	4 673	254,66	0,00*	1-2 1-3 1-4
	(2) Edu. and Services	100	67,55	11,92				4-2 4-3
	(3)Business,Adm., Law, Arts and Humanities, Social Sciences	146	57,53	7,66				5-2 5-3 5-4
	(4) Engr. and Agri.	184	74,83	10,00				
	(5) Health	193	83,67	3,17				
	Total	678	73,22	12,73	677			
The attitude about scientific details and differences	(1) Info.Com.Tech. Natural Sciences Math. Statistics	55	18,85	0,84	673	19,37	0,00*	1-2 1-3 1-5 4-2
	(2) Edu. and ,Services	100	18,20	1,89				4-3 4-5
	(3) Business, Admin., Law, Art and Humanities, Social Sciences	146	17,16	2,83				5-2 5-3
	(4) Engr. and Agri	184	18,76	1,11				
	(5) Health	193	18,30	1,23				
	Total	678	18,20	1,85	677			
Scientific AttitudeLevels in General	(1) Info.Com.Tech. Natural Sciences Math. Stats.	55	106,71	4,29	673	249,62	0,00*	1-2 1-3 1-4
	(2) Edu. and Services	100	89,34	13,44				4-2 4-3
	(3) Business, Adm., Law, Art and Humanities, Social Sciences	146	77,03	8,98				5-2 5-3 5-4
	(4) Engr. and Agri.	184	97,33	11,12				
	(5) Health	193	106,23	3,90				
	Total	678	95,07	14,35	677			

P<.05

As seen in Table 8 the academic staff's scientific attitude level scores differ significantly in terms of their scientific fields (p=0,00) in both two dimensions and scale in general. According to the findings in Table, the scientific attitude level scores of academics working in the fields of information-communication technologies, natural sciences and mathematics are calculated higher than the scientific level scores of academics who are doing researches in the fields of education, services, business, administration, law, arts and humanities, social sciences. In addition, the academics in engineering and agriculture have higher scores in scientific attitude than the academics in the fields of education, services, business, administration, law, arts and humanities, social sciences.

In the subscales "The attitude about scientific principles" and "The attitude about scientific details and differences", the academics of information-communication technologies, natural sciences and mathematics get higher scientific attitude level scores than the academics in the fields education, services, business, administration, law, arts and humanities, social sciences.

4. Discussion and Conclusion

This study was conducted to determine academics' scientific attitude levels. Considering findings of the overall scale and both dimensions, it is seen that the three highest-scored items are about different perspectives, solutions, and opinions. Accepting differences and different views, solutions, opinions, and approaches and even supporting their development can be explained by the tolerant and open-minded characteristics of the scientific attitude. Tolerance generally means acceptance of different beliefs, attitudes, or behaviours -i.e., the otherness, that you may not agree with and what is negatively evaluated -that is not acceptable to a person or social grouping (Kanisaukas, 2010).

Supporting the development of different ideas also recalls being open-minded, which is another characteristic of the scientific attitude. Being open-minded fosters a readiness to challenge conventional wisdom, be attentive to new possibilities, share ideas, and take into account opposing viewpoints (Navarro & Carion, 2008). Emphasizing the tolerance and open-mindedness shows that the academics are open to different approaches and perspectives. These characteristics are compatible with the behaviours of scientific attitude.

According the findings of the second research question (Do the scientific attitude levels of academics vary significantly in terms of their academic titles?), professors get the highest scientific attitude scores. In other words, while academic staff rise in the academic pyramid, their scientific attitude levels are also developing. In Turkiye, The Law on Higher Education, (law number:2547) defines the responsibilities in connection with education, research, teaching staff, students, and other personnel of institutions of higher education and their governing bodies. According to this law (article 13), "professor is a teaching staff member holding the highest academic title". An individual who aims at academic career starts his career journey as a research assistant or an instructor. They should constantly study on writing theses, papers, book chapters and so on to progress along academic career path. As academics progress in academic life, their scientific attitude level also develops in parallel. It is seen that the level of scientific attitude develops simultaneously in the process of producing scientific knowledge. Munoz (2016) mentions research efficiency as one of the efficiencies at higher education institutions. Gralka, Wohlrabe and Bornmann (2019) states that number of publications are related to efficiency of higher education. Depending on these facts, academics' production of knowledge can also be considered to contribute efficiency at higher education. Furthermore, one can accept that more efficiency may result in higher scientific attitude level.

When a lecturer becomes an associate professor or professor, he or she does not have to deal with the bureaucratic affairs and work loads of the department. This makes them more interested in academic research. That is why, it can be thought that when academics concentrate on scientific studies, their intrinsic motivation and creativity increase. If people have an internal chain of causality, they attribute the consequences of their actions to themselves and are intrinsically motivated (that is, when driven or dependent on external factors), intrinsic motivation is weak (Auger and Woodman, 2016). Because of this, it is possible to conclude that the academics who have the highest positions in the academic pyramid have "internal causality chain" in their studies resulting high scientific attitude level.

The higher scientific attitude levels of the academics working at state universities can be explained by the demographic characteristics. While the rate of academic staff in the 25-34 age range from state universities is 30%, this rate is 37% in foundation universities. The rate of academic members aged 55 and above participating in the research from state universities is 15% whereas 11% in foundation universities. Considering the seniority, the ratio of those

working at state universities in the range of 1-10 years is 28%; The ratio of those working at foundation universities in the same seniority year is 37%. Considering these ratios, it is seen that the lecturers working in foundation universities are younger and have less experience.

The scientific attitude levels of the academic staff working in the fields of information and communication technologies, natural sciences, mathematics, and statistics are at the highest level according to findings of this paper. The higher scientific attitude levels of the academics working in the natural sciences can be explained by the positivist understanding of science which has been effective for many years. As it is known, positivism is a philosophical movement developed by Auguste Comte in the 19th century and assumes that what can be known is only facts. Positivism refers to the philosophical attitude of the natural scientist, which involves working with observable social reality to produce legitimate generalizations (Mathotaarachchi and Thilakarathna, 2021). Science explains observable phenomena from the point of view of the positivist philosophy of science (Lane, 1996). Positivism is a paradigm that argues that facts can emerge through methods of experimentation and observation and logical analysis. The positivist understanding accepts science in a conceptual hierarchy. This hierarchy starts with physics and ends with chemistry, biology, psychology and sociology respectively (Fırat, 2006). It has been understood that physics is the owner of the summit. Historically, steam-powered machines were invented, especially as a result of studies in the field of physics. Thus, the industrial revolution was experienced and the technology that facilitates the daily lives of people has developed, along with the advances in engineering and the tendency to control nature. Society benefits from the product aspect of science with the help of the technological developments. For example, people can talk to a friend from a distant part of the world via video by using mobile phones. It is possible to reach long distances in a much shorter time by means of airplanes and high-speed trains compared to transportation vehicles in the past. Today, none of us can even imagine a life without computers and internet. Therefore, as perceptually positivism presents the sciences to people by embodying them through technology, the superiority of physics and other natural sciences has begun.

According to the results of this study, the scientific attitude levels of the academics was determined at a high level in Turkey. This situation is important in terms of showing the tendency of the quality of education in higher education to rise to a higher level. This is important in terms of both the development of academics' qualifications and the participation

of qualified individuals trained by them in social and professional life in the future. The fact that the academics attach importance to different thoughts, approaches and solutions shows that they do not adopt a static point of view. This finding can be interpreted as academics are open to change and development, which can be seen as a prerequisite for scientific progress.

Another important result of the study is that academics' scientific attitude levels develop as they rise to professorship. The increase in the scientific publications of the academic staff, the rise of their titles and the development of their experiences require a labour-intensive knowledge production process. This shows that the scientific attitude progresses over time, in other words, it develops on a process-oriented basis. However, this may turn attention to another problem. There may be a lack of scientific perspectives of young academic candidates who have started their journey of academic career. Individuals who graduated from university in Türkiye may not have developed enough scientific perspective at the end of their undergraduate education.

The reason why the scientific attitude levels of the academics working at state universities in the research sample are higher than those at foundation universities can be explained by the fact that the lecturers at state universities are more advanced in terms of age and seniority. When compared to state universities, foundation universities can be considered very young in terms of both institutional and academic staff, so this result may be considered normal in Türkiye.

Another finding of this study is that the scientific attitude levels of the academics working in the fields of social sciences were lower in the research sample. It can be thought that the positivist understanding of science influences the differentiation of the scientific attitudes of academics according to the fields they work in. There is a philosophical and historical background behind the academics working in the field of natural sciences. Today, the tendency of society to perceive only natural sciences as science continues. For instance, Donmez (2017) states that students at secondary schools accept their science teachers as a scientist. Such a deep-rooted past and a strong perception may lead us to think that the academic staff working in the aforementioned fields contribute to the increase in their scientific attitudes.

Science has been in a continuous progress in its historical development. This has been made possible by the fact that everyone working in science has qualities such as critical thinking,

curiosity, asking questions, open-mindedness, honesty and so on. It is seen that the concept of scientific attitude covers all of these features. The high scientific attitude levels of all academics working at universities may lead to an increase in the quality of higher education and the destruction of dogmatic beliefs that may still exist in society.

One can conclude that making necessary studies during the academic career develops the qualities expressed by the concept of scientific attitude. However, according to the findings of this study, the scientific attitude levels of research assistants and lecturers who are at the beginning of academic life are lower. For this reason, training on scientific attitude awareness might be given to the academics who have just started their academic career. It is possible for foundation universities to support the production of scientific knowledge with various incentive systems considering the financial opportunities they have and the rapid decision-making processes from the point of view of the private sector. Some measures can be considered to improve the scientific attitude levels of academicians working in social fields. For example, incentive and reward systems specific to these fields might be developed.

Although this study has been carried out in Türkiye, characteristics of scientific attitude and scientific attitude levels of academics can be considered as an international research project. Because, scientific attitudes and its characteristics can be considered as a common ground shared by academics from different disciplines in all countries. The scientific attitude levels of academics working in different countries can be compared. As a result of these studies, programs can be developed at universities to improve scientific attitudes among candidates of academics.

5. References

Auger, P., & Woodman, W. R. (2016). Creativity and intrinsic motivation: exploring a complex relationship. *The Journal of Applied Behavioral Science 52*(3), 342-366. https://doi.org/10.1177/0021886316656973

Baptista, A. (2011). Challenges to doctoral research and supervision quality: a theoretical approach. *Procedia Social and Behavioral Sciences, 15*, 3576-3581. https://doi.org/10.1016/j.sbspro.2011.ç04.338

Büyüköztürk, Ş. (2011). *Sosyal bilimler için veri analizi el kitabı.* (15. Baskı). Pegem Akademi.

Byrne, M. S., & Johnstone, A. H. (1987). Critical thinking and science education. *Studies in Higher Education 2*(3), 235-339. https://doi.org/10.1080/03075078712331378102

Cohen, L., Manion, L., & Morrison, K. (2005). *Research methods in education*. Routledge Falmer.

Cortese, A. D. (2003). The critical role of higher education in creating a sustainable future. *Planning for Higher Education, 31*(3), 15-22.

Denicolo, P. (2004). Doctoral supervision of colleagues: peeling off the veneer of satisfaction and competence. *Studies in Higher Education, 29*(6), 693-707. https://doi.org/10.1080/0307507042000287203

Donmez, G. (2017). *Ortaokul öğrencilerinin fen bilimleri dersine,bilime,fen bilimleri öğretmenine ve bilim insanına yönelik metaforik algıları ve imajları* (Unpublished Master Thesis) Adnan Menderes University.

Fırat, N (2006). Pozitivist yaklaşımın eğitim yönetimi alanına yansıması, alana getirdiği katkı ve sınırlılıkları. *Buca Eğitim Fakültesi Dergisi, 20*, 40-51.

Fives, H., Huebner, W., Birnbaum, A.S., & Nicolich, M. (2014). Developing a measure of scientific literacy for middle school students. *Science Education, 98*(4), 549-580. https://doi.org/10.1002/sce.21115

Flegg, R. B., & Hukins, A. A. (1973). The measurement of a scientific attitude-curiosity. *Research in Science Education, 3*(1), 69-74. https://doi.org/10.1007/BF02558559

Gardner, P. (1995). Measuring attitudes to science: Unidimensionality and internal consistency revisited. *Research in Science Education, 25*(3), 283-289. https://doi.org/10.1007/BF02357402

Godin, B., & Gingars, Y. (2000). The place of universities in the system of knowledge production. Research Policy., 29(2), 273-278. https://doi.org/10.1016/S0048-7333(99)00065-7

Güçer, H. (2021). *Öğretim Elemanlarının Bilimsel Tutum Düzeyleri [Scıentıfıc Attıtude Levels of Instructors at Hıgher Educatıon]* (Unpublished Doctoral Thesis) Dokuz Eylül University, İzmir. Institute of Educational Sciences.

Gralka, S., Wohlrabe, K., & Bornmann, L. (2019). How to measure research efficiency in higher education? Research grants vs. publication output. *Journal of Higher Education Policy and Management, 41*(3), 322-341. https://doi.org/10.1080/1360080X.2019.1588492

Jones, B., & Butts, B. (1983). Development of a set of scales to measure selected scientific attitudes. *Research in Science Education, 13*, 133-140. https://doi.org/10.1007/BF02356700

Jung, J. (2020). The fourth industrial revolution, knowledge production and higher education in South Korea. *Journal of Higher Education Policy and Management, 42* (2), 134-156. https://doi.org/10.1080/1360080X.2019.1660047.

Kalkınma Bakanlığı (2013). *Onuncu Kalkınma Planı 2013-2018*. https://www.sbb.gov.tr/wp-content/uploads/2018/11/Onuncu-Kalk%C4%B1nma-Plan%C4%B1-2014-2018.pdf

Kanisauskas, S. (2010). Tolerance boundaries and cultural egalitarianism. *Limes, 3*((1), 67–79. https://doi.org/10.3846/limes.2010.07

Lane, R. (1996). Positivism, scientific realism and political science recent developments in the philosophy of science. *Journal of Theoretical Politics, 8*(3), 361-382.

Lee, J. T., & Kuzhabekova, A. (2019). Building local research capacity in higher education: Aa conceptual model. *Journal of Higher Education Policy and Management, 41*(3), 342-357. https://doi.org/10.1080/1360080X.2019.1596867

Lewins, F. (1992). *Social Science Methodology: A Brief but Critical Introduction Macmillian Education*, Australia.

Mathotaarachchi, K. K., & Thilakarathna, K. K. (2021). Philosophy of approaches insocialin social sciences: Review of positivism, phenomenology and critical social sciences inqualitativein qualitative research. *Technium Social Sciences Journal, 20*, 944-95.

Metcalfe, A. C., & Fenwick, T. (2009). Knowledge for whose society? Knowledge production, higher education and federal policy in Canada. *Higher Education, 57*, 209-225. https://doi.org/10.1007/s10734-9142-41

Moore, W. R., & Foy, R. L. H. (1997). The Scientific attitude inventory: A revision (SAI-II). *Journal of Research in Science Teaching, 34*(4), 327–336. https://doi.org/10.1002/(SICI)1098-2736(199704)

Munoz, D. A. (2016). Assessing the research efficiency of higher education institutions in Chile: A data envelopment analysis approach. *International Journal of Educational Management, 30*(6), 809-825. https://doi.org/10.1108/IJEM-03-2015-0022

Navarro, J.G., & Carion, G. C. (2008). Why open-mindedness needs time to explore and exploit knowledge. *Time Society, 17*(2-3), 195-213. https://doi.org/10.1177/0961463X08093422

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications, *International Journal of Science Education, 25*(9), 1049-1079.

Pitafi, A. I., & Farooq, M. (2012). Measurement of scientific attitude of secondary school students in Pakistan. *Academic Research International, 2*(2), 379-391.

Rubin, A., & Babbie, E. R. (2011). *Empowerment series: Research method for social work* (7th ed.) Belmond: Cangage Learning.

Schwartz, R. S., Lederman, N. G., & Crawford, B. A. (2004). Developing views of nature of science in an authentic context: An explicit approach to bridging the gap between nature of science and scientific inquiry. *Science Education, 88*(4), 610-645. https://doi.org/10.1002/sce.10128

Setiawaty, S., Fatmi, N., Rahmi, A., Unaida, R., Fakhrah, I. H., Muhammed, I., Mursalin, Rohantizani, Alchalil, & Sari, R. P. (2017). Science, technology, engineering, mathematics (STEM) learning on student's science process skills and science attitudes. *Emerald Reach Proceedings Series, 1,* 575-581. https://doi.org/10.1108/978-1-78756-793-1-00036

Suryawati, E. Osman, K., & Meerah, T. S. M. (2010). The effectiveness of RANGKA contextual teaching and learning on students' problem solving skills and scientific attitude. *Social and Behavioral Sciences 9,* 1717-1721. https://d1wqtxts1xzle7.cloudfront.net/55764849/Jurnal_Internasional_RANGKA.pdf

Välimaa, J., & Hoffman, D. (2008). Knowledge society discourse and higher education. *Higher Education.* 56, 265-285. https://doi.org/10.1007/s10734-008-9123-7

Wildan, W., Hakim, A., Siahaan, J., & Anwar, Y. A. A. (2019). A stepwise inquiry approach to improving communication skills and scientific attitudes on a biochemistry course. *International Journal of Instruction, 12*(4), 407-422. https://doi.org/10.29333/iji.2019.12427a

Yükseköğretim Bilgi Sistemi Yükseköğretim Kurulu. https://istatistik.yok.gov.tr/

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 214-236 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Can Machine Learning Be Taught to Pre-service Teachers in the STEM Fields?

Esma Nur Özen [1], Elif Polat *[2], Yavuz Samur [3]

* *Corresponding Author, elif.polat@iuc.edu.tr*
[1]*Istanbul University-Cerrahpasa, Türkiye*
[2]*Istanbul University-Cerrahpasa, Türkiye*
[3]*Bahçeşehir University, Türkiye*

Abstract

Machine Learning (ML) trainings provide students with 21st century skills and enable students to find solutions to their own problems. The purpose of this study is to design, implement, and evaluate ML training for pre-service teachers in the STEM field in order to contribute to the future workforce in the field of computer science. The participants of the study were 74 pre-service teachers who are studying in the departments of Computer Education and Instructional Technology (CEIT), science education, and mathematics education (STEM fields) at a state university in Istanbul. Convenience sampling method was used in the study. In the research, a single-group pre-test-post-test weak quasi-experimental design was used by using the quantitative method in order to evaluate the training by giving ML training. The training was implemented on the online platform for 3 hours for 8 weeks. "Pretest - Posttest Achievement Test," "Online Student Engagement Scale," "Moodle Activity Data," "Demographic Form," and "Attendance Forms" were used to collect data. There is a significant difference between the pre-test and post-test averages in favor of the post-test. There is a significant difference between the pretest and posttest scores according to the departments. It has been concluded that the provided training is effective in the success of pre-service teachers. It can be suggested to offer training to different branches and to select participants from elementary and middle school students.

Keywords: Machine learning, Machine learning instruction, STEM, artificial intelligence, preservice teachers.

Citation: Özen, E. N., Polat, E., & Samur, Y. (2024) "Can machine learning be taught to pre-service teachers in the STEM fields?". *Instructional Technology and Lifelong Learning, 5(1),* 214 - 216. *https://doi.org/10.52911/itall.1458322*

STEM Alanındaki Öğretmen Adaylarına Makine Öğrenmesi Öğretilebilir mi?

Özet

Makine öğrenmesi eğitimleri, öğrencilere 21. yüzyıl becerileri kazandırır ve kendi problemlerine çözüm bulmalarını sağlar. Bu çalışmanın amacı, bilgisayar bilimi alanında gelecekteki iş gücünün oluşturulmasına katkıda bulunmak amacıyla STEM alanındaki öğretmen adaylarına yönelik makine öğrenmesi öğretimini planlamak, uygulamak ve değerlendirmektir. Çalışmanın katılımcıları, İstanbul'da bir devlet üniversitesinde 2020-2021 akademik yılında bilgisayar ve öğretim teknolojileri eğitimi, fen eğitimi ve matematik eğitimi (STEM alanları) bölümlerinde öğrenim gören 74 öğretmen adayıdır. Çalışmada elverişli örnekleme yöntemi kullanılmıştır. Araştırmada, makine öğrenmesi eğitimi verilerek eğitimin değerlendirilmesi amacıyla nicel yöntem kullanılarak tek gruplu ön-test-son-test zayıf yarı deneysel tasarımı kullanılmıştır. Eğitim, 8 hafta boyunca çevrimiçi platformda haftada 3 saat olacak şekilde uygulanmıştır. Veri toplama araçları olarak "Ön Test - Son Test Başarı Testi", " Çevrimiçi Öğrenci Bağlılık Ölçeği", "Moodle Etkinlik Verileri", "Demografik Form" ve "Katılım Formları" kullanılmıştır. Ön-test ve son-test ortalamaları arasında son-test lehine anlamlı bir fark vardır. Bölümlere göre ön test ve son test puanları arasında anlamlı bir fark bulunmaktadır. Verilen eğitimin öğretmen adaylarının başarısında etkili olduğu sonucuna ulaşılmıştır. Farklı branşlara eğitim vermek ve katılımcıların ilkokul ve ortaokul öğrencilerinden seçilmesi önerilebilir.

Anahtar Kelimeler: Makine öğrenmesi, makine öğrenmesi eğitimi, STEM, yapay zeka, öğretmen adayları.

Date of Submission	25.03.2024
Date of Acceptance	04.07.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	This article is extracted from my master thesis/doctorate dissertation entitled “Planning, implementing and evaluation of ML training for preservice teachers in STEM field”, supervised by Yavuz Samur & Elif Polat
Author(s) Contribution	**Author1:** Conceptualization, Methodology, Writing- Original draft preparation. **Author2:** Conceptualization, Supervision, Reviewing and Editing **Author3:** Supervision, Reviewing and Editing.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The authors have no conflict of interest to declare.
Complaints	itall.journal@gmail.com
Grant Support	The authors acknowledge that they received no external funding in support of this research.
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

With the tools that technology provides, we can complete many of our daily tasks in a faster, easier, and more practical manner. When used in education, it not only facilitates tasks but also enhances learning. Teachers' technological knowledge is critical at this point. The use of artificial intelligence (AI) in education has increasingly become more widespread. AI is referred to as the programming of human intelligence functionalities to solve problems on a computer (Nabiyev, 2012). In the field of education, AI is used in profile creation and estimation, assessment and evaluation, adaptive systems, personalized learning, and intelligent teaching systems (Senocak, 2020). Machine learning (ML), a subset of AI, is also finding applications in education. ML is a method of determining a solution by predicting the information taught by the computer in response to a future situation (Çevik & Kayakus, 2020). Many countries have begun to employ ML practices to aid in student development. In education, AI and ML practices are used to provide feedback for individualized instructional plans (Kayahan, 2018). Using AI and ML, it is possible to adapt to a changing world because special educational content can be prepared for each individual student (Demirkaya & Sarpel, 2018). The use of ML is crucial at this point. ML is also used to attract student attention and reduce teacher workload (Nafea, 2018). ML is used to recognize faces/voices, determine success, and separate students based on certain criteria. Another application is to estimate why students drop out of school and identify risks at school (Mduma et al., 2019). Murphy (2019) notes that systems exist which enable educators to proactively intervene by alerting them in advance if a student is expected to be absent on a future date. To summarize, ML platforms are used in education to teach students ML, classify data, and make predictions in general.

Knowledge of mathematics and computers is of great importance in learning ML (Reyes et al., 2020). In the realm of education, ML finds application across diverse areas such as assessment and evaluation, predicting achievement, creating course content, identifying learning styles, and developing intelligent course systems. However, research is insufficient to keep up with the rapidly changing and developing field of education. According to several research studies, AI and ML are causing the birth of new professions. Many countries have shifted their educational policies to avoid unemployment, and Albania sees AI as a business opportunity in this regard (Tataj & Kola, 2021). As a requirement of computer science, learning AI and ML emerges as a necessity (Chung & Shamir, 2020).

According to Sakulkueakulsuk et al. (2018), mastering and applying AI along with its subdivisions is both labor-intensive and challenging. Teaching ML as part of an AI course in undergraduate and graduate schools helps shape career goals. It has been stated that providing AI and ML education programs early enables students to develop career plans at a young age. Based on the studies on the STEM approach, STEM literacy training programs should be planned. As mentioned by Bybee (2010), preservice teachers and in-service teachers should be trained to equip people with 21st-century skills. The high level of knowledge that teachers have in the STEM approach and the development of a perspective towards the STEM approach enhance the efficiency of STEM education (Wang et al., 2011).

Kim and Kwon (2024) conducted a systematic review of 36 articles evaluating AI education at the K-12 level from 2013 to 2022. They found that introducing students to AI assessments in formal learning environments from an early age is crucial. Martin et al. (2024) organized five projects as exhibitions to help 125 elementary and middle school students aged 7-14 understand AI and ML. The findings showed that students were able to process data from cameras involved in ML and respond to the system's confidence intervals. Not only do programming skills improve as a result of training, but so do creativity and cognitive thinking skills.

There are benefits to programming education, but to translate these benefits into practice, tools appropriate for the target audience should be chosen. Therefore, a platform with AI and ML that is suitable for the target audience should be selected. For a target audience with basic programming knowledge, block-based ML platforms are preferred, whereas text-based ML platforms are preferred for a target audience with intermediate and higher knowledge. Quiroz and Gutierrez (2024) developed activities using a Scratch extension to study middle school students' experiences. They found that students' interest in AI increased and the coding foundation offered was more beneficial compared to other technological tools. Priya et al. (2024) conducted an experimental controlled study with 41 high school students by developing a game with ML. The students in the experimental group performed better in tests than those in the control group, showing that the game helped introduce ML concepts.

According to a study conducted by Tektas et al. (2010), AI courses should be included as compulsory courses at the undergraduate and graduate levels. Young people educated in AI and ML contribute to a significant decrease in import purchases of countries. In this context,

teaching ML is a requirement for the future workforce. It is worth noting that text-based Python and the block-based ML for Kids platform are being used to teach ML. It was found that the ML for Kids platform is not yet widely used in education (Zhu, 2019). In a study conducted by Park et al. (2020), the ML platform called ML for Kids was used to improve the instructional model for software education based on ML.

With the growing importance of ML, how to incorporate it into computer science education is viewed as a problem that field experts and practitioners should work on collaboratively in an interdisciplinary manner (Zhu, 2019). In education, ML is used for teaching, classification, and estimation purposes. ML training is becoming more popular as the demand for up-to-date educational content, technical support, and educational content that is relevant to everyday life grows.

Tseng et al. (2024) organized a two-week AI and ML Summer Camp for teenagers aged 13-18 to create ML-supported personal mobile applications in teams. This study highlighted the importance of collaboration, model testing interfaces, and student-centered projects in actively engaging students in exploring the role of data in ML systems. In another study, Reyes et al. (2020) trained high school students in ML by adding ML training to curricula through gamification, aiming to teach students the fundamentals of ML. The students expressed their pleasure in experiencing ML through Scratch. Moreover, despite the fact that the majority of the participants had prior knowledge of ML, it was concluded that learning ML was simple because complex concepts were not part of the training.

Peters (2019) aimed to teach the principles of programming to high school students through ML. Working with robots that were programmed using ML was found to be motivating, and the workshop, as a group activity, was a lot of fun.

Students can gain 21st-century skills by participating in training programs that introduce ML and explain how to use it. As a result, students can be empowered to solve their own problems. For this reason, training should be given to teachers in the STEM field as early as possible. Moreover, it has been found that the literature lacks studies that contribute to the use of ML in education. The literature shows that studies on ML training are limited. Therefore, ML training programs should be offered to contribute to the literature and to the development of preservice teachers in science education, mathematics education, and CEIT departments, which are some

of the STEM fields in faculties of education. Preservice teachers may be given new opportunities if the training programs are related to the technology that is considered necessary today. Experimental studies should be carried out on this subject, and how to use it concretely in education should be examined (Demirkaya & Sarpel, 2018).

For this reason, in the present study, preservice teachers in the STEM field were given training in ML, and the training was evaluated. The goal of this study was to plan, implement, and evaluate the ML training for preservice teachers in the STEM field in order for them to contribute to the development of the computer science field's future workforce. In this context, the research questions of this study are as follows:

- Is the ML training provided to pre-service teachers in STEM fields effective in teaching ML?
- Is there a significant difference between pre-test and post-test achievement test scores across departments?
- Is there a significant difference between pre-test and post-test achievement test scores based on practical and theoretical questions in the achievement test?
- To what extent does engagement in the ML training given to pre-service teachers in the STEM field predict achievement?

2. Method

2.1. Research Model

In this study, the ML training was given to preservice teachers in a faculty of education's CEIT, science education, and mathematics education departments, and the training was evaluated using quantitative methods. Quantitative methods are research methods that rely on objective measurement and analysis (Buyukozturk et al., 2008).

This study was prepared as a single-group pretest-posttest quasi-experimental design. Single-group pretest-posttest models are impartial implementations of pre- and post-practice measurements (Karasar, 2017). Single-group pretest-posttest models are used to conduct pre- and post-practice analyses. This study made use of an achievement test (as a pretest and a posttest), Moodle activity data, the Demographic Data Form, the Course Attendance Form, and the Online Student Engagement Scale.

2.2. Sample

The study was conducted on a completely voluntary basis. Special announcements about the training were made to preservice teachers studying in the departments of science education, mathematics education, and CEIT.

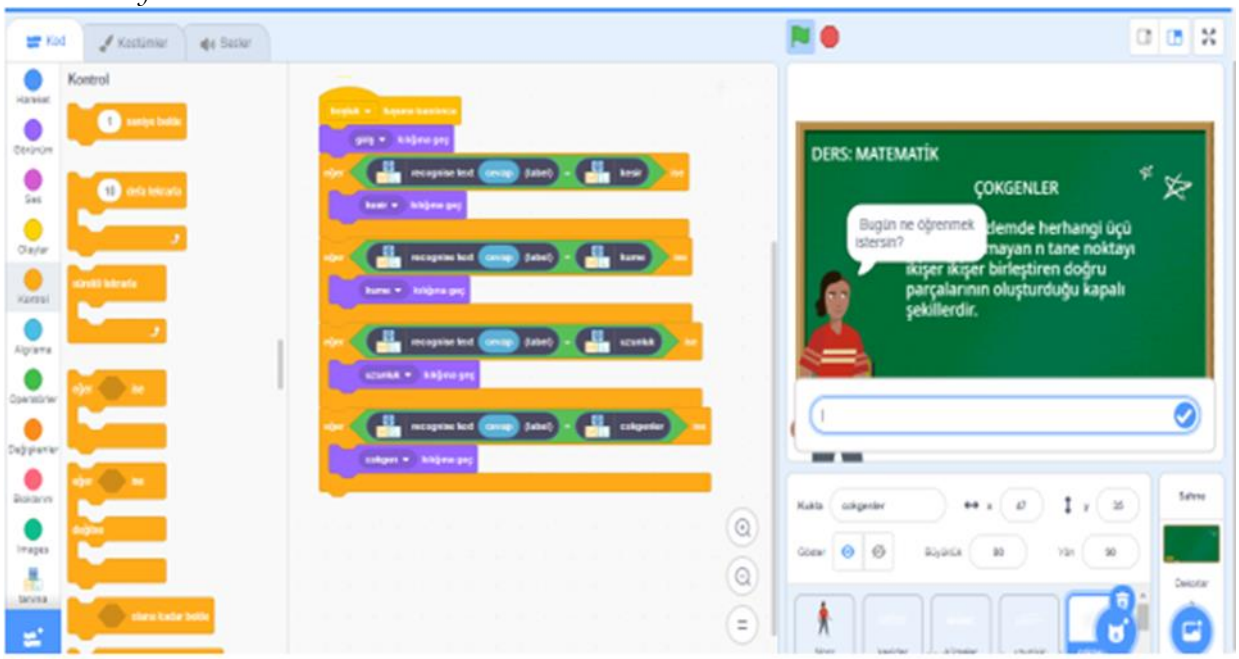
The convenience sampling method was used in the study. This sampling method is the most efficient and straightforward way to select a sample in order to avoid issues with funding, time, and workload (Buyukozturk et al., 2008). The sample consisted of 74 preservice teachers who were studying in the departments of CEIT, science education, and mathematics education at a state university in Istanbul.

2.3. Training Material Preparation Process

The researcher reviewed the literature for examples in the field of practice before preparing the training content. Due to the limited Scratch activities regarding ML for Kids, the training content was prepared by the researcher. Some activities were adapted from the existing activities on the ML for Kids platform. A total of 17 activities were developed for the training, covering the subjects of text, numbers, audio, and images. Additionally, a presentation was prepared to present general information after a literature review was carried out.Two educational technology specialists and two computer engineers working in the field of AI and ML provided expert opinions during the content preparation process. In addition, preservice teachers were interviewed to ensure the content was appropriate for the target audience. Great care was taken to create content that was relevant and suitable for the preservice teachers.

Figure 1

ML Activity



2.3.1. ML Training Process

Preservice teachers in the departments of CEIT, science education, and mathematics education received the training over an eight-week period. The ML training included the use of the ML for Kids and Scratch 3.0 platforms. ML for Kids is a free ML platform designed for children (Lane, 2018). Text, numbers, sound, and images are used to create projects on this platform. Block- and text-based ML projects can be created on the Scratch, Python, and App Inventor platforms (Zhu, 2019).

Since the participants would be learning about ML platforms for the first time during the training, the preparation of ML projects using the Scratch platform, a block-based coding platform, was approved by the experts. Before the training began, the participants were given general information about the training and asked to participate voluntarily. The importance of attending the training regularly was emphasized, and then the Demographic Data Form and the achievement test as a pretest were administered through an online platform. Due to the Covid-19 pandemic, the training was delivered as a live course via an online platform. The first lesson was planned as a general introduction.

Table 1

Machine Learning Training Plan

Week	Seminar	Topic(s)	Activity
1	-	General Information and Presentation	What is Artificial Intelligence? The Future of Artificial Intelligence History of Artificial Intelligence Types of Artificial Intelligence What is Machine Learning? Methods of Machine Learning Usage Areas Introduction to Machine Learning Advantages of Machine Learning Deep Learning (**180 min**)
2	Fundamentals and Current Topics of Machine Learning (**60 min**)	Texts	Learning Emotions Animal Kingdom I Want to Learn Mathematics Tourist Information Chatbot (**120 min**)
3	Use of Adaptive Systems in Education (**45 min**)	Numbers	Eat the Bug Pacman Game (**135 min**)
4	Artificial Intelligence and Fuzzy Technology (**45 min**) Use of Smart Interfaces in Education: Examples from the Artificial Intelligence Center (**30 min**)	Numbers	XOX Game Book Recommendation (**105 min**)
5	Artificial Intelligence and Robotics (**60 min**)	Sounds	Recognize My Voice Open Sesame Listen and Explain Our Target is the Bottle (**120 min**)
6	Modeling Metacognitive Activities in Informal Learning Environments: Recommendations from Theory to Practice (ML) (**45 min**)	Images	Recognize My Face Book Analysis My Best Friend Tom Rock-Paper-Scissors Game Making (**135 min**)
7	Use of ML Techniques in Education (**45 min**)	-	Project Presentations (**135 min**)
8	Artificial Intelligence in Education (**45 min**) Applications of Artificial Intelligence Algorithms (**30 min**)	-	Project Presentations (**105 min**)

2.4. Data Collection

The preservice teachers were given the achievement test online as a pretest before the ML training and as a posttest after the training. The Demographic Data Form was administered prior to the training, and the Online Student Engagement Scale was administered afterwards, both of which were done online. The participants' engagement was closely monitored to ensure that they did not drop out during the training process. The purpose and content of the training, as well as the voluntary nature of participation, were explained to the participants prior to the training.

2.5. Data Collection Instruments

In this study, the achievement test (as a pretest and a posttest), Moodle activity data, the Demographic Data Form, the Course Attendance Form, and the Online Student Engagement Scale were used as data collection instruments.

2.5.1. Achievement Test (Pretest and Posttest)

The achievement test, which included the subjects found in the ML curriculum for preservice teachers in the STEM field, was developed by the researcher. An indicator chart with eight main objectives was created. To assess these objectives, 38 multiple-choice questions were formulated. Necessary changes were made, and a pilot study was carried out with ten preservice teachers. Subsequently, item difficulty (p) and item discrimination (r) were analyzed.

Table 2

Item Analysis Results for The Achievement Test (Pretest and Posttest)

Item Difficulty	Item Discrimination
0.72	<0.20 and >0.40

According to Table 2, there were 30 questions with high item discrimination ($r > 0.40$). There were 6 questions with item discrimination between 0.25 and 0.39, and 2 questions with item discrimination of $r < 0.20$. Item difficulty was 0.75 for 32 of the questions. As a result, the average item difficulty (p) was found to be 0.72. The developed achievement test was determined to be appropriate based on the analysis.

2.5.2. *Online Student Engagement Scale*

The original form of the Online Student Engagement Scale was developed by Dixson (2015) and adapted into Turkish by Polat et al. (2022). The 19-item scale had 5-point Likert-type options. These were: (1) Does not define me at all, (2) Does not define me, (3) Undecided, (4) Defines me, and (5) Defines me completely. The scale consisted of 4 factors: skills (6 items), emotion (5 items), engagement (6 items), and performance (2 items).

Table 3

Reliability Results for The Online Student Engagement Scale

Cronbach alpha internal consistency coefficient	χ^2	SD
0.95	273.844	142

The Cronbach alpha internal consistency coefficient ranged from α = 0.77 to α = 0.87. The χ2 value was 273.844, and the standard deviation (SD) was found to be 142. Accordingly, the χ2 / SD (273.844 / 142) ratio was found to be 1.928. Cronbach alpha was determined to be 0.95. In the current study, the Cronbach alpha internal consistency coefficient was found to be 0.95 as well. As a result, it was determined that using the scale was appropriate.

2.5.3. *Moodle Activity Data*

Data were gathered to determine the level of engagement in the training by the participants. Moodle activity data were collected on how participants reviewed course content and course recordings after they were shared in the Moodle system. Figure 2 shows the content shared within the Moodle system. The system automatically marked the status of the participants who examined the content as "completed," as shown in Figure 3.

Figure 2

Content Shared Within the Moodle System

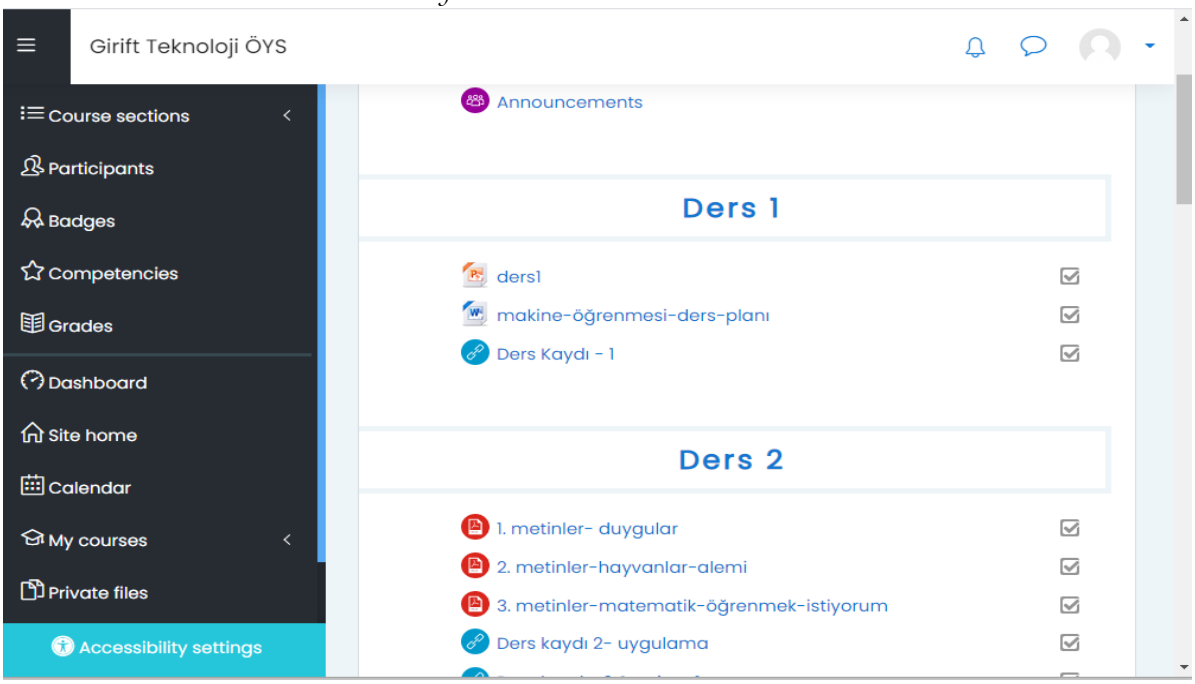
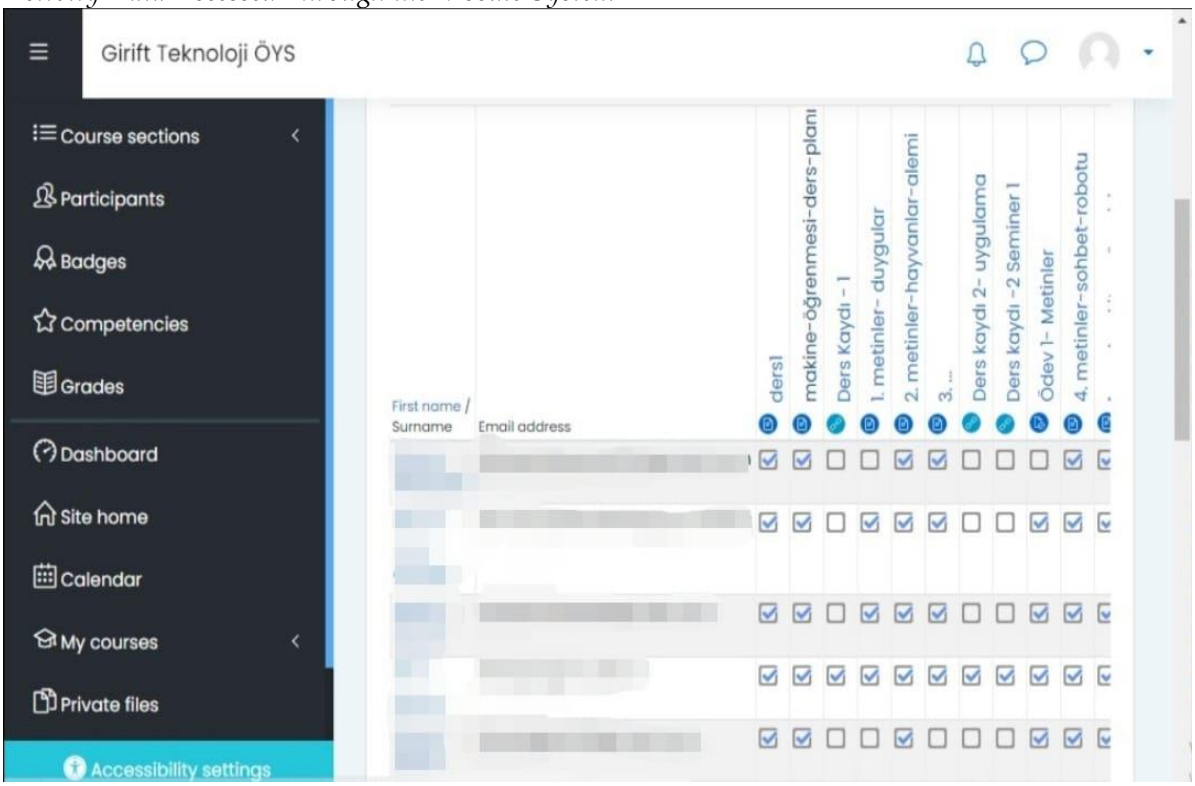


Figure 3

Activity Data Accessed Through the Moodle System



2.5.4. Course Attendance Form

The Course Attendance Form was used to track who was present during the training. It was administered through the online platform during each training session. The Course Attendance Form taken via the online platform is shown in Figure 4.

Figure 4

The Course Attendance Form Taken from The Online Platform

	A	B	C
1	Zaman damgası	Ad Soyad	8. hafta derse katıldım
2	3.5.2021 21:20:39		Evet
3	3.5.2021 21:20:39		Evet
4	3.5.2021 21:20:44		Hayır
5	3.5.2021 21:20:44		Evet
6	3.5.2021 21:20:50		Evet
7	3.5.2021 21:20:50		Evet
8	3.5.2021 21:20:50		Evet
9	3.5.2021 21:20:50		Evet
10	3.5.2021 21:20:52		Evet
11	3.5.2021 21:20:52		Evet
12	3.5.2021 21:20:53		Evet
13	3.5.2021 21:20:56		Hayır
14	3.5.2021 21:20:59		Evet
15	3.5.2021 21:21:04		Evet
16	3.5.2021 21:21:05		Hayır
17	3.5.2021 21:21:05		Evet
18	3.5.2021 21:21:06		Evet
19	3.5.2021 21:21:07		Evet
20	3.5.2021 21:21:08		Evet
21	3.5.2021 21:21:08		Evet
22	3.5.2021 21:21:09		Evet

Form Yanıtları 1

2.5.5. Demographic Data Form

The researcher created it based on a literature review to collect demographic information about the participants. The participants were asked about their age, gender, grade level, computer knowledge, ML experiences, and other relevant information.

2.6. Data Analysis

The achievement test (as a pretest and a posttest), Moodle activity data, Demographic Data Form, Course Attendance Form, and Online Student Engagement Scale data were coded using Microsoft Excel. Then, the analysis was conducted using SPSS 21. For the 38 questions in the achievement test, 1 point was given for each correct answer and 0 for each wrong answer, both in the pre-test and post-test. Thus, participants could get a total of 38 points. The answers to the Online Student Engagement Scale were coded between 1 and 5, depending on the scale items. Participants could get a maximum of 95 points on the 19-item scale. Then, the scores were converted into a 100-point system to ensure equivalent evaluations.

Through a Microsoft Excel document obtained from the system, Moodle activity data were coded as 1 for completed activities and 0 for incomplete activities. The engagement data were gathered using the Course Attendance Form for 8 weeks, and coding was done by giving 1 point for those who attended the lesson and 0 points for those who did not. Participants who attended all lessons for 8 weeks received 8 points.

After coding the achievement test as the pretest and posttest, the data were analyzed using SPSS according to the research questions, employing t-test, ANOVA, and multiple linear regression (MLR) analysis procedures.

2.7. Validity And Reliability

The analyses were designed to produce appropriate results while adhering to ethical guidelines. At this point, opinions from experts in the field were solicited at regular intervals.

2.7.1. Item Analsysis of The Achievement Test (Pretest and Posttest)

The achievement test, used as the pretest and posttest for the ML training, was pilot tested, and item difficulty (p) and item discrimination (r) were analyzed. There were 30 questions with high item discrimination ($r > 0.40$), 6 questions with item discrimination between 0.25 and 0.39, and 2 questions with item discrimination of $r < 0.20$. Upon examination, it was determined with the experts that the question "Which of the following is not one of the project types in ML for Kids?" lacked meaningful expression. Consequently, the question was revised to "Which of the following is not among the types of projects prepared in ML for Kids?"

Item difficulty was 0.75 for 32 of the questions. This was attributed to ML being a new subject, and the participants' lack of knowledge about it, as concluded by experts in the field. As a result, the average item difficulty (p) was found to be 0.72. The developed achievement test was determined to have suitable validity and reliability based on the analysis.

2.7.2. Reliability of The Online Student Engagement Scale

Since the factor structure of the original scale was deemed appropriate by experts in the study by Polat et al. (2022), confirmatory factor analysis (CFA) was performed to test the construct validity of the scale. The Cronbach alpha internal consistency coefficient ranged from $\alpha = 0.77$ to $\alpha = 0.87$ in the study, which included 254 university students. Separate t-tests were performed to examine the significance levels of the mean values. Since this value was 0.00 ($p > 0.05$), it was accepted as a good fit. The $\chi 2$ value was 273.844, and the standard deviation (SD) was 142. The

AGFI was found to be acceptable, and all other indices indicated a good fit. Thus, it was confirmed that the model had four factors. The t-value for all of the items was greater than +1.96 and was significant ($p < 0.05$). When the data collected in the study were analyzed, the Cronbach alpha internal consistency coefficient was determined to be 0.95. As a result, it was determined that using the scale was appropriate.

3. Result

The collected data were analyzed, and the findings were determined after the ML training. The research question, "Is the ML training for preservice teachers in the STEM field effective?" was examined and analyzed. The results were derived from the preservice teachers' responses to the achievement test before and after the ML training. The achievement test, used as both the pretest and posttest, consisted of 38 multiple-choice questions, each with 5 choices. Scores on the scale ranged from a minimum of 0 to a maximum of 100.

Table 4

Descriptive Statistics for The Achievement Test (Pretest and Posttest)

	N	M	Min.	Max.	Skewness	Kurtosis
Pretest	74	59.51	26.40	84.48	-0.09	-0.08
Posttest	74	76.02	50.16	92.40	-0.46	-0.05

According to the pretest and posttest descriptive statistics of the preservice teachers shown in Table 3, 74 people participated in both the pretest and the posttest. The average, minimum, maximum, skewness, and kurtosis values of the pretest were 59.51, 25.40, 84.48, -0.09, and -0.08, respectively. The average, minimum, maximum, skewness, and kurtosis values of the posttest were 76.02, 50.16, 92.40, -0.46, and -0.05, respectively.

Table 5

The T-Test Results for The Achievement Test (Pretest and Posttest)

	N	M	SD	t	P
Pretest	74	59.51	11.66	11.58	0.000
Posttest	74	76.02	9.35		

When Table 5 is examined, a significant difference is seen between the pretest and posttest mean scores of the preservice teachers in favor of the posttest ($t = 11.58$, $p < 0.05$). To test the magnitude of the resulting difference, the effect size was calculated. The effect size was $d = 1.56$. The analysis revealed a significant increase in the mean posttest score compared to the pretest score, suggesting that the machine learning training positively impacted the preservice teachers' learning of ML.

Analyses were conducted for the research question, "Is there a significant difference between the pretest and posttest achievement test scores depending on departments?" The results were derived from the preservice teachers' responses to the achievement test before and after the ML training and the Demographic Data Form. The achievement test, used as the pretest and posttest, consisted of 38 multiple-choice questions, each with 5 choices. Scores ranged from a maximum of 100 to a minimum of 0 on the scale. The departments were determined based on the demographic data obtained prior to the training.

Table 6

Descriptive Statistics for The Achievement Test (Pretest and Posttest) By Departments

Department		N	M	Min.	Max.	SD
Science Education	Pretest	21	58.83	44.88	79.20	10.50
	Posttest	21	73.54	52.80	87.12	8.69
Mathematics Education	Pretest	20	57.82	34.32	84.48	12.70
	Posttest	20	76.69	55.44	92.40	10.47
CEIT	Pretest	33	60.96	26.40	84.84	11.90
	Posttest	33	77.20	50.16	92.40	9.03

According to Table 6, the mean total score of the preservice teachers who took the pretest was 58.83 in the science education department, 57.82 in the mathematics education department, and 60.96 in the CEIT department. For the posttest, the mean total score was 73.54 in the science education department, 76.69 in the mathematics education department, and 77.20 in the CEIT department. ANOVA was performed to determine whether the pretest and posttest (achievement test) scores differed depending on the departments, and the results are given in Table 7.

Table 7

ANOVA Results for The Achievement Test (Pretest and Posttest) By Departments

		Sum of Squares	df	Mean Square	F	p
Pretest	Between departments	136.36	2	68.18	0.49	0.61
	Within departments	9804.93	71	138.10		
	Total	9941.29	73			
Posttest	Between departments	183.84	2	91.92	1.05	0.35
	Within departments	6200.03	71	87.32		
	Total	6383.87	73			

According to Table 7, there was no significant difference between the pretest and posttest total scores depending on the departments in the training taken by the preservice teachers in the departments of science education, mathematics education, and CEIT (pretest $F = 0.49$, $p > 0.05$ and posttest $F = 1.05$, $p > 0.05$). When the mean scores were examined, it was found that the

biggest difference was among the preservice teachers in the mathematics education department.

Analyses were conducted for the research question, "Is there a significant difference between the pretest and posttest achievement test scores depending on practical and theoretical questions?" The results were derived from the preservice teachers' responses to the achievement test before and after the ML training. The achievement test, used as both the pretest and posttest, consisted of 38 multiple-choice questions, each with 5 choices. Scores ranged from a minimum of 0 to a maximum of 100. The analysis was conducted by separating the topics in the specifications table as practical and theoretical questions. There were 13 practical questions and 25 theoretical questions. Since the total score of the practical and theoretical questions was calculated as 100, each correct answer was multiplied by 2.64. Thus, the highest score to be obtained from the practical questions was 34, and the highest score from the theoretical questions was 66. T-test analysis was performed to determine whether there was a difference between the pretest and posttest (achievement test) scores of the 74 preservice teachers who took part in the study depending on practical and theoretical questions.

Table 8

Descriptive Statistics for The Achievement Test (Pretest and Posttest) Practice Questions

	N	M	Min.	Max.	Skewness	Kurtosis
Pretest Practice Questions	74	40.56	15.84	55.44	-0.56	0.08
Posttest Practice Questions	74	53.16	34.32	63.36	-0.99	0.82

According to Table 8, based on the descriptive statistics of the pretest and posttest (achievement test) practical questions, the average, minimum, maximum, skewness, and kurtosis of the pretest practical questions were 40.56, 15.84, 55.44, -0.56, and 0.08, respectively. The average, minimum, maximum, skewness, and kurtosis values of the posttest practical questions were 53.16, 34.32, 63.36, -0.99, and 0.82, respectively.

Table 9

T-Test Results for The Achievement Test (Pretest and Posttest) Practice Questions

	N	M	SD	T	P
Pretest Practice Questions	74	40.56	8.46	124.53	0.000
Posttest Practice Questions	74	53.16	6.25		

Table 9 reveals a significant difference in the mean scores of the pretest and posttest practical questions ($t = 124.53$, $p < 0.05$). The effect size was found to be $d = 1.69$. As a result, the average

score for the practical questions in the posttest was higher than the average score for the practical questions in the pretest.

Table 10

Descriptive Statistics for The Achievement Test (Pretest and Posttest) Theoretical Questions

	N	M	Min.	Max.	Skewness	Kurtosis
Pretest Theoretical Questions	74	18.94	2.64	31.68	-0.09	0.51
Posttest Theoretical Questions	74	22.87	10.56	34.32	-0.26	0.25

According to Table 10, based on the descriptive statistics of the pretest and posttest (achievement test) theoretical questions, the average, minimum, maximum, skewness, and kurtosis of the pretest theoretical questions were 18.94, 2.64, 31.68, -0.09, and 0.51, respectively. The average, minimum, maximum, skewness, and kurtosis values of the posttest theoretical questions were 22.87, 10.56, 34.32, -0.26, and 0.25, respectively.

Table 11

T-Test Results for The Achievement Test (Pretest and Posttest) Theoretical Questions

	N	M	SD	T	p
Pretest Theoretical Questions	74	18.94	5.32	5.15	0.000
Posttest Theoretical Questions	74	22.87	5.30		

Table 11 reveals a significant difference in the mean scores of the pretest and posttest theoretical questions ($t = 5.15$, $p < 0.05$). The effect size was found to be $d = 0.74$. As a result, the average score for the theoretical questions in the posttest was higher than the average score for the theoretical questions in the pretest.

Analyses were carried out for the research question, "To what extent does engagement in ML training given to preservice teachers in the STEM field predict achievement?" The data for this research question came from the Online Student Engagement Scale, Moodle activity, and Course Attendance Form. MLR analysis was used to determine how well each variable predicted the posttest (achievement test).

The Online Student Engagement Scale had 19 5-point Likert-type questions. These were: (1) Does not define me at all, (2) Does not define me, (3) Undecided, (4) Defines me, and (5) Defines me completely. The highest possible score was 100. Moodle activity data included data from 29 activities, consisting of course content and course records shared with the preservice teachers during the training. The total score from Moodle activity data was 100.

The Course Attendance Form was completed online in each course to determine the status of engagement in the weekly classes over the course of eight weeks. The analysis was carried out by calculating the average of the Course Attendance Form. The highest possible score was 100.

Table 12

Descriptive Statistics Results for The Moodle Activity Data, Online Student Engagement Scale, And Course Attendance Form

	N	M	SD	Min.	Max.	Skewness	Kurtosis
Moodle Activity Data	74	82.36	11.50	52	100	0.05	-0.40
Online Student Engagement Scale	74	73.62	15.50	23	100	-1.21	1.66
Course Attendance Form	74	94.39	8.22	75	100	-1.18	0.22

According to Table 12, 74 people participated in Moodle activities. The average, skewness, kurtosis, minimum, maximum, and standard deviation values of the data were 82.36, 0.05, -0.40, 52, 100, and 11.50, respectively. A total of 74 people filled out the Online Student Engagement Scale. The average, skewness, kurtosis, minimum, maximum, and standard deviation values of the scale were 73.62, -1.21, 1.66, 23, 100, and 15.50, respectively. Finally, 74 people were recorded in the Course Attendance Form. The average, skewness, kurtosis, minimum, maximum, and standard deviation values of the form were 94.39, -1.18, 0.22, 75, 100, and 8.22, respectively.

Table 13

Results for Relationships Between Variables

	Posttest	Moodle Activity Data	Online Student Engagement Scale
Moodle Activity Data	0.15	-	-
Online Student Engagement Scale	0.34	0.04	-
Course Attendance Form	0.38**	0.33**	0.30**

**p < 0.01, *p < 0.05

The posttest was found to have a significant relationship with the Online Student Engagement Scale and the Course Attendance Form, as shown in Table 13.

Table 14

MLR Results for The Variables Affecting Posttest (Achievement Test) Scores

R	R^2	Adjusted R^2	F	P
0.45	0.20	0.17	6.242	0.001

Table 14 shows the MLR analysis conducted to test the degree to which the Moodle activity, Online Student Engagement Scale, and Course Attendance Form data of the preservice teachers

studying in the mathematics education, science education, and CEIT departments could predict the posttest scores.

4. Discussion and Conclusion

This study was prepared to plan, implement, and evaluate ML training for preservice teachers in the STEM field to contribute to the development of the computer science field's future workforce. It was found that there was a significant difference between the mean pretest and posttest (achievement test) scores in favor of the posttest. As a result, the provided training has had a positive impact on preservice teachers' ML. The application of ML in educational practices is a relatively new topic in the literature. For this reason, no study could be found in the literature that provides ML training to preservice teachers using ML for Kids. However, there are studies in the literature on training given to elementary and middle school students (Martin et al., 2024). Chklovski et al. (2019) trained 3rd and 8th-grade students and found them to be increasingly interested. In ML training, homework, discussion platforms, and guest educator seminars have been observed to be effective in providing different perspectives beyond learning new knowledge. As part of the study, preservice teachers studying in the STEM fields in a faculty of education were trained.

There was a significant difference between the practical and theoretical questions in the pretest and the posttest (achievement test). Hitron et al. (2019), who reached the same conclusion through a sample with different characteristics, found a significant difference between the pretest and posttest in the training offered to 10–13-year-old children.

There was no significant difference between the pretest and posttest scores depending on the departments. When the averages were examined, it was found that the highest difference was among the preservice teachers who studied in the mathematics education department. In the current study, the sample included preservice teachers in the STEM field in a faculty of education. Ahmad et al. (2020) conducted a study on undergraduate students in the department of physics and stated that academic departments were an important predictor in measuring students' performance. Similarly, Buyruk and Korkmaz (2016), who conducted a study on a sample having the same characteristics as the sample of the current study, stated that the highest levels of awareness of the STEM approach were in science education, CEIT, and mathematics education students, in the order given.

How the posttest predicted engagement data was examined, revealing that the posttest was significant in predicting the Online Student Engagement Scale and Moodle activity data. Yildiz (2014), who examined Moodle data in a similar manner, stated that ML predictions reduced error rates. Gok (2017), who conducted a study on a sample with different characteristics, stated that the success rate was high when regression and classification methods were used to predict the overall success of 6th, 7th, and 8th-grade students.

In future studies, training can be implemented face-to-face. The spread of ML can be aided by developing resources that are accessible to all students and teachers. At this point, a variety of platforms may also be preferred for diversity instead of just relying on the ML for Kids platform. Language support on an ML platform is extremely useful during the learning phase. Moreover, because there is no ML platform specific to Turkey, developing an ML platform can contribute to the literature. The research is limited to university students. Additionally, providing education online due to pandemic conditions is among other limitations.

5. References

Ahmad, S. A., Hussain, I., Ahmad, R., & Din, M. N. U. (2020). Performance based prediction of the students in the physics subject using traditional and machine learning approach at higher education level. *International Journal of Innovation in Teaching and Learning (IJITL)*, *6*(1), 174-190. https://doi.org/10.35993/ijitl.v6i1.997

Buyruk, B., & Korkmaz, O. (2016). Teacher candidates STEM awareness levels. *Online Submission*, *4*(1), 272-279. https://dergipark.org.tr/en/download/article-file/777013

Buyukozturk, S., Cakmak, E. K., Akgun, O. E., Karadeniz, S., & Demirel, F. (2008). *Scientific research methods*. Pegem academy. https://avesis.medeniyet.edu.tr/yayin/d93be4a3-e3bb-42ae-8635-96946af53ee9/bilimsel-arastirma-yontemleri

Bybee, R. W. (2010). What is STEM education?. *Science*, *329*(5995), 996. https://www.science.org/doi/10.1126/science.1194998

Cevik, K. K., & Kayakus, M. (2020). Prediction of solution time of user requests delivered to the information technologies department via machine learning. *Journal of Engineering Sciences and Design*, *8*(3), 728-739. https://doi.org/10.21923/jesd.722323

Chklovski, T., Jung, R., Fofang, J. B., Gonzales, P., Hub, B. T., & La Paz, B. (2019). Implementing a 15-week AI-education program with under-resourced families across 13 global communities. *In International joint conference on artificial intelligence.*

Chung, C. J., & Shamir, L. (2020). Introducing machine learning with scratch and robots as a pilot program for k-12 computer science education. *Science Education*, *6*, 7. https://people.cs.ksu.edu/~lshamir/publications/ICFL2020.pdf

Demirkaya, H., & Sarpel, E. (2018). In the training and development applications virtual reality from the new generation computer technologies, cluster computing and artificial

intelligence. *Karadeniz Uluslararasi Bilimsel Dergi,* (40), 231-245. https://doi.org/10.17498/kdeniz.460145

Dixson, M. D. (2015). Measuring student engagement in the online course: The online student engagement scale (OSE). *Online Learning*, *19*(4), n4. https://files.eric.ed.gov/fulltext/EJ1079585.pdf

Gok, M. (2017). Predicting academic achievement with machine learning methods. *Gazi University Journal of Science and Technology Part C: Design and Technology*, *5*(3), 139-148. https://dergipark.org.tr/en/download/article-file/341510

Hitron, T., Orlev, Y., Wald, I., Shamir, A., Erel, H., & Zuckerman, O. (2019, May). *Can children understand machine learning concepts? the effect of uncovering black boxes.* In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems. England. https://doi.org/10.1145/3290605.3300645

Karasar, N. (2017). *Preparing report in research.* Nobel publication distribution.

Kayahan, S. (2018). Artificial intelligence in educational applications: A review. *University of Trakya, 201*, 20.

Kim, K., & Kwon, K. (2024). A systematic review of the evaluation in K-12 artificial intelligence education from 2013 to 2022. *Interactive Learning Environments*, 1-29. https://doi.org/10.1080/10494820.2024.2335499

Lane, D. (2018) Explaining artificial intelligence. *Hello World, 4*, 44-46.

Martin, F., Vahedian Movahed, S., Dimino, J., Farrell, A., Irankhah, E., Ghosh, S., ... & Narain, S. (2024). Perception, Trust, Attitudes, and Models: Introducing Children to AI and Machine Learning with Five Software Exhibits. *In Proceedings of the 55th ACM Technical Symposium on Computer Science Education V.* 2 (pp. 1740-1741). https://doi.org/10.1145/3626253.3635512

Mduma, N., Kalegele, K., & Machuve, D. (2019). A survey of machine learning approaches and techniques for student dropout prediction. *Data Science Journal, 18*, 1–10. https://doi.org/10.5334/dsj-2019-014

Murphy, R. F. (2019). *Artificial intelligence applications to support k–12 teachers and teaching*. RAND Corp.,USA. https://www.rand.org/pubs/perspectives/PE315.html

Nabiyev, V. V. (2012). *Artificial intelligence: human-computer interaction. Seckin Publishing.*

Nafea, I. T. (2018). Machine learning in educational technology, H. Farhadi (Ed.), *Machine learning - advanced techniques and emerging applications* (s. 175-183). Intech Open. https://www.jstor.org/stable/pdf/resrep19907.pdf

Park, D., Ahn, J., Jang, J., Yu, W., Kim, W., Bae, Y., & Yoo, I. (2020). The development of software teaching-learning model based on machine learning platform. *Journal of The Korean Association of Information Education, 24*(1), 49-57. https://doi.org/10.14352/jkaie.2020.24.1.49

Peters, L. (2019). *An educational programming environment for teaching the principles of machine learning using lego mindstorms* [Unpublished doctoral dissertation]. University of Applied Sciences Leipzig.

Polat, E., Hopcan, S., & Arslantaş, T. K. (2022). Çevrimiçi öğrenci bağlılık ölçeğinin Türkçe'ye uyarlanması: geçerlik ve güvenirlik çalışması. *Eğitim Teknolojisi Kuram ve Uygulama*, *12*(1), 41-56.

Priya, S., Bhadra, S., Chimalakonda, S., & Venigalla, A. S. M. (2024). ML-Quest: a game for introducing machine learning concepts to K-12 students. *Interactive Learning Environments, 32*(1), 229-244. https://doi.org/10.1080/10494820.2022.2084115

Quiroz, P., & Gutierrez, F. J. (2024). Scratch-NB: A Scratch Extension for Introducing K-12 Learners to Supervised Machine Learning. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education,* V. 1 (pp. 1077-1083). https://doi.org/10.1145/3626252.3630920

Reyes, A. A., Elkin, C., Niyaz, Q., Yang, X., Paheding, S., & Devabhaktuni, V. K. (2020, August). A preliminary work on visualization-based education tool for high school machine learning education. In *2020 IEEE Integrated STEM Education Conference (ISEC), IEEE*. https://ieeexplore.ieee.org/abstract/document/9280629

Sakulkueakulsuk, B., Witoon, S., Ngarmkajornwiwat, P., Pataranutaporn, P., Surareungchai, W., Pataranutaporn, P., & Subsoontorn, P. (2018). Kids making AI: integrating machine learning, gamification, and social context in STEM education. In *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering*. https://ieeexplore.ieee.org/abstract/document/8615249

Senocak, D. (2020). Artificial intelligence in open and distance learning environments: Its opportunities and the concerns raised. *Journal of Open Educational Practices and Research, 6*(3), 56-78. https://dergipark.org.tr/en/download/article-file/1191727

Tataj, X., & Kola, M. (2021). Education policies in line with the latest developments in the field of artificial intelligence: case of Albania. *Human & Human, 8*(27), 101-116. https://doi.org/10.29224/insanveinsan.818263

Tektas, M., Tektas, N., Onat, N., Gokmen, G., Kocyigit, G., & Akinci, T. Ç. (2010). Preparation of web based artificial intelligence techniques training simulators. *Marmara University BAP Commission Presidency Project Report,* 76-90. https://docplayer.biz.tr/631443-Web-tabanli-yapay-zeka-tekn-kler-proje-no-fen-e-050608-138.html

Tseng, T., Davidson, M. J., Morales-Navarro, L., Chen, J. K., Delaney, V., Leibowitz, M., ... & Shapiro, R. B. (2024). Co-ML: Collaborative machine learning model building for developing dataset design practices. *ACM Transactions on Computing Education, 24* (2), 1-37. https://doi.org/10.1145/3641552

Wang, H. H., Moore, T. J., Roehrig, G. H., & Park, M. S. (2011). STEM integration: Teacher perceptions and practice. *Journal of Pre-College Engineering Education Research (JPEER), 1*(2), 2. https://doi.org/10.5703/1288284314636

Yildiz, O. (2014). *Evaluation of the performance of distance education students with machine learning*. [Unpublished doctoral dissertation]. Istanbul University.

Zhu, K. (2019). *An educational approach to machine learning with mobile applications* [Unpublished doctoral dissertation]. Massachusetts Institute of Technology.

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 237-256 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

In-service and Pre-service Teachers' Teaching Concerns

İmren Özaydın *[1], Ayla Çetin Dindar [2]

* *Corresponding Author, aylacetin@gmail.com*
[1]*Bartin University, Türkiye*
[2]*Bartin University, Türkiye*

Abstract

The focus of this study was to compare pre-service teachers and in-service teachers in terms of their teaching concerns by gender and teaching experience. Therefore, the current study examined whether there were any significant gender and teaching experience differences in in-service or pre-service teachers' teaching concerns. In total, 357 teachers (279 female and 78 male) participated in the study, of which 212 were in-service and 145 were pre-service teachers. The adapted and translated version of the Teacher Concerns Checklist was used to assess teachers' concerns. A two-way MANOVA was conducted to comprehensively examine whether the teaching concerns of participants varied based on gender and teaching experience. Findings regarding teachers' teaching concerns showed that all participants mostly felt slightly concerned. By systematically investigating and addressing these concerns, teacher preparation programs can become more adaptive, supportive, and effective in nurturing competent and resilient educators.

Keywords: Teaching Concerns, In-service Teachers, Pre-service Teachers

Citation: Özaydın, İ., Çetin Dindar, A. (2024) In-service and pre-service teachers' teaching concerns. *Instructional Technology and Lifelong Learning, 5(1)*, 237 - 256. https://doi.org/ 10.52911/itall.1513618

Öğretmen Adaylarının ve Hizmet içi Öğretmenlerinin Öğretime İlişkin Kaygıları

Özet

Bu çalışmanın amacı, öğretmen adayları ile hizmet içi öğretmenlerinin öğretim kaygılarını cinsiyet ve öğretim deneyimi göre karşılaştırmaktır. Bu amaç doğrultusunda, mevcut çalışmada öğretmen adayları ve hizmet içi öğretmenlerinin öğretim kaygılarında cinsiyet ve öğretim deneyimi açısından anlamlı farklılıklar olup olmadığı incelenmiştir. Çalışmaya toplam 145'i öğretmen adayı ve 212'si hizmet içi olmak üzere 357 öğretmen (279 kadın ve 78 erkek) katılmıştır. Katılımcı öğretmenlerin öğretim kaygılarını değerlendirmek için Öğretmen Kaygıları Kontrol Listesi'nin uyarlanmış ve çevrilmiş versiyonu kullanılmıştır. Katılımcıların öğretim kaygılarının cinsiyete ve öğretim deneyimine göre değişip değişmediğini kapsamlı bir şekilde incelemek amacıyla iki yönlü MANOVA yürütülmüştür. Öğretmenlerin öğretim kaygılarıyla ilgili bulgular incelendiğinde, tüm katılımcıların çoğunlukla öğretim ile ilgili hafif kaygı duyduğunu göstermiştir. Bu kaygıların sistematik olarak araştırılması ve ele alınmasıyla, öğretmen yetiştirme programları yetkin ve dayanıklı eğitimciler yetiştirmede daha uyumlu, destekleyici ve etkili hale getirilebilir.

Anahtar Kelimeler: Öğretime ilişkin Kaygılar, Hizmet içi Öğretmenler, Öğretmen Adayları

Date of Submission	10.07.2024
Date of Acceptance	05.09.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	-
Author(s) Contribution	**Author1:** Conceptualization, Methodology, Writing- Original draft preparation. **Author2:** Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing. **Author3:** Supervision, Validation. …
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The authors have no conflict of interest to declare.
Complaints	itall.journal@gmail.com
Grant Support	The authors acknowledge that they received no external funding in support of this research.
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

According to Fuller's (1969) theory of concerns about teaching, the measure of teachers' concerns about teaching can be broken down into three areas: "Concerns about self, concerns about the teaching task, and concerns about the impact that teaching has on students' learning". These concerns reflect different stages of focus and anxiety that individuals might experience in their roles. Self-concern relates to the individual's personal feelings, fears, and anxieties about their role. This can include worries about their own competence, acceptance by colleagues and students, and how they are perceived. In terms of teaching, a teacher with self-concern might be preoccupied with questions like: Am I doing a good job? Do the students like me? How do I compare to other teachers? etc. Task-concern focuses on the practical aspects of teaching tasks. It involves worries and considerations about the tasks and responsibilities inherent in the role. For teachers, this could include concerns about managing classroom activities effectively, having too many students in limited learning environments, creating lesson plans, grading assignments on time, maintaining classroom discipline, meeting curriculum standards, etc. Once both self-concern and task-concern are addressed, teachers begin to focus on the impact their teaching has on student learning. Impact concern is centered on the outcomes and effectiveness of one's work, particularly its impact on others. In teaching, this relates to the teacher's focus on how their teaching affects their students' learning and development. Teachers with impact-concern might think about the following: Is the material clear for the students? How can I improve student engagement and learning outcomes? Are my teaching methods effective? How can I support students who are struggling? etc. These concerns often evolve over time as individuals become more comfortable and proficient in their roles. For instance, new teachers might start with high self-concern, then shift to task-concern as they gain confidence, and eventually develop impact-concern as they focus on their students' learning and development. On the other hand, teachers may or may not be aware of their own concerns. These concerns can be shared with others and some of them cannot (Fuller, 1971). Stair, Warner and Moore (2012) emphasized that teachers at different stages had different teachers' concerns about self-concern, task-concern, and impact-concern. Their findings reveal that teachers at the early stage of their career had higher self-concerns and task-concerns, with higher impact-concerns in the following years. There was no significant difference between the two groups regarding impact-concern scores. This study also confirmed some of the findings of George

(1978), which reported that pre-service teachers exhibited significantly higher self-concern scores and lower task concern scores compared to their in-service counterparts, with no significant difference in impact concern scores. Pre-service teachers had the highest self-concern and the lowest task concern, while in-service teachers had the highest impact concern and similar levels of task and self-concerns.

By understanding the specific concerns and challenges teachers face, educators and program designers can tailor training and support to address these issues effectively. This not only helps in alleviating the immediate concerns of teachers but also fosters a more positive and productive teaching environment. Moreover, identifying and addressing teachers' concerns can lead to the development of more relevant and practical curriculum content, improved instructional strategies, and better support systems within teacher preparation programs. It ensures that these programs are responsive to the real-world demands of teaching, thereby equipping future teachers with the skills and confidence they need to succeed in the classroom.

Pre-service teachers have more limited teaching experience and practice knowledge than in-service teachers. Developing lesson plans, managing classrooms, creating materials based on specific objectives, applying different teaching approaches based on students' levels, etc., are more practical, especially for experienced teachers. Being a teacher has long been viewed as a female-dominated profession. This perception is partly due to the flexibility that teaching offers in terms of working hours, which can be more accommodating to those balancing work with family responsibilities. Additionally, the long summer holidays provide extended breaks, which can be particularly appealing for those who wish to spend more time with their families during these periods. This combination of factors has contributed to the profession's association with women. According to George's (1978) research, gender influences teachers' concerns. Females exhibit higher levels of both self-concerns and task-concerns, while there is no significant gender difference in impact-concerns.

The focus of this study was to compare pre-service teachers and in-service teachers in terms of their teaching concerns by gender and teaching experience. Therefore, the current study examined whether there were any significant gender and teaching experience differences in in-service or pre-service teachers' teaching concerns.

The following research questions were investigated in this study:

- What are the levels of in-service science teachers' teaching concerns?
- What are the levels of pre-service science teachers' teaching concerns?
- Does teaching experience make any significant difference in teachers' teaching concerns?
- Does gender make any significant difference in teachers' teaching concerns?

2. Method

The descriptive survey research design was employed in this current study. All participants were asked to complete the same instrument.

2.1. Population and Sampling

The target population was all in-service and pre-service teachers in Turkiye. The accessible population was represented by the conveniently located schools and universities that were available for participation in the study. This allowed for the inclusion of a diverse sample of educational institutions within a manageable geographic area. The instrument was shared through formal (school managers shared with in-service teachers or advisors of pre-service teachers shared with pre-service teachers) and informal (such as social media, etc.) ways to reach both in-service and pre-service teachers. In total, 357 teachers (279 female and 78 male) participated in the study, of which 212 were in-service and 145 were pre-service teachers (Table 1). Teachers were also asked to write about their teaching experience. There were eleven different teaching disciplines included in the study, encompassing both in-service and pre-service teachers.

Table 1.

The descriptive statistics of the teachers by gender

	In-service teachers	Pre-service teachers	Total
Female	157	122	279
Male	55	23	78
Total	212	145	357

Table 2.

The descriptive statistics of the teachers by teaching experience

Teaching Experience	Frequency	Percent	Cumulative Percent
Pre-service Teachers	145	40.6	40.6
Less than a year	5	1.4	42.0
1 -5 years	60	16.8	58.8
6 - 10 years	57	16.0	74.8
11 – 15 years	35	9.8	84.6
16 – 20 years	20	5.6	90.2
More than 20 years	35	9.8	100.0
Total	357	100.0	

Table 3.

The descriptive statistics of the teachers by teaching discipline

Teaching Discipline	Frequency	Percent	Cumulative Percent
Science	105	29.4	29.4
Chemistry	75	21.0	50.4
Psychological Counseling and Guidance	26	7.3	57.7
Turkish Language	14	3.9	61.6
Computer	8	2.2	63.9
Pre-school	25	7.0	70.9
Social Sciences	10	2.8	73.7
English	12	3.4	77.0
Mathematics	26	7.3	84.3
Elementary	46	12.9	97.2
Religion	10	2.8	100.0
Total	357	100.0	

2.2. Instrument

In this study, the adapted and translated version (Boz, 2008) of the Teacher Concerns Checklist (TCC) was used to assess teachers' concerns. The checklist consists of three factors: self-concern, task-concern, and impact-concern. There are 45 items in this checklist, and some sample items are presented in Table 4. The responses were on a 5-point Likert scale, from 1, which refers to "Not Concerned", to 5, which refers to "Extremely Concerned". The study results reveal that the adapted and translated version of the TCC was valid and reliable. The Cronbach alpha value for self-concern was.89, for task-concern was.81, and for impact-concern was 0.91 (Boz, 2008).

Table 4.

The sample items from the checklist

Factor Name	Sample Items
Self-concern	"Having an embarrassing incident occur in my classroom for which I might be judged responsible."
	"My ability to work with disruptive students."
Task-concern	"The rigid instructional routine."
	"Having too many students in a class."
Impact-concern	"Understanding why certain students make slow progress."
	"Whether students can apply what they learn."

The means were calculated for each factor while calculating the participants' teaching concern scores. The intervals of teaching concerns were calculated by dividing the difference between the highest and lowest scores that could be obtained from the scale by five (level = (5-1)/5 =0.8). Limit values and levels were determined by adding the calculated value of 0.8 to the lowest possible value, and intervals were as follows: (1) 1.00-1.80, (2) 1.81-2.60, (3) 2.61-3.40, (4) 3.41-4.20, (5) 4.21- 5.00.

2.3. Data Collection and Data Analysis

The TCC was applied by the instructors during appropriate class hours in the fall and spring semesters of the 2023-2024 academic year to the pre-service teachers. Meanwhile, the TCC was also shared with in-service teachers through social media and school managers, and they responded to the instrument through the link. In-service and pre-service teachers were informed about the study and told that the information they provided would only be used for research and no personal information was asked. During the data collection process, the teachers' names or any information that would reveal their identity were not requested. The average time to complete the instrument was about 20 minutes.

The possible threat to internal validity arose from participant selection, which aimed to ensure a diverse representation across various disciplines, necessitating a substantial number of participants to be recruited. Another potential threat was related to the selection of instrumentation. To mitigate this threat, a rigorous, validated, and reliable instrument was used. This strategy was instrumental in minimizing the impact of instrumentation on the study's findings, thereby enhancing the overall internal validity of the research.

The TCC was applied to the in-service and pre-service teachers. The data obtained were analyzed via the SPSS program. Participants' teaching concerns levels were determined using descriptive statistics according to teaching discipline, teaching experiences, and gender. First,

the data cleaning and missing analysis were conducted. Whether there was a difference according to the variables specified in the participants' teaching concerns was tested using MANOVA. Before the analysis, the assumptions regarding the test (multivariate outlier, sample size, normality, linearity, correlations between dependent variables, equality of variances, variance-covariance matrix equality) were checked. The mean, median, mode, skewness, and kurtosis values were calculated to reveal whether the data was distributed normally. Additionally, Kolmogorov-Smirnov normality test and Q-Q graphs were examined, and it was determined that the data showed normal distribution for all variables. Then, the Mahalanobis distance was checked to test the multivariate outlier assumption. Scatterplots were examined for linearity. Finally, the assumption of correlations between dependent variables was met since the pairwise correlations remained below .80 when checked (Tabachnick & Fidell, 2007). The assumptions of equality of variances and variance-covariance matrix equality are explained in the "Results" section before the relevant tests. Furthermore, the partial eta-squared value ($\eta 2$) was gotten to the extent to which the independent variable explained variance in the dependent variables. According to Cohen (1988), $\eta 2 = .01$ indicated a small effect, .06 indicated a medium effect, and .14 indicated a large effect, providing benchmarks for interpreting the impact of the independent variable on the study outcomes.

3. Result

3.1. Results regarding the level of teachers' teaching concerns

In order to determine the level of participants' teaching concerns, descriptive statistics results were utilized for each factor according to gender and presented in Table 5. The level of participants' teaching concerns the limit values previously explained under the Instrument heading. When the descriptive statistics in Table 4 were examined according to gender, it was observed that the mean scores were quite close to each other in all factors. However, the mean scores of the female participants were slightly higher than the male participants. A similar tendency was also observed for the mean scores of pre-service or in-service teachers (Table 6); the mean scores were quite close to each other in all factors, but the mean scores of the pre-service teachers were slightly higher than those of the in-service teachers.

Table 5.

The descriptive statistics for each factor in terms of gender

Factor	Gender	Mean	SD	N	Level
Self-Concern	Female	2.09	.78	87	Slightly Concerned
	Male	1.94	.70	18	Slightly Concerned
	Total	2.06	.76	105	Slightly Concerned
Task-Concern	Female	2.34	.68	87	Slightly Concerned
	Male	2.12	.79	18	Slightly Concerned
	Total	2.30	.70	105	Slightly Concerned
Impact-Concern	Female	2.03	.70	87	Slightly Concerned
	Male	1.99	.76	18	Slightly Concerned
	Total	2.02	.71	105	Slightly Concerned

Table 6.

The descriptive statistics for each factor in terms of pre-service or in-service teachers

Factor	Participant	Mean	SD	N	Level
Self-Concern	Pre-service teachers	2.22	.81	69	Slightly Concerned
	In-service teachers	1.75	.56	36	Not Concerned
	Total	2.06	.76	105	Slightly Concerned
Task-Concern	Pre-service teachers	2.34	.72	69	Slightly Concerned
	In-service teachers	2.21	.67	36	Slightly Concerned
	Total	2.30	.70	105	Slightly Concerned
Impact-Concern	Pre-service teachers	2.05	.73	69	Slightly Concerned
	In-service teachers	1.98	.67	36	Slightly Concerned
	Total	2.02	.71	105	Slightly Concerned

When the descriptive statistics in Table 7 were examined according to in-service teachers' experience, it was observed that the mean scores of the participants were not much apart from each other, but the means differed based on the experience. In terms of self-concern, when the experience increased, mainly the teachers' concerns decreased. In terms of task-concern, there were ups and downs according to teaching experiences increased. Furthermore, in terms of impact-concern, when the experience increased, mostly the teachers' concerns decreased.

Table 7.

The descriptive statistics for each factor in terms of in-service teachers' experiences

	Experience	Mean	SD	N	Level
Self-Concern	1 – 5 years	2.05	.73	65	Slightly Concerned
	6 – 10 years	1.88	.61	57	Slightly Concerned
	11 – 15 years	1.73	.59	35	Not Concerned
	16 – 20 years	1.81	.63	20	Slightly Concerned
	More than 20 years	1.85	.66	35	Slightly Concerned
	Total	2.04	.73	357	Slightly Concerned
Task-Concern	1 – 5 years	2.43	.75	65	Slightly Concerned
	6 – 10 years	2.51	.81	57	Slightly Concerned
	11 – 15 years	2.38	.76	35	Slightly Concerned
	16 – 20 years	2.53	.88	20	Slightly Concerned
	More than 20 years	2.46	.85	35	Slightly Concerned
	Total	2.46	.78	357	Slightly Concerned
Impact-Concern	1 – 5 years	2.20	.71	65	Slightly Concerned
	6 – 10 years	2.14	.67	57	Slightly Concerned
	11 – 15 years	2.02	.66	35	Slightly Concerned
	16 – 20 years	2,11	.65	20	Slightly Concerned
	More than 20 years	2.04	.80	35	Slightly Concerned
	Total	2.13	.72	357	Slightly Concerned

3.2. Results Regarding Gender and Teaching Experiences

A two-way MANOVA was conducted to comprehensively examine whether the teaching concerns of participants varied based on gender and teaching experience. The results of this analysis are detailed and discussed, providing insights into the potential differences and their implications for educational practices. In other words, a two-way MANOVA was conducted to test statistically significant differences between the groups based on gender and teaching experience, focusing on a linear combination of the sub-dimensions of the participants' teaching concerns. During the preliminary assumption checks before conducting the analysis, the results of Levene's Test indicated that the assumption of equality of variances was satisfied for all three sub-dimensions ($p > .05$). This compliance with the homogeneity of variances assumption ensures the robustness and validity of the subsequent analysis. According to the results of Box's M Test (Box's M=88.571; F=1.378; $p < .05$), the assumption of the equality of variance-covariance matrices was not met. Consequently, Pillai's Trace value was used for the multivariate F-test to ensure the robustness of the analysis. The multivariate statistics are presented in Table 8. The multivariate F-test result did not reveal a statistically significant difference between the groups based on gender and teaching experience interaction for a linear combination of the sub-dimensions of teaching concerns [Pillai's Trace = .057, $F(15, 1035) = 1.331$, $p = .176$]. Since the interaction effect was not significant, the effects of the independent variables were examined

individually. This approach allows for a clearer understanding of how each independent variable—gender and teaching experience—separately influences the sub-dimensions of teaching concerns. The multivariate F-test result revealed a statistically significant difference between the groups based on gender for a linear combination of the sub-dimensions of teaching concerns [Pillai's Trace = .039, $F(3, 343) = 4.618$, $p < .05$, $\eta^2 = .039$]. The partial eta-squared value indicated that 3.9% of the variance is explained by gender, suggesting a small effect size. The multivariate F-test result revealed a statistically significant difference between the groups based on teaching experience for a linear combination of the sub-dimensions of teaching concerns [Pillai's Trace = .142, $F(15, 1035) = 3.416$, $p < .05$, $\eta^2 = .047$].

Table 8.

The multivariate statistics for teaching concerns

Effect	Pillai's Trace Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power
Gender	.039	4.618	3	343	.003	.039	.889
Teaching Experience	.142	3.416	15	1035	.000	.047	.999
Gender * Teaching Experience	.057	1.331	15	1035	.176	.019	.824

Detailed results from the univariate F-tests are presented in Table 9, providing further insights into the specific sub-dimensions of teaching concerns that contribute to the observed multivariate effect. These findings help identify which aspects of teaching concerns were influenced by gender, teaching experience and gender and teaching experience interaction. The Bonferroni correction was applied to reduce the Type-I error rate, adjusting the significance level to $\alpha = .0167$ ($\alpha = .05/3$). This adjustment ensures a more stringent criterion for determining statistical significance, thereby minimizing the likelihood of false positives in the multiple comparisons.

Table 9.

The univariate statistics for the factors of teaching concerns

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power
Gender	Self	1.548	1	1.548	3.106	.079	.009	.420
	Task	6.603	1	6.603	11.030	.001*	.031	.912
	Impact	3.146	1	3.146	6.081	.014*	.017	.691
Teaching	Self	10.280	5	2.056	4.126	.001*	.056	.955
Experience	Task	3.112	5	.622	1.040	.394	.015	.371
	Impact	1.366	5	.273	.528	.755	.008	.195
Gender *	Self	3.838	5	.768	1.540	.177	.022	.538
Teaching	Task	6.389	5	1.278	2.134	.061	.030	.702
Experience	Impact	3.932	5	.786	1.520	.183	.022	.532
Error	Self	171.925	345	.498				
	Task	206.536	345	.599				
	Impact	178.476	345	.517				

Upon examining Table 9, it is evident that there is a significant difference between the groups for all factors regarding gender or teaching experience. The significant differences observed were in task-concern and impact-concern with respect to gender (female participants had higher concerns for both factors), and in self-concern with respect to teaching experience (pre-service teachers had higher concerns). The mean score of female teachers' task-concern was 2.34 (SD = .68), and the mean of male teachers was 2.12 (SD = .79). The mean score of female teachers' impact-concern was 2.03 (SD = .70), and the mean of male teachers was 1.99 (SD = .76). This indicates that gender influences task and impact concerns, while teaching experience primarily affects self-concern. The mean score of pre-service teachers' self-concern was 2.22 (SD = .81) and the significant differences observed between the pre-service teachers and the in-service teachers with teaching experience within 6-10 years (M = 1.88, SD = .61), within 11-15 years (M = 1.73, SD = .59), and within more than 20 years (M = 1.85, SD = .66). This finding underscores the influence of the independent variables on each specific aspect of the participants' teaching concerns.

4. Discussion and Conclusion

In this study, the pre-service and in-service teachers' teaching concerns were determined and examined in terms of the teaching experience and gender variables. Findings regarding teachers' teaching concerns showed that all participants mostly felt slightly concerned.

According to Fuller (1969), when individuals choose teaching as their career path and enter teacher training programs, they often begin to experience a range of concerns related to the demands of the profession. These concerns stem from the realization that, as future educators, they will be entrusted with significant responsibilities, not only in the classroom but also in their interactions with school administration, students, and students' families. The multifaceted nature of these responsibilities—ranging from managing classroom dynamics to addressing the diverse needs of students and maintaining effective communication with parents—can create a sense of apprehension among pre-service teachers. This anxiety is a natural response to the recognition that teaching requires high expertise, dedication, and the ability to navigate complex interpersonal relationships within the educational environment. As they progress through their training, these pre-service teachers continue to grapple with these concerns, which play a crucial role in shaping their professional identity and preparedness for the teaching role.

Based on the findings in this study, when teaching concerns across the gender variable were compared, it was observed that the mean scores for self-concern, task-concern, and impact-concern factors were relatively similar. However, the mean scores for female participants were slightly higher than those of male participants. This suggests that female teachers may have high teaching concerns due to their higher self-discipline and sensitivity. This finding aligns with existing literature, which often highlights that female educators tend to exhibit higher levels of concern in various dimensions of teaching (Pigge & Marso, 1997), particularly in relation to self-efficacy, classroom management, and the perceived impact on student outcomes. This finding is supported by Guillaume and Rudney (1993), who assert that gender is a determining factor in teaching concerns. Additionally, Pigge and Marso (1987) also found that female teachers tend to exhibit higher levels of concern compared to their male counterparts. The current study revealed that female teachers were more concerned with task- and impact concerns than males. The task-concerned teachers are focused on the teaching responsibilities themselves. This implied that female teachers actively seek out new teaching methods, materials, and tools that can enhance their effectiveness in the classroom than male ones. The impact-concerned female teachers focus more on students and think critically about how to address best their students' mental, emotional, and social needs. On the other hand, the study by Yurtseven and Yaylı (2019) concluded that the self-concern factor was more

pronounced in female pre-service teachers than in males, with the averages in other dimensions being close to each other, further supporting our findings. These heightened concerns among female educators may be attributed to gendered expectations and the distinct ways in which male and female educators experience and navigate professional challenges within the educational environment.

However, it is important to note that not all research aligns with these conclusions. Ghaith and Shaaban (1999) argued that gender is not a significant variable in forming teaching concerns, suggesting that factors other than gender may play a more crucial role. These differing perspectives highlight the complexity of the issue and suggest that the relationship between gender and teaching concerns may be influenced by contextual factors or varying methodologies across studies.

In the light of results, when comparing the teaching concern factors of pre-service and in-service teachers, it was found that the mean scores across all factors were relatively similar. However, the mean scores for pre-service teachers were slightly higher than those of in-service teachers. This suggests that pre-service teachers may experience a slightly greater concern intensity than their more experienced counterparts. According to Fuller (1969), pre-service teachers' concerns about the teaching profession tend to focus on specific areas at different stages of their development. These concerns can be broadly categorized into self-concerns, task-concerns, and impact-concerns. Self-concerns center around the individual pre-service teacher. Those who experience self-concerns are primarily worried about their ability to succeed in the teaching profession. They often grapple with doubts about their competence and fear whether they will be able to meet the demands of teaching effectively, leading to heightened levels of stress and anxiety. Task-concerns are focused on the teaching responsibilities themselves. Pre-service teachers with task concerns are preoccupied with becoming effective educators. This leads them to actively seek out new teaching methods, materials, and tools that can enhance their effectiveness in the classroom. Their goal is to master the skills necessary to deliver high-quality instruction. Impact-concerns shift the focus to students. Pre-service teachers who are concerned with the impact of their teaching are more student-centred in their approach. They begin to think critically about how to best address their students' mental, emotional, and social needs. These teachers are driven by a desire to positively influence their students' learning experiences and overall development, often engaging in research and reflection to find the most effective

strategies for meeting the diverse needs of their students. In essence, Fuller's framework illustrates the progression of concerns that pre-service teachers may experience, moving from a focus on their own adequacy and teaching skills to a broader concern for the impact they have on their students. This progression reflects their growing confidence and professional maturity as they prepare for teaching. Pre-service teachers tend to be more self- and task-concerned, and this current study empirically supports that pre-service teachers' self-concerns are significantly higher than other concerns. Those who experience self-concerns are primarily worried about their ability to succeed in the teaching profession. They often grapple with doubts about their competence and fear whether they will be able to meet the demands of teaching effectively, leading to heightened levels of stress and anxiety. As teaching experience increases, the level of self-concern decreases, and the level of task- and impact-concerns increases. This finding is consistent with the study of Çakmak (2008), who asserted that experienced teachers were not very self-concerned.

Studies conducted with pre-service teachers have found that female teachers exhibit higher levels of concern than their male counterparts across various factors. These studies emphasized that gender differences might play a significant role in teaching concerns (Fuller, 1969; Şaban, 2004; Taşğın, 2006; Yaylı & Hasırcı, 2009; Mergen et al., 2014; Varol et al., 2014), with female pre-service teachers often reporting more significant concerns related to aspects such as self-efficacy, classroom management, and the perceived impact of their teaching on students. From the moment pre-service teachers begin their education and training, they start to develop a range of concerns about their future and the teaching profession. These concerns often revolve around their ability to succeed in the field, manage classroom dynamics, and effectively meet the diverse needs of their future students (Yeşilyurt, 2013). These concerns evolve over time, shifting in focus as pre-service teachers progress through their educational journey. Initially, concerns tend to be self-directed, centred on their own abilities and suitability for the teaching profession. As they gain more experience and confidence, these self-concerns gradually transition into task-related concerns, where the focus shifts to mastering teaching responsibilities, such as lesson planning and classroom management. Eventually, these concerns further evolve into impact concerns, emphasizing their influence on their students' learning and development. Throughout their training and into their professional careers, teachers continue to experience a variety of concerns that reflect their growth and adaptation

within the educational field (Fuller, 1969). These concerns can stem from both external environmental factors and internal personal factors unique to each individual. The frequency and timing of these concerns can also vary widely, depending on the individual's circumstances, experiences, and personal development. Some may experience certain concerns early in their training, while others may encounter them later or more sporadically, reflecting the diverse nature of how prospective teachers navigate their professional preparation. A similar result was observed in a study conducted by Ekizler (2013) with pre-service English teachers, where it was found that their concerns were slightly higher compared to in-service teachers. This finding also aligns with the results of Boz and Boz's (2010) study, which investigated pre-service science teachers and reported comparable outcomes. These studies collectively suggest that pre-service teachers, regardless of their subject area, may experience a higher level of concern as they prepare to enter the teaching profession.

It was observed that while the mean scores of in-service teachers were relatively consistent overall, there was notable variation when examined in relation to their years of experience. Specifically, self-concerns tended to decrease as teachers gained more experience, indicating that experienced teachers may feel more confident in their abilities. In contrast, task-concerns showed fluctuations, suggesting that these concerns may be influenced by specific stages in a teacher's career or changing responsibilities. Additionally, impact-concerns were generally found to decrease with increasing experience, possibly reflecting a shift in focus or a greater sense of efficacy in addressing students' needs as teachers become more experienced in teaching. Kafkaş, Açak, Çoban, and Karademir (2010) support the findings of this study concerning self-concerns among teachers. They found that as teaching experience increases, the level of self-concern tends to decrease while the perception of self-efficacy grows. Boz and Cetin-Dindar (2023) also reported a negative correlation between teaching concerns and self-efficacy, indicating that teachers with high self-efficacy beliefs were less teaching concerned. Similarly, Yurtseven and Yaylı (2019) observed that the concern levels of teachers can vary significantly depending on their experience, with those new to the profession experiencing higher levels of concern compared to their more experienced teachers. According to their research, as teachers gain more experience, these initial concerns often give way to increased self-confidence. Additionally, Ekizler (2013) reported that as in-service teachers' competence improves over time, their levels of concern decrease correspondingly. These findings

collectively suggest that experience plays a crucial role in shaping the concerns and self-perceptions of teachers throughout their careers.

4.1. Implications of Research

This current study explored the differences between teaching concerns, gender, and teaching experience, revealing significant differences. It was found that gender influenced task- and impact-concerns, while teaching experience primarily affected self-concerns. These findings indicate that different variables have distinct impacts on teaching concerns. The study highlights the need for further investigation into the teaching concerns of both pre-service and in-service teachers, as current research in this area is limited. While most studies have focused on pre-service teachers' concerns, there is also a pressing need to examine the concerns of in-service teachers to gain a more comprehensive understanding of how these factors evolve throughout a teaching career.

Research on the professional concerns of teachers has shown that the variability in the scales used and the differences in academic departments may have influenced the research results. These factors could lead to variations in findings, as the tools and contexts in which the studies were conducted might capture different aspects of teachers' teaching concerns or reflect the unique challenges teachers face in specific disciplines. Consequently, these differences highlight the need for careful consideration when interpreting and comparing the results across studies. By systematically investigating and addressing these concerns, teacher preparation programs can become more adaptive, supportive, and effective in nurturing competent and resilient educators.

4.2. Limitations and Suggestions

The sample size in this study was relatively small and limited to a specific geographic region, which may be limited in representing the broader population of in-service and pre-service teachers. Future research could benefit from a larger, more diverse sample to enhance the generalizability of the findings. Including a more varied demographic in terms of teaching experience, educational settings, and cultural backgrounds would provide a more comprehensive understanding of teaching concerns.

The study relied heavily on self-reported data, which may be subject to social desirability bias. Participants might have underreported or exaggerated their teaching concerns. Employing a

mixed-methods approach, including observations or interviews, could yield more nuanced insights. As the current research captures the concerns of teachers at a single point in time, longitudinal studies could provide valuable insights into how teaching concerns evolve over time, particularly as pre-service teachers transition into in-service roles.

Future studies could conduct comparative analyses between in-service and pre-service teachers across different educational systems or regions to identify commonalities and differences in teaching concerns. Research could examine the impact of targeted professional development programs on alleviating teaching concerns, particularly for pre-service teachers transitioning into the profession. Longitudinal research tracking the evolution of teaching concerns from pre-service education through the early years of teaching could provide deeper insights into how initial concerns persist, diminish, or transform over time. Investigating the relationship between early teaching concerns and long-term outcomes like teacher retention, job satisfaction, and burnout could offer valuable implications for teacher preparation programs. Research could explore how cultural and institutional differences influence teaching concerns and the effectiveness of support systems, providing insights into contextually appropriate interventions.

5. References

Boz, Y. (2008). Turkish student teachers' concerns about teaching. *European Journal of Teacher Education, 31*(4), 367-377. https://doi.org/10.1080/02619760802420693

Boz, Y., & Boz, N. (2010). The nature of the relationship between teaching concerns and sense of efficacy. *European Journal of Teacher Education, 33*(3), 279-291. https://doi.org/10.1080/02619768.2010.490910

Boz, Y., & Cetin-Dindar, A. (2023) Teaching concerns, self-efficacy beliefs and constructivist learning environment of pre-service science teachers: A modelling study. *European Journal of Teacher Education, 46*(2), 274-292. https://doi.org/10.1080/02619768.2021.1919079

Çakmak, M. (2008). Concerns about teaching process: Student teachers' perspective. *Educational Research Quarterly, 31*(3), 57-77.

Çelen, A., & Bulut, D. (2019). Assessment of occupational anxiety levels of physical education preservice teachers. *The Journal of Academic Social Science, 18*(18), 247-261. https://doi.org/10.16992/ASOS.865

Çubukçu, Z., & Dönmez, A. (2011). The examination of the professional anxiety levels of teacher candidates. *Journal of Theory and Practice in Education, 7*(1), 3-25.

Ekizler, F. (2013). *The relationship between teaching concerns and self-efficacy levels of pre-and in-service EFL teachers* [Unpublished master's thesis]. Pamukkale University, Denizli.

Fuller, F. F. (1969). Concerns of teachers: A developmental conceptualization. *American Educational Research Journal, 6*, 207–226.

Fuller, F. F. (1971). *Relevance for teacher education: A teacher concerns model*. Austin: University of Texas Research & Development Center for Teacher Education.

Geçer, K., & Taşdemir, C. (2020). Determining the factor affecting professional anxiety levels of pre-service science teachers. *Turkish Journal of Educational Studies, 7*(3), 65-78.

George, A. A. (1978). *Measuring self, task, and impact concerns: A manual for use of the teacher concerns questionnaire*. The University of Texas at Austin: The University of Texas.

Ghaith, G., & Shaaban, K. (1999). The relationship between perceptions of teaching concerns, teacher efficacy, and selected teacher characteristics. *Teaching and Teacher Education, 15*(5), 487-496.

Guillaume, A. M., & Rudney, G. L. (1993). Student teachers' growth toward independence: An analysis of their changing concerns. *Teaching and Teacher Education, 9*(1), 65-80.

Kafkaş, M. E., Açak, M., Çoban, B., & Karademir, T. (2010). Investigation of the relationship between preservice physical education teachers' sense of self-efficacy and professional concerns. *Inonu University Journal of the Faculty of Education, 11*(2), 93-111.

Mergen, H., Arslan, H., Mergen, B. E., & Arslan, E. (2014). Pre-service teachers' anxiety and attitudes toward their profession. *NWSA-Education Sciences, 9*(2), 162-177. http://dx.doi.org/10.12739/NWSA.2014.9.2.1C0612

Pigge, F. L., & Marso, R. N. (1987). Relationships between student characteristics and changes in attitudes, concerns, anxieties, and confidence about teaching during teacher preparation. *The Journal of Educational Research, 81*(2), 109-115.

Pigge, F. L., & Marso, R. N. (1997). A Seven Year Longitudinal Multi-Factor Assessment of Teaching Concerns Development Through Preparation and Early Years of Teaching. *Teaching and Teacher Education, 13*(2), 225–235. http://dx.doi.org/10.1016/S0742-051X(96)00014-5.

Stair, K. S., Warner, W. J., & Moore, G. E. (2012). Identifying concerns of preservice and in–service teachers in agricultural education. *Journal of Agricultural Education, 53*(2), 153–164. http://dx.doi.org/10.5032/jae.2012.02153

Şaban, A., Korkmaz, İ., & Akbaşlı, S. (2004). The professional concerns of pre-service teachers. *Eurasian Journal of Educational Research, 17*, 198–208.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th Eds.). New York: Allyn & Bacon/Pearson Education.

Taşğın, Ö. (2006). Observation of concern levels teacher candidates, who enrolled physical education and sports college, according to some variables. *Kastamonu Education Journal, 14*(2), 679-686.

Varol, Y. K., Erbaş, M. K., & Ünlü, H. (2014). Beden eğitimi öğretmen adaylarının mesleki kaygı düzeylerinin öğretmenlik mesleğine yönelik tutumlarının yordama gücü. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, 12*(2), 113-123.

Yaylı, D., & Hasırcı, S. (2009). Concerns of prospective teachers of Turkish on teaching. *The Journal of International Social Research, 2*(9), 520-525.

Yeşilyurt, E. (2013). Teacher self-efficacy perceptions of teacher candidates. *Electronic Journal of Social Sciences, 12*(45), 88-104.

Yurtseven, T., & Yaylı, D. (2019). Teaching concerns and self-efficacy beliefs of pre-service Turkish teachers. *Journal of Language Education and Research, 5*(1), 47-67.

Instructional Technology and Lifelong Learning Vol.5, Issue 2, 257-277 (2024)

ITALL

Research Article

ISSN: 2717-8307

The Process of Teaching and Learning from the Views of Prospective Mathematics Teachers: The Case of Algebraic Inequalities

Emel TOPBAŞ TAT *[1], Hafize GÜMÜŞ [2]

* *Corresponding Author, etopbastat@erbakan.edu.tr*
[1]*Necmettin Erbakan University, Türkiye*
[2]*Necmettin Erbakan University, Türkiye*

Abstract

This study explores the views of prospective mathematics teachers on the process of teaching and learning about algebraic inequalities. Phenomenology, one of the qualitative research methods, was used in the study. The participants of the study consisted of 6 prospective middle school mathematics teachers studying in the last year of the Elementary Mathematics Teacher Education Program of a university in the Central Anatolia Region of Türkiye in the spring semester of the 2021-2022 academic year. Data were collected through semi-structured interviews. The obtained data were analyzed using content analysis, one of the qualitative analysis methods. As a result of the analysis of the interviews with the prospective middle school mathematics teachers, three main themes were obtained. Teaching inequalities, the difficulties that students may experience in inequalities, and the methods that can be used to overcome difficulties were the main categories that emerged. Direct quotations from the prospective teachers' views were also included in the presentation of the findings. As a result of the study, it is recommended that more practice should be included in teacher education programs to improve prospective mathematics teachers' knowledge and experience of meaningful learning and overcoming difficulties.

Keywords: Mathematics education, Algebra, Inequalities, Prospective teachers, Views

Citation: Topbaş Tat, E., & Gümüş, H. (2024). The process of teaching and learning from the views of prospective mathematics teachers: the case of algebraic inequalities. *Instructional Technology and Lifelong Learning, 5*(1), 257-277. https://doi.org/10.52911/itall.1552703

Matematik Öğretmen Adaylarının Gözünden Öğretme ve Öğrenme Süreci: Cebirsel Eşitsizlikler Örneği

Özet

Bu çalışma, matematik öğretmeni adaylarının eşitsizlikleri öğrenme ve öğretme sürecine ilişkin görüşlerini araştırmaktadır. Çalışmada nitel araştırma yöntemlerinden fenomenoloji kullanılmıştır. Çalışmanın katılımcılarını 2021-2022 eğitim-öğretim yılı bahar döneminde Türkiye'nin İç Anadolu Bölgesi'ndeki bir üniversitenin İlköğretim Matematik Öğretmenliği Programı son sınıfında öğrenim gören 6 ortaokul matematik öğretmeni adayı oluşturmaktadır. Veriler yarı yapılandırılmış görüşmeler yoluyla toplanmıştır. Elde edilen veriler nitel analiz yöntemlerinden biri olan içerik analizi kullanılarak analiz edilmiştir. Ortaokul matematik öğretmeni adayları ile yapılan görüşmelerin analizi sonucunda üç ana tema elde edilmiştir. Eşitsizliklerin öğretimi, öğrencilerin eşitsizlikler konusunda yaşayabilecekleri zorluklar ve zorlukların üstesinden gelmek için kullanılabilecek yöntemler ortaya çıkan ana kategoriler olmuştur. Bulguların sunumunda öğretmen adaylarının görüşlerinden doğrudan alıntılara da yer verilmiştir. Çalışma sonucunda, matematik öğretmeni adaylarının anlamlı öğrenme ve zorlukların üstesinden gelme konusundaki bilgi ve deneyimlerini geliştirmek için öğretmen eğitimi programlarında daha fazla uygulamaya yer verilmesi önerilmektedir.

Anahtar Kelimeler: Matematik Eğitimi, Cebir, Eşitsizlikler, Öğretmen adayları, Görüşler

Date of Submission	19.09.2024
Date of Acceptance	12.11.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgments	-
Author(s) Contribution	**Author1:** Conceptualization, Methodology, Writing- Original draft preparation, Writing- Reviewing and Editing **Author2:** Data curation, Writing- Original draft preparation
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	itall.journal@gmail.com
Grant Support	The author(s) acknowledge that they received no external funding supporting this research.
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Algebra is used in almost every aspect of our lives and is defined in many different ways. Algebra can be defined as "the branch of mathematics that deals with symbolizing general numerical relationships and mathematical structures and with operating on those structures" (Kieran, 1992, p.391). The word algebra comes from the name of Harizmi's book. "The term Al Cabr, which is mentioned in the title of Harizmi's book, was used as algebra in English and French and was used as cebir in Turkish" (Baki, 2014, p.81). Algebra acts as a conceptual bridge between both sub-fields of mathematics and elements of other disciplines (Erbaş et al., 2009). It is also a field that opens the doors of abstract thinking to students.

Algebra is one of the five learning areas of the Turkish Middle School Mathematics Curriculum (Ministry of National Education [MoNE], 2018). The five basic sub-learning areas of this learning area in the curriculum are algebraic expressions, equality and equations, linear equations, algebraic expressions and identities, and inequalities. Among these sub-learning areas, algebraic expressions are included in 6th and 7th grade, equality and equations in 7th grade, linear equations, algebraic expressions, and identities and inequalities in 8th grade (MoNE, 2018). The last sub-learning area taught in middle school algebra is inequalities. Although inequalities are included in the curriculum in grade 8, the topics of equality and equations that can be the basis of this subject are included in grades 6 and 7, and the use of inequality symbols at a basic level has been taught since primary school. Inequalities are open propositions like equations and differ in that they include one of the ordering relations such as "≤", "<", ">" and "≥" instead of "=" (Argün et al., 2014). Since inequalities are also complementary to the understanding of the concepts of equivalence and equality, it is stated that the knowledge possessed is critical in realizing the conceptual understanding of equations and equation solution (Tsamir & Almog, 2001).

Algebra teaching in schools aims to provide students with competencies such as being aware of the meanings of symbolic and graphical representations, expressing mathematical results and relationships through symbols, identifying variables in problem situations by making sense of the concept of variable, and determining solution sets of equations and inequalities (Baki, 2008). However, studies conducted in this area have revealed that students at different grade levels generally have difficulties in the subjects of the algebra learning area (Abu Mokh

et al., 2019; Dede & Peker, 2007; Knuth et al., 2005; MacGregor & Stacey, 1997.). Inequalities are one of the topics that students have difficulty in algebra (Blanco & Garrote, 2007; Çoban & Yenilmez, 2020; Siagian et al., 2022; Tsamir & Almog, 2001). When we look at the studies on inequalities, it is seen that students generally have difficulties in the process of solving inequalities, in expressing and interpreting the solutions obtained (Blanco & Garrote, 2007). For example, students have been found to multiply a negative number to an inequality without reversing the direction of the inequality sign (Kroll, 1986). Similarly, Çoban and Yenilmez (2020) found that the most common difficulties with inequalities were determining the direction of inequalities in reverse, not realizing the situation of equality, writing the algebraic expression appropriate to the given expression incorrectly, showing the inequality incompletely on the number line, showing the inequality in the opposite direction on the number line, making an operation error in solving the inequality, and ignoring the negative sign.

Obstacles in the understanding of algebra can be analyzed under three headings: the structure of algebra (epistemological obstacle), students' mental development and readiness level (psycho-genetic obstacle), and deficiencies in algebra teaching (didactical obstacle) (Reconceptualising School Algebra, 1997, as cited in Dede & Argün, 2003). The obstacles related to deficiencies in algebra teaching emphasize the importance of the teacher's role in understanding algebra. The selected teaching models, the application of these models, the metaphors, examples, materials and activities used by the teacher may cause students to experience difficulties in algebra teaching. For example, misconceptions may arise due to students' incomplete understanding of the new knowledge or incorrectly associating it with the previous knowledge (Rowell et al., 1990). Similarly, concretizing mathematical concepts at the primary and secondary school levels will facilitate students' meaningful learning (Clements & McMillen, 1996). For this reasons, teachers' having sufficient knowledge in their field, keeping up with the new approaches, and being able to analyze the mistakes and misconceptions that their students may make will make algebra teaching much more understandable and effective. For this purpose, it is important to examine prospective middle school mathematics teachers' views about teaching and learning process of algebraic inequalities. Despite calls from the mathematics education community for more research in this area, there has been relatively little research into inequalities (Moon, 2019). When the

literature on inequalities is examined, it is seen that most of the studies are about students' difficulties with inequalities, besides, there are a few studies investigating prospective teachers' awareness of these difficulties, but no study has been found on their views on teaching and learning of inequalities. Therefore, the research problem of this study was determined as: What are the views of prospective middle school mathematics teachers on the process of teaching and learning inequalities? And the sub-problems were identified as: (1) What are the views of prospective middle school mathematics teachers on how the teaching of inequalities should be? (2) What are the views of prospective middle school mathematics teachers on the difficulties that students may experience with inequalities? (3) What are the views of prospective middle school mathematics teachers on the methods that can be used to overcome difficulties that students may experience with inequalities? It is thought that the answers to these questions will contribute to eliminating the deficiency in the literature on this subject by revealing the views and awareness of prospective teachers about teaching inequalities.

2. Method

In this study, the views of prospective teachers on the subject of inequalities were examined. Phenomenology, a qualitative research method, was used in the study. A phenomenological study reveals the meaning of experiences related to a particular phenomenon for individuals (Rose et al., 1995). Similarly, Creswell (2013) defines phenomenology as the meaning of people's experiences about a phenomenon or concept. The purpose of phenomenological research is to reveal in detail the thoughts of individuals about a phenomenon based on their experiences, feelings, and thoughts. In the present study, the concept of teaching inequalities is considered as a phenomenon. How do the prospective teachers handle teaching the concept of inequalities? Are the prospective teachers aware of students' difficulties with the concept of inequalities? How do they plan to solve these difficulties? So, this research aims to bring an understanding and explanation to such questions.

2.1. Participants

The convenience sampling method was used to determine the participants of the study. Convenience sampling is a non-probability sampling method in which participants are selected based on their ease of access, availability, and willingness to participate in a study

(Etikan et al., 2016; Yıldırım & Şimşek, 2006). The participants of the study consisted of 6 prospective middle school mathematics teachers studying in the last year of the Elementary Mathematics Teacher Education Program of a university in the Central Anatolia Region of Türkiye in the spring semester of the 2021-2022 academic year. Four of the prospective teachers participating in the study are female and two are male. Participants were identified on a voluntary basis.

2.2. Data Collection

In the study, a semi-structured interview form was used to determine the views of prospective mathematics teachers on the teaching of inequalities. Although a semi-structured interview begins with a predetermined set of questions, additional questions, called probes, can be generated during the interview based on the interviewee's responses (Tyson, 1991). A semi-structured interview form was prepared by the researchers, which included questions about how the teaching process should be regarding the three objectives of inequalities at the 8th-grade level, which concrete materials and technologies can be used, what kind of activities can be planned, what difficulties students may experience in this subject, how they plan to overcome these difficulties, and to what extent they consider themselves competent to overcome these difficulties. For example, the objectives of the inequalities sub-learning area of the 8th grade algebra learning area were specified and they were asked how these objectives should be taught and what attention should be paid to teaching them. The prepared interview form was presented to the expert opinion, and the interview form, which was finalized with an expert suggestion, was made ready for application. The data were collected at the end of the spring semester of the 2021-2022 academic year. Face-to-face interviews were conducted with the prospective teachers, and the interviews were recorded with the permission of the participants. Each interview lasted between 15-25 minutes.

2.3. Data analysis

In order to analyze the data obtained, the audio-recorded interviews were first transcribed and recorded as separate written documents for each prospective teacher. The names of the prospective teachers were not used when saving the files, but each prospective teacher was numbered and coded as PT1, PT2, PT3, PT4, PT5 and PT6. The same codes were also used in the presentation of the findings to indicate the prospective teachers. The data obtained were

analyzed using content analysis, one of the methods of qualitative analysis. The written data were first classified through coding and the codes were handled within the framework of sub-themes. Themes were obtained by rearranging the sub-themes. The presentation of the findings on the themes included direct quotations from the views of the prospective teachers.

3. Result

As a result of the analysis of the interviews with prospective teachers, three main themes were obtained: Views on teaching inequalities, views on the difficulties that students may experience in inequalities, and views on the methods that can be used to overcome difficulties. In this section, the themes obtained will be examined in subtitles.

3.1. Views on Teaching Inequalities

This main theme consists of the sub-themes of prerequisite knowledge, issues to be considered in teaching, and materials and activities that can be used in teaching.

3.1.1. Prerequisite Knowledge

Under this sub-theme, prospective teachers' views on the concepts and topics that are prerequisite for the inequalities sub-learning area of 8th grade algebra learning area were determined. As prerequisite concepts, prospective teachers stated the meanings of concepts such as less, more, least, greatest, greater than, less than, greater than or equal to, and less than or equal to; equality, variable and unknown, algebraic expressions, equations and linear equations. The views of the participants about the prerequisite concepts are presented in Table 1.

Table 1.

Views of Prospective Teachers for Prerequisite Concepts

	Participant					
Code	PT1	PT2	PT3	PT4	PT5	PT6
The meanings of concepts such as less, more, least, greatest, greater than, less than, greater than or equal to, and less than or equal to	X		X		X	
Equality		X	X	X	X	X
Variable and unknown		X				X
Algebraic expressions	X	X		X		X
Equations	X	X	X			X
Linear Equations				X		

As can be seen from Table 1, all prospective teachers except the PT1 have stated the concept of equality as a prerequisite for the teaching of inequalities. While the linear equations are presented as a prerequisite for inequalities by only one prospective teacher, four prospective teacher specified algebraic expressions (except for PT3 and PT5) and equations (except PT4 and PT5) as prerequisite concepts. Some examples including the opinions of prospective teachers about prerequisite concepts are presented below.

> PT2: *For example, first of all, they need to learn the concept of variable or unknown concept. Then the equation; the algebraic expression, equation they had seen before. Because, for example, in the solution of inequalities, it looks like the solutions of equations, they must first know them. … With equations, you can first know the meaning of an equality and then move on to the meaning of an inequality…*
>
> PT3: *First of all, equality. Equality is very important to learn inequality. The balance situation is very important, the students need to know it. In order to pass on to inequality, they need to know very well what the equation is. Or, the student should know the expressions such as the least and the greatest, in advance. For this, because in order to make sense of those symbols in inequality…*
>
> PT4:*… Algebraic expressions that we saw first in the sixth grade, we can say this as a prerequisite. Then they see again in the 8th grade, they see the thing this time, they see linear equations. These two issues are actually very related to this, so it would be better for me to learn equality first and then learn about the inequality.*

3.1.2. Issues to be Considered in Teaching

Under this sub-theme, it was tried to determine the views of the prospective teachers on the important issues that should be considered in the teaching of inequalities sub-learning area of the 8th grade algebra learning area. In this direction, the objectives of the inequalities sub-learning area of 8th grade algebra learning area were specified and it was asked how the

teaching of these objectives should be and what should be paid attention in teaching. Many codes have been collected under this sub-theme. For example, prospective teachers emphasized the importance and necessity of using information technologies as well as concrete materials in the teaching of inequalities. Therefore, two of these codes were determined as "use of concrete materials" and "use of information technologies". The views of the prospective teachers on the issues to be considered in the teaching of inequalities are presented in Table 2.

Table 2.

The Views of Prospective Teachers about the Issues to be Considered in Teaching

	Participant					
Code	PT1	PT2	PT3	PT4	PT5	PT6
Concretization	X	X	X	X	X	X
Use of concrete materials	X	X				X
Use of information technologies	X		X			X
Use examples from daily life or the environment	X	X	X	X	X	X
Utilizing discussions					X	
Transition between verbal and algebraic representations		X				X
Work on the number line	X	X	X	X	X	X
Benefit from activities			X			
Paying attention to readiness	X	X	X	X		
Explaining concepts and rules with reasons		X		X	X	X

According to Table 2, all of the prospective teachers mentioned the importance of using examples and problems from daily life and the environment, as well as concretization in the teaching of inequalities. They also emphasized the necessity of giving special attention to the representations and studies on the number line. Some of the prospective teachers' opinions gathered under this sub-theme are presented below:

> PT1: … *For example, let me give an example from myself. This second thing, the explanation was a stage that I never understood, you know, you change direction, but how does it change direction? It's negative, you know, it's multiplied by a negative, okay, but I never understood why. Therefore, when multiplying or dividing is with a negative number, first of all, the students should definitely find out why. If we start from there, everything will be solved in my opinion…*
>
> PT2: … *Because they can learn in a more meaningful way by associating it with daily life. If we give it directly with memorisation, the student may not know, for example, in which case to use greater than, less than or less than or equal to, greater than or equal to. But I think it may make more sense to students when they think about daily life…*

> *PT3 : ... we can use virtual manipulatives and dynamic software for better comprehension. For example, GeoGebra can be very suitable for this. Because while a variable is changing, both its increase and decrease, why it is more, why it cannot exceed that limit can be shown on GeoGebra. In this way, it makes more sense in the child's mind. ...*

When the prospective teachers were asked what kind of suggestions they had to increase the effectiveness of teaching inequalities, they made statements similar to their views in Table 2. In addition, some prospective teachers mentioned some codes under the title of suggestions to increase the effectiveness of teaching inequalities, which they did not mention under the sub-theme of issues to be considered in teaching. For example, although PT2 did not mention the use of activities in the sub-theme of issues to be considered in teaching, she suggested the use of activities in the suggestions to increase the effectiveness of teaching. In addition, while in parallel with Table 2 she talked about the use of technology, the use of concrete materials, attention to readiness and concretization, she suggested taking into account misconceptions from the codes not in the Table 2. Therefore, in addition to their views in Table 2, the prospective teachers suggested using the history of mathematics, paying attention to misconceptions, ensuring active participation of students, ensuring cooperative learning and making preparation before the lesson in order to increase the effectiveness of teaching inequalities.

3.1.3. Materials and Activities that can be Used in Teaching

Prospective teachers mentioned that there are various concrete materials that can be used in teaching inequalities and identified them as algebra tiles, number line, models of scale or seesaw and various mathematical tools. Websites, dynamic geometry software (GeoGebra, GSP, Cabri etc.), virtual manipulatives (such as NLVM), excell and smart board applications were mentioned as information technologies that can be used in teaching inequalities. The findings regarding whether the prospective teachers think of using technology in the teaching inequalities are presented in Table 3.

Table 3.

Prospective Teachers' Views on Using Concrete Materials/Information Technologies in Teaching

	Participant					
Code	PT1	PT2	PT3	PT4	PT5	PT6
I think to use concrete materials	X	X	X	X	X	X
I plan to make use of information technologies	X	X	X		X	X

According to Table 3, PT4 stated that he did not think of utilizing information technologies in teaching inequalities. Some of the other prospective teachers mentioned the importance of using appropriate concrete materials or information technology in teaching, but stated that they could not remember concrete materials or information technology that could be used in teaching inequalities and that they planned to prepare and research on this subject before the lesson. Some of the views of prospective teachers on materials that can be used in teaching inequalities are presented below:

> PT5: … *Of course I think, I think everyone should do this. Because I think the material has a great advantage especially in mathematics. … I will use materials because I believe they will be useful. … Preliminary preparation, well, I will look at articles written about inequalities. ... Inspired by them, I will either create my own material in a similar way or I will use it and present it to the students...*

As a result of the analysis of prospective teachers' views on what kind of activities they can plan in teaching inequalities, the codes of "activities related to daily life", "activities for cooperative learning", "activities involving the use of technology" and "activities involving the use of concrete materials" were obtained. In addition, one prospective teacher stated that she could not specify what kind of activity she could design, but she thought that she could design an appropriate activity with pre-lesson preparation. The findings regarding the activities that prospective teachers plan to design in teaching inequalities are presented in Table 4.

Table 4.

Prospective Teachers' Views on Activities that can be Designed in Teaching

	Participant					
Code	PT1	PT2	PT3	PT4	PT5	PT6
Activities related to daily life			X		X	
Activities for cooperative learning			X			
Activities involving the use of concrete materials	X		X	X		X
Activities involving the use of technology	X		X			

According to Table 4, while the teachers stated that they would mostly design activities involving the use of concrete materials in teaching inequalities, PT1 stated that he planned to design activities involving the use of both concrete materials and technology. In addition to these, PT3 stated that she planned to prepare activities by considering different situations.

Some of the views of prospective teachers about the activities that can be designed in teaching are presented below:

> PT3: *... For example, as I said, in GeoGebra, there are graphs, table representations that show the change of variables with the introduction of an inequality. From there, I can show the situation where the equilibrium situation in inequality is actually disrupted. ... We can also design new models for inequality through cooperative learning. For example, as I said, someone can be a grocer, like a shopkeeper, can be designed in the classroom in this way. The children go and shop, the amount of money, the equality and inequality here. … These kinds of activities can be designed in general.*
>
> *PT4: I can do something like this for inequality: I can use the tiles of the clasroom as something, I can use them as a number line. We choose a point, that point is the zero point. According to that, let's say, for example, the numbers less than 12 or let's show the set of numbers on the number line, let's think of it as an inequality. So when we show this to the students, when we fill in each tile, the students will know that they are included in that tile. But for example, we can say like this; when we say the set of numbers less than 9, we know that 9 is not included, and then the ninth tile is left blank. I can design an activity like this and teach them to understand inclusion or exclusion…*

3.2. Views on the Difficulties that Students may Experience in Inequalities

In order to determine prospective teachers' awareness of the difficulties students may experience with inequalities, they were asked what kind of difficulties the students may experience with inequalities. The prospective teachers stated that there may be difficulties in teaching inequalities, such as difficulties with $<$, $>$, $\leq$, $\geq$ symbols and their meanings, in the case of changing the direction of inequality, in showing inequality on the number line, in solving inequalities, in the use of variables, in conceptualizing inequality because of not being able to make sense of equality (prerequisite), and in moving from the concept of equality to inequality. The findings regarding the views of the prospective teachers about the difficulties that students may experience in inequalities are presented in Table 5.

Table 5.

Prospective Teachers' Views on the Difficulties that Students may Experience in Inequalities

	Participant					
Code	PT1	PT2	PT3	PT4	PT5	PT6
Difficulties with symbols <, >, ≤ , ≥ and their meanings	X	X		X	X	X
In the event of a change in the direction of inequality	X	X	X			
Showing inequality on the number line		X	X	X		
In solving inequalities		X				
With variables		X			X	
In conceptualizing inequality because of not being able to make sense of equality				X		
Moving from the concept of equality to inequality						X

According to Table 5, the prospective teachers stated that they thought that the students would have the most difficulties with the symbols for inequality and their meanings and this was followed by the statements that there would be difficulties in the case of changing the direction of the inequality and showing the inequality on the number line. An examples of prospective teachers' views on the difficulties that students may experience with inequalities is presented below:

> *PT6: ... What kind of difficulties, they may not be able to move from the concept of equality to inequality. As I have said before, they cannot understand the direction of inequality because of the equality of x+3 and 3+x. In other words, if 6>a, they can understand it as a>6. They may encounter difficulties in this way. ... If there is no equality in "less than or equal to" or "greater than or equal to" signs if it is inequality, why is it included. There were other misconceptions, but these are the ones I can think of right now.*

3.3. Views on the Methods that can be Used to Overcome Difficulties

The prospective teachers stated that students may experience certain difficulties while learning inequalities and made some suggestions about the ways to overcome these difficulties. The suggestions of the prospective teachers on this issue were coded as "getting students active", "coding for symbols", "identifying misconceptions and planning lessons accordingly", "using concrete materials", "using technology", "using daily life situations", "checking prior knowledge" and "designing activities based on constructivism". The findings obtained in this regard are presented in Table 6.

Table 6.

Prospective Teachers' Views on the Methods that can be Used to Overcome Difficulties

	Participant					
Code	PT1	PT2	PT3	PT4	PT5	PT6
Getting students active	X			X		
Coding for symbols	X					
Identifying misconceptions and planning lessons accordingly		X				X
Using concrete material			X		X	
Using technology					X	
Using daily life situations			X			
Checking prior knowledge		X	X			
Designing activities based on constructivism				X		

According to Table 6, prospective teachers mostly suggested checking prior knowledge, using concrete material, getting students active, identifying misconceptions and planning lessons accordingly to solve the problems that students may experience. Other methods suggested by the teachers included coding for symbols, utilizing technology, using daily life situations and designing activities based on constructivism. Examples of prospective teachers' views on suggestions that can be used to overcome the difficulties that students may experience in inequalities are presented below:

> PT2: … *Before, for example, while checking their readiness, if there are any misconceptions about equality, they can be eliminated first. Later on, when the subject is being taught, I can do activities in which I can recognize them, or we can guide the student with questions. if there are misconceptions, like why do you think like this questions can be asked, you know, why exactly we can find out and follow a path accordingly...*
>
> PT5: … *Afterwards, I need to have appropriate materials so that I can explain them to the student. Or I need to have appropriate technology-supported activities. … I try to explain the situation to the student in the best way possible by using materials or technology-supported activities.*

The prospective teachers were also asked to what extent they felt competent in overcoming the difficulties they might encounter. While three of the prospective teachers stated that they did not feel very competent, one prospective teacher stated that she did not think that she would have much difficulty, one prospective teacher stated that he would rate her competence as good, and one prospective teacher stated that she would rate her competence it as 7 out of 10. However, an important point that draws attention is that the prospective

teachers stated that when evaluating their level of competence, they were based on their current situation and that the parts they saw as lacking in competence could only be completed with experience. The views of the prospective teachers on how competent they feel in overcoming the difficulties that may be experienced in inequalities are given below.

> PT1: *Now, I think the place where students have difficulty is important here. I mean, based on my knowledge within the scope of the course we took before, I don't think it will be very difficult. For example, I would give myself three and a half to four out of five.*
>
> *PT2: I may not be that competent right now because as I gain more experience, I think I will be able to see where students make mistakes, what they think, why they do that, I think it would be a little more, I think I can see better by being involved in the work. Right now, not that much, right now we can know as much as we see from the lessons. Since we have never met students, we have not seen them that much in the internship, and even if we did, we did not come across those subjects, so I don't feel very adequate right now.*
>
> PT3: *Actually, I don't feel very competent at the moment because we also go to the internship and we see it there. Students are really indifferent to mathematics now, there is an incredible negative prejudice against mathematics. So I think I need to experience for a while. I need to be able to convince students that math is a good subject, that inequality, for example, is actually something that will be useful for them. For this, I think I need a process first. I don't feel competent at the moment.*
>
> PT4: *… If the top level is very good right now, I would consider myself as good…*
>
> PT5: *I don't think I am sufficient right now because I don't know much in terms of materials or technology-supported things. But it is not very difficult by searching on the internet, we have already received their teaching in our faculty. We have a certain knowledge of how we can do it, what we can do. There is no question mark in our minds. With just a few researches, we can collect them ourselves and transfer them to the students.*
>
> *PT6: …Let me say out of 10. I think that I can handle these difficulties that I will face at a level of 7 out of 10. The three points I did not give may be due to student differences, as I said, because I have not yet gained experience…. You know, I have deducted three points because of the situations that I cannot affect, that I have not yet encountered. I think that if I go to the school now, I can eliminate the difficulties, I can deal with them at the rate of 7 out of 10....I can complete the rest when I participate in working life….*

4. Discussion and Conclusion

In this study, the views of prospective middle school mathematics teachers on algebraic inequalities were determined. As a result of the research, prospective teachers' approaches to teaching inequalities, information technologies and concrete materials they are aware of for

teaching inequalities, activities they plan to do, their awareness of common difficulties encountered in the literature on inequalities, their suggestions and plans to overcome difficulties, and their views on how competent they feel in overcoming difficulties were determined. The findings were analyzed under the themes of views on teaching inequalities, views on the difficulties that students may experience in inequalities, and views on the methods that can be used to overcome the difficulties.

The theme of views on teaching inequalities was examined through the sub-themes of prerequisite knowledge, issues to be considered in teaching, and materials and activities that can be used. As prerequisite concepts, the prospective teachers stated the meanings of concepts such as less, more, least, greatest, greater than, less than, greater than or equal to, and less than or equal to; equality, variable and unknown, algebraic expressions, equations and linear equations. In teaching inequalities, they drew attention to many important points such as using concrete materials, benefiting from information technologies, using examples from daily life or the environment, ensuring the transition between verbal and algebraic representations, paying attention to readiness, and explaining concepts and rules with their reasons. As a matter of fact, Çoban and Yenilmez (2020) stated that most of the students could not understand the subject of inequalities conceptually and had difficulty in writing the inequality given verbally as a mathematical sentence. As a result of the findings, it can be said that the views of prospective teachers on the teaching of inequalities are supportive of learning the subject of inequalities by conceptualising and making sense of it. It is thought that this situation can be explained by the fact that prospective teachers acquired knowledge and experience about teaching inequalities in the course Teaching Algebra, which they took in the third year of the elementary mathematics teacher education program. In the study, it was also tried to determine the opinions of prospective teachers about various concrete materials and information technologies that can be used in teaching inequalities. Virtual manipulatives belonging to NLVM and NCTM, GeoGebra, one of the dynamic mathematics software, videos on the subject in Education Information Network (EBA), two-pan balance and seesaw models, and four-pan algebra balance are among the materials and technological tools recommended to be used in teaching inequality (Yazlık, 2019). In this direction, as a result of the findings, it can be stated that prospective teachers are aware of concrete materials and information technologies that can be used in teaching algebra, but it is necessary to improve their

knowledge on materials and information technologies specific to teaching inequality. The prospective teachers explained this situation by not being able to remember and stated that they planned to prepare the appropriate materials for the lesson with pre-lesson preparation. However, similar to some studies in the literature (e.g., McCarty, 1998; Öksüz & Ak, 2009; Ünlü, 2017), it can be said that prospective teachers agree that it is beneficial to use information technologies and concrete materials in teaching. Students, particularly younger students, learn more meaningfully in learning environments where information is represented by concrete manipulatives (Clements, 1999; Kelly, 2006). Similarly, research shows that the use of information technologies in teaching has many benefits (Seferoğlu, 2001). Therefore, the fact that prospective teachers have positive views on the use of technology and concrete materials can be considered as a positive prediction that they will include them in their future classroom practices.

It is a necessity for teachers to be aware of students' difficulties and mistakes in the learning process in order to ensure meaningful learning (Yetkin, 2003). In this direction, it has been investigated whether prospective teachers are aware of student difficulties related to inequalities. According to the findings, prospective teachers stated that they thought that students might have difficulty with symbols for inequalities and their meanings, in the case of changing the direction of an inequality, showing inequalities on the number line, solving inequalities, the use of variables and moving from the concept of equality to inequality. In parallel with the findings of this study, Çoban and Yenilmez (2020) found that although most of the students were aware of the symbols in the subject of inequalities, they did not know what they meant conceptually and had difficulties in representing the inequality on the number line. Accordingly, within the framework of the findings obtained in this study, it can be said that prospective teachers are aware of the difficulties that may be experienced regarding inequalities. It is thought that this situation can be explained by the information they gained from the courses they took in the elementary mathematics teacher education program and their own student or teaching experiences (within the scope of the teaching practice courses or tutoring, etc.) as stated by the prospective teachers in the interviews.

The suggestions of the prospective teachers about the ways to overcome the difficulties that students may experience while learning inequalities can be listed as making the students active, coding for symbols, identifying misconceptions and planning lessons accordingly,

using concrete materials, benefiting from technology, benefiting from daily life situations, checking prior knowledge and designing activities based on constructivism. Another result obtained from the findings is that prospective teachers consider themselves competent at different levels in overcoming the difficulties they may encounter in the process of teaching inequalities. However, an important point that draws attention is that the prospective teachers stated that when evaluating their level of competence, they were based on their current situation and that the parts they saw as lacking in competence could only be completed with experience. This result can be explained by the fact that, as stated by the prospective teachers in the interviews, for some prospective teachers, addressing the difficulties that can be encountered in inequalities in undergraduate courses is sufficient to see themselves as competent in this subject, while some prospective teachers need also experience factor to feel competent in this subject. In mathematics teaching, it is possible to mention the main principles that should be followed in achieving the goal and overcoming the difficulties. For example, Altun (2001) lists the basic principles necessary for effective mathematics teaching as follows: Establishing conceptual foundations, giving importance to the preconditionality relationship, giving importance to key concepts, determining the roles of the teacher and the student well in teaching, benefiting from the environment in teaching, including research studies and developing a positive attitude towards mathematics (pp. 8-15). During the teacher preparation program, prospective teachers acquire knowledge and develop beliefs about the teaching and learning process (Van Zoest & Bohl, 2005). It is recommended that the knowledge, beliefs and experiences aimed to be gained during teacher education should be at a level that increases the competences of prospective teachers towards the teaching process and improves their self-efficacy in this regard. It can also be suggested that more practices be included in teacher education programs to improve prospective mathematics teachers' knowledge and experiences about meaningful learning and overcoming difficulties. For future research, increasing the sample size to include more diversity or exploring similar perspectives in other mathematical subjects might be suggested.

5. References

Abu Mokh, R., Othman, A., & Shahbari, J. A. (2019). Mistakes made by students with logical connectives when solving equations and inequalities, and how teachers assess these mistakes. *International Journal of Research in Education and Science*, *5*(2), 421–428.

Altun, M. (2001). *İlköğretim ikinci kademede (6, 7 ve 8. sınıflarda) Matematik öğretimi*. [Mathematics teaching in the second level of elementary education (6th, 7th and 8th grades)]. AlfaYayınları.

Argün, Z., & Arıkan, A., Bulut, S., Halıcıoğlu, S. (2014). *Temel matematik kavramların künyesi* [A vocabulary of basic mathematical concepts]. Gazi Kitabevi.

Baki, A. (2008). *Kuramdan uygulamaya matematik eğitimi* [Mathematics education from theory to practice]. Harf Eğitim Yayınları.

Baki, A. (2014). *Matematik tarihi ve felsefesi* [History and philosophy of mathematics]. Pegem Akademi.

Blanco, L. J., & Garrote, M. (2007). Difficulties in learning inequalities in students of the first year of pre-university education in Spain. *Eurasia Journal of Mathematics, Science and Technology Education, 3*(3), 22–229.

Clements, D. H. (1999). 'Concrete' manipulatives, concrete ideas. *Contemporary Issues in Early Childhood, 1*(1),*45–60.*

Clements, D.H., & McMillen, S. (1996). Rethinking concrete manipulatives. *Teaching Children Mathematics, 2*(85), 270–279.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (Third Ed.). Sage Publications.

Çoban, K., & Yenilmez, K. (2020). Sekizinci sınıf öğrencilerinin eşitsizlikler konusunda karşılaştıkları güçlüklerin incelenmesi [Investigation of the difficulties encountered by eighth grade students on inequalities]. *Eskişehir Osmangazi Üniversitesi Türk Dünyası Uygulama ve Araştırma Merkezi Estüdam Eğitim Dergisi, 5*(1), 40–56.

Dede, Y., & Argün, Z. (2003). Cebir, öğrencilere niçin zor gelmektedir? [Why do students have difficulty with algebra?]. *Hacettepe University Journal of Education, 24*, 180–185.

Dede, Y., & Peker, M. (2007). Öğrencilerin cebire yönelik hata ve yanlış anlamaları: Matematik öğretmen adayları'nın bunları tahmin becerileri ve çözüm önerileri [Students' errors and misunderstanding towards algebra: Pre-service mathematics teachers' prediction skills of error and misunderstanding and solution suggestions]. *Elementary Education Online, 6*(1), 35–49.

Erbaş, A. K., Çetinkaya, B., & Ersoy, Y. (2009). Öğrencilerin basit doğrusal denklemlerin çözümünde karşılaştıkları güçlükler ve kavram yanılgıları [Student difficulties and misconceptions in solving simple linear equations]. *Education and Science, 34*(152), 44–59.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4.

Kelly, A. C. (2006). Using manipulatives in mathematical problem solving: A performance-based analysis. *The Montana Mathematics Enthuasiast, 3*(2), 184–193.

Kieran, C. (1992). The learning and teaching of school algebra. In D. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp. 390-419). New York: Macmillan Publishing Company.

Knuth, E. J., Alibali, M. W., McNeil, N. M., Weinberg, A. & Stephens, A. C. (2005). Middle school students' understanding of core algebraic concepts: Equality and variable. *International Reviews on Mathematical Education, 37*, 1–9.

MacGregor, M. & Stacey, K. (1997). Ideas about symbolism that students bring to algebra. *The Mathematics Teacher, 90*(2), 110–113.

McCarthy, P. J. (1998). *Teacher attitudes towards computers and the relationship between attitudes towards computers and level of involvement with computers among New York City Special Education teachers* [Doctoral dissertation]. Columbia University.

Ministry of National Education (2018). *Matematik Dersi Öğretim Programı (İlkokul ve ortaokul 1, 2, 3, 4, 5, 6, 7 ve 8. sınıflar)*[Mathematics Curriculum (Primary and middle school grades 1, 2, 3, 4, 5, 6, 7 and 8)]. Republic of Türkiye Ministry of National Education.

Moon, K. (2019). Preservice teachers' understanding of two-variable inequalities: APOS Theory. Otten, S., Candela, A. G., de Araujo, Z., Haines, C., & Munter, C, *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 686- 694). St Louis, MO: University of Missouri.

Öksüz, C. & Ak, Ş. (2009). Öğretmen adaylarının ilköğretim matematik öğretiminde teknoloji kullanımına ilişkin algıları [Preservice teachers' perceptions for technology use in the teaching of mathematics in elementary schools]. *Van Yüzüncü Yıl University Journal of Education, 6*(2), 1–19.

Rose, P., Beeby, J., & Parker, D. (1995). Academic rigour in the lived experience of researchers using phenomenological methods in nursing. *Journal of Advanced Nursing, 21*, 1123–1129.

Rowell, A. J., Dawson, C. J., & Harry, L. (1990). Changing misconceptions: A challenge to science education. *International Journal Science Education, 12(2)*, 167–175.

Seferoğlu, S. S. (2001). Öğretmenlerin bilişim teknolojilerinin kullanımıyla ilgili görüşleri [Teachers' views on the use of information technologies]. *Proceedings of 1th International Educational Technology Conference (IETC-2001)*, 334–350. Sakarya University.

Siagian, M. D. & Suryadi, D. & Nurlaelah, E. & Prabawanto, S. (2022). Investigation of secondary students' epistemological obstacles in the inequality concept. *Mathematics Teaching Research Journal, 14*(4), 106–128.

Tyson, P. (1991). Talking about lesson planning: The use of semi-structured interviews in teacher education. *Teacher Education Quarterly, 18*(3), 87–96.

Tsamir, P., & Almog, N. (2001). Students' strategies and difficulties: The case of algebraic inequalities. *International Journal of Mathematical Education in Science and Technology, 32*(4), 513–524.

Ünlü, M. (2017). Matematik öğretmen adaylarının matematik derslerinde öğretim materyali kullanımına ilişkin görüşleri [Pre-service mathematics teachers' views about using instructional materials in mathematics lessons]. *Journal of Theory and Practice in Education, 13*(1), 10–34.

Van Zoest, L. R., & Bohl, J. (2005). Mathematics teacher identity: A framework for understanding secondary school mathematics teachers' learning through practice. *Teacher Development, 9*(3), 315–345.

Yazlık, D. Ö. (2019). Eşitsizlik kavramı ve eşitsizlik kavramının öğretimi [The concept of inequality and teaching the concept of inequality]. G. Sarpkaya Aktaş (Ed.), *Uygulama Örnekleriyle Cebirsel Düşünme ve Öğretimi* (ss. 221–250). Pegem Akademi.

Yetkin, E. (2003). Student difficulties in learning elementary mathematics. *ERIC Digest*, 1–6.

Yıldırım, A. & Şimşek, H. (2006). *Sosyal bilimlerde nitel araştırma yöntemleri* (6. Baskı). Seçkin Yayıncılık.

Instructional Technology and Lifelong Learning Vol.5, Issue2, 278-299 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Determination of artificial intelligence literacy and attitudes towards artificial intelligence of teachers working with gifted students and examining them according to some variables

Derya Yüreğilli Göksu *[1], Seçkin Göksu [2]

* *Corresponding Author, deryaygoksu@gazi.edu.tr*
[1] *Gazi University, Türkiye*
[2] *Ministry of National Education, Türkiye*

Abstract

This research aimed to determine the level of artificial intelligence literacy and attitudes towards artificial intelligence of teachers working with gifted students and to examine the results according to some variables. The study was conducted with the participation of 107 science and art center (BİLSEM) teachers selected by convenience sampling method. Data were collected using the Artificial Intelligence Literacy Scale and the General Attitude Towards Artificial Intelligence Scale. The findings show that teachers generally have high levels of artificial intelligence literacy and attitudes towards artificial intelligence. In gender comparisons, it was found that male teachers had higher AI literacy and attitudes than female teachers. Other variables such as age, professional experience, working time in BİLSEM, education level and branch did not have a significant effect on artificial intelligence literacy and attitude. As a result, it was observed that the knowledge and attitudes of teachers working with gifted students towards artificial intelligence were generally positive, but there were gender differences. Therefore, it is recommended that teachers' access to artificial intelligence training and professional development opportunities should be increased and especially female teachers' knowledge and attitudes towards technology should be improved.

Keywords: Artificial intelligence, Artificial intelligence literacy, Attitude towards artificial intelligence, Teachers working with gifted students, BİLSEM

Citation: Yüreğilli Göksu, D. & Göksu, S. (2024) Determination of artificial intelligence literacy and attitudes towards artificial intelligence of teachers working with gifted students and examining them according to some variables. *Instructional Technology and Lifelong Learning, 5(2),* 278 - 299. https://doi.org/10.52911/itall.1551369

Özel yetenekliler ile çalışan öğretmenlerin yapay zekâ okuryazarlığının ve yapay zekâya yönelik tutumlarının belirlenmesi ve bazı değişkenlere göre incelenmesi

Özet

Bu araştırma, özel yetenekli öğrencilerle çalışan öğretmenlerin yapay zekâ okuryazarlığı ve yapay zekâya yönelik tutumlarının ne düzeyde olduğunu belirlemeyi ve sonuçları bazı değişkenlere gore incelemeyi amaçlamıştır. Araştırma, kolayda örnekleme yöntemiyle seçilen 107 bilim ve sanat merkezi (BİLSEM) öğretmeninin katılımıyla gerçekleştirilmiştir. Veriler, Yapay Zekâ Okuryazarlığı Ölçeği ve Yapay Zekâya Yönelik Genel Tutum Ölçeği kullanılarak toplanmıştır. Bulgular, öğretmenlerin genel olarak yapay zekâ okuryazarlığı ve yapay zekâya yönelik tutumlarının yüksek olduğunu göstermektedir. Cinsiyet karşılaştırmalarında, erkek öğretmenlerin yapay zekâ okuryazarlığı ve tutumlarının kadın öğretmenlerden daha yüksek olduğu tespit edilmiştir. Yaş, mesleki deneyim, BİLSEM'de çalışma süresi, eğitim seviyesi ve branş gibi diğer değişkenlerin yapay zekâ okuryazarlığı ve tutum üzerinde anlamlı bir etkisi bulunmamıştır. Sonuç olarak, özel yetenekli öğrencilerle çalışan öğretmenlerin yapay zekâya ilişkin bilgi ve tutumlarının genel olarak olumlu olduğu, ancak cinsiyet farklılıklarının bulunduğu görülmüştür. Bu nedenle, öğretmenlerin yapay zekâ eğitimi ve profesyonel gelişim fırsatlarına erişimlerinin artırılması, özellikle kadın öğretmenlerin teknolojiye yönelik bilgi ve tutumlarının geliştirilmesi önerilmektedir.

Anahtar Kelimeler: Yapay zeka, Yapay zeka okuryazarlığı, Yapay zekaya yönelik tutum, Özel yeteneklilerle çalışan öğretmenler, BİLSEM

Date of Submission	17.09.2024
Date of Acceptance	29.11.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	---
Author(s) Contribution	Author1: Conceptualization, Data Collection, Methodology, Data Analysis, Writing- Original draft preparation. Author2: Literature Review, Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The authors has no conflict of interest to declare.
Complaints	Itall.journal@gmail.com
Grant Support	---
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Artificial intelligence, as a rapidly developing technology, has started to gain an important place in education systems. Teachers need to have artificial intelligence literacy in order to adapt to this technology and use it effectively in the classroom environment. This is critical to ensure that teachers both understand the technology and transfer it to their students accurately and effectively.

AI literacy refers to the capability of individuals to comprehend the functioning of artificial intelligence technologies, their various applications, and the impact these technologies have (Long & Magerko, 2020). Artificial intelligence literacy involves understanding not just the technical aspects of AI, but also its social, ethical and educational dimensions (Tuomi, 2018). Teachers' having AI literacy in this context provides an important advantage in teaching students the potential and limitations of this technology.

Artificial intelligence in education holds the promise of enhancing student performance, offering personalized learning opportunities, and improving the efficiency of teaching methods (Holmes et al., 2019). However, the realisation of this potential depends on teachers' mastery of artificial intelligence technologies. AI literacy for teachers teaches them how to integrate these technologies correctly and at the same time helps them to develop students' digital literacy (Lynch, 2020). Another important aspect of teachers' AI literacy is its contribution to developing critical thinking skills. By grasping the role of AI in decision-making, educators can help students understand the functioning of these systems and prompt them to critically evaluate AI (Crompton, Burke, & Gregory, 2020).

In order to improve teachers' AI literacy, continuous professional development programmes and certification programmes that provide AI training should be established (Xu & Zhang, 2020). These programs help educators gain a deeper understanding of AI's role in education and provide them with guidance on how to effectively integrate these technologies into their teaching practices.

Moreover, integrating content related to artificial intelligence into education programmes enables pre-service teachers to get to know artificial intelligence at an early stage and gain the necessary skills in this regard. Such training encourages teachers to have a more positive view of technology and develop innovative teaching strategies (Luckin, 2017).

Artificial intelligence is becoming more prevalent in the education sector, and the perspectives of teachers regarding this technology are crucial. Their attitudes significantly influence the adoption and effectiveness of AI in educational settings. AI is viewed as a tool that could enhance student performance, offer customized learning experiences, and reduce teachers' workloads (Holmes, Bialik, & Fadel, 2019). However, in order to integrate this technology effectively, teachers' attitudes towards AI should be positive and supportive.

Artificial intelligence is used in different fields in education and offers various advantages. Learning analytics, adaptive learning systems, automated assessment tools and virtual classroom assistants are the main examples of artificial intelligence applications (Zawacki-Richter et al., 2019). These applications enable personalized learning experiences tailored to each student's needs while also easing teachers' workloads. To fully leverage the potential of artificial intelligence, it is essential for teachers to have a high level of trust and acceptance of these technologies.

Teachers' attitudes towards AI are often shaped by several key factors: trust in the technology, perceived usefulness, perception of occupational threat, and sense of competence in using the technology (Teo, 2011). Teachers' positive attitudes towards these technologies may encourage the wider and effective use of AI in education, while negative attitudes may complicate the integration processes.

Teachers' trust in AI depends on their beliefs about the extent to which this technology will benefit the educational process. If teachers believe that AI will provide significant added value in education, they will adopt this technology more willingly (Scherer et al., 2019). Moreover, offering training and professional development is crucial for boosting teachers' confidence in these technologies.

The growing presence of artificial intelligence in education could potentially lead some teachers to perceive it as a threat to their profession. In particular, teachers' concerns that their jobs are threatened by AI may cause them to develop negative attitudes towards these technologies (Van der Spoel et al., 2020). In order to prevent this situation, it is necessary to establish a clear understanding that AI will be used to support teachers' work rather than replace them. Simultaneously, it is essential to enhance teachers' confidence in their ability to effectively utilize this technology by ensuring they have the requisite knowledge and skills.

Based on existing research and literature, it is evident that teachers' literacy in artificial intelligence and their attitudes toward it are of utmost importance. This study aims to assess the level of AI literacy and attitudes among teachers. Additionally, it investigates whether these factors vary based on gender, age, years of experience in the profession, tenure at BİLSEM, educational background, and teaching subjects. To address these objectives, the study seeks to answer the following question:

1) What is the level of AI literacy and attitudes toward AI among teachers who work with gifted students?
2) Is there a significant difference in the artificial intelligence literacy and attitude towards artificial intelligence scores of teachers working with gifted students according to their gender?
3) Is there a significant difference in the scores of artificial intelligence literacy and attitude towards artificial intelligence of teachers working with gifted students according to their ages?
4) Is there a significant difference in the artificial intelligence literacy and attitude towards artificial intelligence scores of teachers working with gifted students according to their working time in the profession?
5) Is there a significant difference in artificial intelligence literacy and attitude towards artificial intelligence scores of teachers working with gifted students according to their working time in BİLSEM?
6) Is there a notable variation in the artificial intelligence literacy scores and attitudes towards AI among teachers working with gifted students based on their educational level?
7) Is there a significant difference in artificial intelligence literacy and attitude towards artificial intelligence scores of teachers working with gifted students according to their branches?

2. Method

This research was designed with the survey model, one of the quantitative research types. In survey models, the aims are usually expressed with question sentences. These are; "What was it? What is it? What is it related to?" questions. While answering these questions, it is not so powerful in finding the real answers to the question "Why?" (Büyüköztürk, 2016). In survey research, information is usually collected from a large population by using answer options determined by the researcher. Generally, in survey research, researchers are interested in how opinions and characteristics are distributed in terms of individuals in the sample rather than why they originate (Fraenkel & Wallen, 2006).

2.1. Sample

The focus of this study is teachers working in science and art centres. In the process of sample selection for the research, convenience sampling method was used. Convenience sampling is a method that allows the researcher to create a sample that is easily accessible from the available resources and includes a sufficient number of participants (Singleton et al., 2005, pp. 155-160). This approach provides the opportunity to collect samples quickly and economically based on the subjective evaluations of the researcher (Aaker et al., 2007, p. 394; Malhotra, 2004, p. 321; Zikmund, 1997, p. 428; as cited in Haşıloğlu et al., 2015, p. 20). In convenience sampling, it is also possible to have a prior acquaintance or relationship between the researcher and the participants, which eliminates the randomness of the sample (Baştürk & Taştepe, 2013, p. 145).

The study group consisted of 107 teachers working in BİLSEMs across Turkey in the 2023-2024 academic year. According to the demographic information of the BİLSEM teachers participating in the study, 41% of the teachers were male and 59% were female.

2.2. Data Collection and Analysis

In order to collect data in line with the sub-problems of the study, the "Artificial Intelligence Literacy Scale (AILS)" adapted by Polatgil and Güler (2023) and the "General Attitude Towards Artificial Intelligence Scale" adapted by Kaya *et al*. (2022) were used. The relevant scales were delivered to the teachers via digital form on the BİLSEM coordinators and BİLSEM directors sharing platform established by the Ministry of National Education and data were collected.

Quantitative data analysis methods were employed to address the research sub-problems. To assess teachers' levels of artificial intelligence literacy and their attitudes towards AI, the arithmetic mean from descriptive statistics was utilized. For comparison analyses, the 'Independent Samples t-Test' and 'One-Way ANOVA' were applied, as the data were found to be normally distributed.

3. Result

This section examines the level of attitudes among teachers working with gifted students towards both artificial intelligence literacy and AI itself. It also investigates whether there are significant differences in attitude levels based on factors such as gender, age, years of experience, time spent at BİLSEM, educational background, and teaching subjects, with the results displayed in tables.

In the initial phase of the study, Table 1 presents the findings from the artificial intelligence literacy scale for teachers working with gifted students.

Table 1.

Results of Teachers' Artificial Intelligence Literacy Scale

	N	Mean	Std, Deviation
M1	107	4,63	0,622
M2	107	3,56	1,312
M3	107	3,79	0,798
M4	107	3,73	0,937
M5	107	4,05	0,873
M6	107	4,32	0,722
M7	107	4,03	0,770
M8	107	3,96	0,764
M9	107	4,02	0,789
M10	107	4,42	0,659
M11	107	4,41	1,000
M12	107	4,05	1,119
Total	107	4,08	0,46608

As seen in Table 1, the participants' mean agreement with the items ranged between 3,56 and 4,63. The item with the highest level of agreement (X=4,63) is item 1 (M1: I can distinguish between smart devices and non-smart devices). The least agreed (X=3,56) with item 2 (M2: I do not know how artificial intelligence technology can help me). According to the artificial intelligence literacy scale data of the teachers working with gifted students, their total

arithmetic mean was calculated as X=4,08. This finding indicates that the participants' artificial intelligence literacy levels are notably high.

Table 2 displays the results concerning the overall attitudes of teachers working with gifted students towards artificial intelligence.

Table 2.

Results of Teachers' General Attitude Scale towards Artificial Intelligence

	N	Mean	Std, Deviation
M1	107	4,55	0,662
M2	107	4,64	0,554
M3	107	4,65	0,600
M4	107	4,59	0,700
M5	107	4,63	0,771
M6	107	3,82	1,062
M7	107	4,56	0,675
M8	107	4,07	0,918
M9	107	3,86	0,995
M10	107	3,71	1,028
M11	107	4,21	0,877
M12	107	3,66	1,055
M13	107	3,14	1,136
M14	107	3,04	0,931
M15	107	4,07	0,924
M16	107	3,35	1,158
M17	107	4,08	0,992
M18	107	3,62	1,043
M19	107	3,42	0,912
M20	107	3,85	1,062
Total	107	3,55	0,54984

Table 2 shows that the participants' average scores for general attitudes towards artificial intelligence range from 3,04 to 4,65. The one they agree with the most (X=4,65) is item 3 (M3: Artificial intelligence is exciting). The least agreement (X=3,04) is item 14 (M14: Organisations use artificial intelligence in an unethical way). The total arithmetic mean of the general attitudes of teachers working with gifted students towards artificial intelligence was calculated as X=3,55. This result indicates that the participants had a high level of general attitudes towards artificial intelligence.

In the second stage, normality test was performed to determine whether the data of the artificial intelligence literacy and general attitude towards artificial intelligence scales of

teachers working with gifted students for comparison analyses showed normal distribution. The results are presented in Table 3.

Table 3.

Normality Test Results of Artificial Intelligence Literacy and General Attitude Towards Artificial Intelligence Scales

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Artificial intelligence Literacy	0,072	107	0,200	0,982	107	0,159
General Attitude towards artificial intelligence	0,060	107	0,200	0,980	107	0,103

According to the Shapiro-Wilk test, since the significance level of artificial intelligence literacy and general attitude towards artificial intelligence scale of teachers working with gifted students was greater than 0.05, it was shown to have a normal distribution.

Skewness and kurtosis coefficients were checked for the normal distribution assumption and the results are presented in Table 4.

Table 4.

Examination of Normality Assumption for the Scales

Artificial Intelligence Literacy		General Attitude towards Artificial Intelligence	
Skewness	kurtosis	Skewness	kurtosis
-0,126	-0,533	-0,369	0,058

Table 4 shows that the skewness value for the artificial intelligence literacy scale is -0,126, and the kurtosis value is -0,533. For the general attitude towards artificial intelligence scale, the skewness is -0,369 and the kurtosis is 0,058. Since the skewness and kurtosis values fall within the range of -1 to +1, the data are considered to be normally distributed (Tabachnick & Fidell, 2015).

Given that the data exhibit a normal distribution, an independent samples t-test was conducted to examine whether there were significant differences between male and female participants on the artificial intelligence literacy and general attitude towards artificial intelligence scales. The independent samples t-test assesses whether the means of two groups differ significantly (Smith & Brown, 2020). Levene's Test was used to verify the equality of variances between the groups. The results of the independent samples t-test concerning the

significance of differences in scores on the artificial intelligence literacy and general attitude towards artificial intelligence scales by gender are presented in Table 5.

Table 5.

Independent Sample t-Test Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Artificial Intelligence Literacy Scale	Male	44	4,1894	0,50908	0,07675
	Woman	63	4,0040	0,42106	0,05305
General Attitude Scale towards Artificial Intelligence	Male	44	4,0943	0,63275	0,09539
	Woman	63	3,8937	0,47157	0,05941

When Table 5 is analysed, the mean score of male participants in the artificial intelligence literacy scale was found as 4,1894, standard deviation 0,50908 and standard error 0,07675; the mean score of female participants was found as 4,0040, standard deviation 0,42106 and standard error 0,05305. In the general attitude towards artificial intelligence scale, the mean score of male participants was 4,0943, standard deviation 0,63275 and standard error 0,09539; the mean score of female participants was 3,8937, standard deviation 0,47157 and standard error 0,05941.

Independent sample t test results regarding the significance between the scores of artificial intelligence literacy and general attitude towards artificial intelligence scales according to gender are given in Table 6.

Table 6.

Independent Sample t-Test Results

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Artificial Intelligence Literacy Scale	3,238	0,075	2,056	105	0,021	0,18543
General Attitude Scale towards Artificial Intelligence	4,751	0,032	1,786	75,004	0.039	0.20067

In the artificial intelligence literacy scale, Levene's Test result (F = 3,238, Sig. = 0,075) shows that the variances are equal. t-test result (t = 2,056, df = 105, Sig. = 0,021) shows that there is a significant difference between men and women. In the general attitude towards artificial intelligence scale, Levene's Test result (F = 4,751, Sig. = 0,032) shows that the variances are not equal. Therefore, the "Equal variances not assumed" line was checked. t-test result (t = 1,786, df = 75,004, Sig. = 0,039) shows that there is a significant difference between men and women.

According to these results, it is concluded that men's artificial intelligence literacy and general attitudes towards artificial intelligence are higher than women.

One-way anova analysis for unrelated samples was performed to examine the differences between the values of artificial intelligence literacy and general attitude towards artificial intelligence scales in three different groups of different age groups (31-40 years old, 41-50 years old, 51 years old and above) of teachers working with gifted students. In Table 7 below, descriptive statistical results of artificial intelligence literacy and general attitude towards artificial intelligence scales for each age group are given.

Table 7.

Descriptive Statistics Results of One-Way Anova Analysis for Unrelated Samples According to Different Age Groups

	Groups	N	Mean	Std. Deviation	95% CI for Mean Lower Bound	95% CI for Mean Upper Bound
Artificial Intelligence Literacy Scale	31-40	34	4,0588	0,47785	3,8921	4,2256
	41-50	60	4,1097	0,44587	3,9945	4,2249
	51 and above	13	4,0000	0,54857	3,6685	4,3315
General Attitude Scale towards Artificial Intelligence	31-40	34	3,8500	0,49175	3,6784	4,0216
	41-50	60	4,0508	0,55453	3,9076	4,1941
	51 and above	13	3,9615	0,64844	3,5697	4,3534

Levene's Test statistics and significance values are given in Table 8 to check whether the variances between the groups are homogenous.

Table 8.

Levene's Test Statistic Results According to Different Age Groups

	Levene Statistic	df1	df2	Sig.
Artificial Intelligence Literacy Scale	0,312	2	104	0,733
General Attitude Scale towards Artificial Intelligence	0,749	2	104	0,475

When Table 8 is analysed, since the p values are greater than 0,05, the variances are homogeneously distributed. Anova table evaluates whether the mean differences between groups are statistically significant (Öztürk, 2018). Table 9 shows the Anova results of the scales according to different age groups.

Table 9.

Anova Results According to Different Age Groups

		Sum of Squares	df	Mean Square	F	Sig.
Artificial Intelligence Literacy Scale	Between Groups	0,151	2	0,076	0,344	0,710
	In Group	22,875	104	0,220		
	Total	23,027	106			
General Attitude Scale towards Artificial Intelligence	Between Groups	0,879	2	0,439	1,466	0,236
	In Group	31,168	104	0,300		
	Total	32,047	106			

When Table 9 is examined, since p values are greater than 0,05, there is no statistically significant difference between the values of artificial intelligence literacy and general attitude towards artificial intelligence scale according to age groups. This shows that there is no significant difference between the groups.

One-way anova analysis for unrelated samples was performed to examine the differences between the values of artificial intelligence literacy and general attitude towards artificial intelligence scales in four different groups according to the duration of teachers working with gifted students (6-10 years, 11-15 years, 16-20 years, 21 years and above). In Table 10 below, descriptive statistics results of artificial intelligence literacy and general attitude towards artificial intelligence scales for each age group are given.

Table 10.

Descriptive Statistical Results of One-Way Anova Analysis for Unrelated Samples According to Working Hours in the Profession

	Groups	N	Mean	Std. Deviation	95% CI for Mean Lower Bound	95% CI for Mean Upper Bound
Artificial Intelligence Literacy Scale	6-10 Years	5	4,3167	0,45795	3,7480	4,8853
	11-15 Years	27	3,9753	0,48855	3,7820	4,1686
	16-20 Years	25	4,0967	0,42606	3,9208	4,2725
	21 Years and above	50	4,3167	0,47405	3,9703	4,2397
Attitude Scale towards Artificial Intelligence	6-10 Years	5	3,9800	0,60889	3,2240	4,7360
	11-15 Years	27	3,8037	0,53004	3,5940	4,0134
	16-20 Years	25	4,0020	0,42044	3,8285	4,1755
	21 Years and above	50	4,0560	0,60404	3,8843	4,2277

Levene's Test statistics and significance values are given in Table 11 to check whether the variances between the groups are homogenous.

Table 11.

Levene's Test Statistical Results According to Working Period in the Profession

	Levene Statistic	df1	df2	Sig.
Artificial Intelligence Literacy Scale	0,242	3	103	0,867

General Attitude Scale towards Artificial Intelligence	1,631	3	103	0,187	

When Table 11 is analysed, since the p values are greater than 0,05, the variances are homogeneously distributed. Table 12 shows the Anova results of the scales according to the working hours in the profession.

Table 12.

Anova Results According to Working Period in the Profession

		Sum of Squares	df	Mean Square	F	Sig.
Artificial Intelligence Literacy Scale	Between Groups	0,614	3	0,205	0,941	0,424
	In Group	22,413	103	0,218		
	Total	23,027	106			
General Attitude Scale towards Artificial Intelligence	Between Groups	1,138	3	0,379	1,265	0,290
	In Group	30,908	103	0,300		
	Total	32,047	106			

Upon examining Table 12, it can be observed that the p-values exceed 0.05, indicating that there is no statistically significant difference in artificial intelligence literacy and general attitudes towards artificial intelligence based on years of experience in the profession. This suggests that the differences between the groups are not significant.

To further investigate potential differences in artificial intelligence literacy and attitudes towards artificial intelligence among teachers working with gifted students at BİLSEM, a one-way ANOVA was conducted. This analysis compared four distinct groups based on their years of experience (1-5 years, 5-10 years, 10-15 years, and 16 years or more). In Table 13 below, the descriptive statistical results of the artificial intelligence literacy and general attitude towards artificial intelligence scales for the working time in each BİLSEM are given.

Table 13.

Descriptive Statistical Results of One-Way Anova Analysis for Unrelated Samples According to Working Period in BİLSEM

	Groups	N	Mean	Std. Deviation	95% CI for Mean Lower Bound	95% CI for Mean Upper Bound
Artificial Intelligence Literacy Scale	1-5 Years	69	4,0725	0,47805	3,9576	4,1873
	5-10 Years	28	4,1101	0,43982	3,9396	4,2807
	10-15 Years	4	3,7500	0,62731	2,7518	4,7482
	16 Years and above	6	4,2500	0,29814	3,9371	4,5629
General Attitude Scale	1-5 Years	69	3,9870	0,51311	3,8637	4,1102
	5-10 Years	28	3,9464	0,59316	3,7164	4,1764

towards Artificial Intelligence	10-15 Years	4	3,8875	0,79517	2,6222	5,1528
	16 Years and above	6	4,0500	0,72801	3,2860	4,8140

Levene's Test statistics and significance values are given in Table 14 to check whether the variances between the groups are homogenous.

Table 14.

Levene's Test Statistical Results According to Working Period in BİLSEM

	Levene Statistic	df1	df2	Sig.
Artificial Intelligence Literacy Scale	1,494	3	103	0,221
General Attitude Scale towards Artificial Intelligence	1,014	3	103	0,390

When Table 14 is analysed, since the p values are greater than 0,05, the variances are homogeneously distributed. Table 15 shows the Anova results of the scales according to the working hours in BİLSEM.

Table 15.

Anova Results According to Working Period in BİLSEM

		Sum of Squares	df	Mean Square	F	Sig.
Artificial Intelligence Literacy Scale	Between Groups	0,638	3	0,213	0,979	0,406
	In Group	22,388	103	0,217		
	Total	23,027	106			
General Attitude Scale towards Artificial Intelligence	Between Groups	0,097	3	0,032	0,104	0,957
	In Group	31,950	103	0,310		
	Total	32,047	106			

Table 15 reveals that the p-values are above 0,05, indicating no statistically significant differences in artificial intelligence literacy and general attitudes towards artificial intelligence based on the number of years worked at BİLSEM. This implies that there are no significant differences between the groups.

One-way anova analysis for unrelated samples was performed to examine the differences between the values of artificial intelligence literacy and general attitude towards artificial intelligence scales in three different groups according to the education levels (Bachelor's, Master's and Doctorate) of teachers working with gifted students. In Table 16 below, descriptive statistics results of artificial intelligence literacy and general attitude towards artificial intelligence scales for each education level are given.

Table 16.

Anova Results According to Working Period in BİLSEM

	Groups	N	Mean	Std. Deviation	95% CI for Mean Lower Bound	95% CI for Mean Upper Bound
Artificial Intelligence Literacy Scale	Licence	32	4,1641	0,46349	3,9970	4,3312
	Master's Degree	57	4,0512	0,49068	3,9210	4,1814
	PhD	18	4,0231	0,38752	3,8304	4,2159
General Attitude Scale towards Artificial Intelligence	Licence	32	4,0375	0,58833	3,8254	4,2496
	Master's Degree	57	3,9377	0,57533	3,7851	4,0904
	PhD	18	3,9889	0,38902	3,7954	4,1823

Levene's Test statistics and significance values are given in Table 17 to check whether the variances between the groups are homogenous.

Table 17.

Levene's Test Statistical Results According to Educational Background

	Levene Statistic	df1	df2	Sig.
Artificial Intelligence Literacy Scale	1,182	2	104	0,311
General Attitude Scale towards Artificial Intelligence	1,134	2	104	0,326

Analysis of Table 17 indicates that the p-values exceed 0,05, suggesting that the variances are homogeneously distributed. Table 18 presents the ANOVA results for the scales based on educational background.

Table 18.

Anova Results According to Educational Background

		Sum of Squares	df	Mean Square	F	Sig.
Artificial Intelligence Literacy Scale	Between Groups	0,332	2	0,166	0,760	0,470
	In Group	22,695	104	0,218		
	Total	23,027	106			
General Attitude Scale towards Artificial Intelligence	Between Groups	0,208	2	0,104	0,339	0,713
	In Group	31,839	104	0,306		
	Total	32,047	106			

When Table 18 is analysed, since the p values are greater than 0,05, there is no statistically significant difference between the values of artificial intelligence literacy and general attitude towards artificial intelligence scale according to educational status. This shows that there is no significant difference between the groups.

One-way anova analysis for unrelated samples was performed to examine the differences between the values of artificial intelligence literacy and general attitude towards artificial intelligence scales in nineteen different groups according to the branches of teachers working with gifted students (Physics, Chemistry, Biology, Science, Primary Mathematics, High School Mathematics, Philosophy, Geography, History, Turkish, Literature, Music, Visual Arts, Foreign Language, Social Sciences, Information Technologies, Technology and Design, Classroom Teaching, Psychological Counselling and Guidance). In Table 19 below, descriptive statistics results of artificial intelligence literacy and general attitude towards artificial intelligence scales for each branch are given.

Table 19.

Descriptive Statistics Results of One-Way Anova Analysis for Unrelated Samples According to Branches

	Groups	N	Mean	Std, Deviation	95% CI for Mean Lower Bound	95% CI for Mean Upper Bound
Artificial Intelligence Literacy Scale	Physics	6	4,4444	0,32347	4,1050	4,7839
	Chemistry	3	3,4167	0,36324	2,5143	4,3190
	Biology	6	3,9583	0,44954	3,4866	4,4301
	Science	7	4,4643	0,43795	4,0593	4,8693
	Primary Mathematics	8	3,8021	0,49988	3,3842	4,2200
	High School Maths	7	4,0833	0,37577	3,7358	4,4309
	Philosophy	3	4,0833	0,22048	3,5356	4,6310
	Geography	3	4,3056	0,37577	3,3721	5,2390
	History	7	4,0952	0,65692	3,4877	4,7028
	Turkish	9	4,0833	0,49652	3,7017	4,4650
	Literature	4	3,9792	0,45833	3,2499	4,7085
	Music	3	4,1389	0,19245	3,6608	4,6170
	Visual Arts	7	4,0000	0,68211	3,3692	4,6308
	Foreign Language	3	3,7222	0,29266	2,9952	4,4492
	Social Sciences	4	4,1667	0,44618	3,4567	4,8766
	Information Technology	3	3,7500	0,71200	1,9813	5,5187
	Technology and Design	8	4,1667	0,30861	3,9087	4,4247
	Classroom Teaching	7	4,2619	0,38917	3,9020	4,6218
	PDR	9	4,0556	0,26021	3,8555	4,2556
General Attitude Scale towards Artificial Intelligence	Physics	6	4,4917	0,21311	4,2680	4,7153
	Chemistry	3	3,3667	0,70946	1,6043	5,1291
	Biology	6	3,9667	0,42032	3,5256	4,4078
	Science and Technology	7	4,2000	0,42230	3,8094	4,5906
	Primary Mathematics	8	3,8313	0,60589	3,3247	4,3378
	High School Maths	7	3,5643	0,51778	3,0854	4,0432
	Philosophy	3	4,0500	0,88459	1,8526	6,2474
	Geography	3	4,5000	0,45000	3,3821	5,6179
	History	7	4,0929	0,45955	3,6678	4,5179
	Turkish	9	3,8278	0,45833	3,4755	4,1801
	Literature	4	4,3125	0,54218	3,4498	5,1752

Music	3	4,2000	0,69462	2,4745	5,9255
Visual Arts	7	3,6857	0,65174	3,0830	4,2885
Foreign Language	3	3,7833	0,75719	1,9024	5,6643
Social Sciences	4	3,8125	0,41908	3,1457	4,4793
Information Technology	3	3,6167	1,08666	0,9172	6,3161
Technology and Design	8	4,1563	0,36296	3,8528	4,4597
Classroom Teaching	7	4,0143	0,38157	3,6614	4,3672
PDR	9	4,0444	0,48441	3,6721	4,4168

Levene's Test statistics and significance values are given in Table 20 to check whether the variances between the groups are homogenous.

Table 20.

Levene's Test Statistic Results According to Branches

	Levene Statistic	df1	df2	Sig.
Artificial Intelligence Literacy Scale	1,697	18	88	0,055
General Attitude Scale towards Artificial Intelligence	1,137	18	88	0,332

Table 20 shows that the p-values are greater than 0,05, indicating that the variances are uniformly distributed. Table 21 presents the ANOVA results for the scales based on different teaching subjects.

Table 21.

Anova Results According to Branches

		Sum of Squares	df	Mean Square	F	Sig.
Artificial Intelligence Literacy Scale	Between Groups	5,146	18	0,286	1,407	0,149
	In Group	17,881	88	0,203		
	Total	23,027	106			
General Attitude Scale towards Artificial Intelligence	Between Groups	7,660	18	0,426	1,536	0,097
	In Group	24,387	88	0,277		
	Total	32,047	106			

When Table 21 is examined, since the p values are greater than 0.05, there is no statistically significant difference between the values of artificial intelligence literacy and general attitude towards artificial intelligence scale according to the branches. This shows that there is no significant difference between the groups.

4. Discussion and Conclusion

In this study, the general levels of artificial intelligence literacy and total scores towards artificial intelligence of teachers working with gifted students were revealed. In addition, it was evaluated in terms of variables such as gender, age, working time in the profession, working time in BİLSEM, education level and branch. The results revealed that these variables did not have significant effects on teachers' knowledge levels and attitudes towards artificial intelligence except for the gender variable.

In the analyses, it was observed that the scores of teachers working with gifted students on AI literacy and attitudes towards AI were positively high. Similar studies have also examined teachers' attitudes towards AI-based educational tools. According to the results, most of the teachers stated that AI tools can be useful in classroom applications. However, some teachers expressed concerns that AI could reduce the role of teachers or that over-dependence on these technologies could harm pedagogical approaches (Zawacki-Richter et al., 2019).

In the study conducted by Johnson et al. (2017), the advantages of artificial intelligence tools for teachers in classroom management were examined in detail. The study revealed that teachers improved classroom management processes such as lesson planning and student engagement by using artificial intelligence technologies.

The study by Seyrek et al. (2024) indicates that teachers generally have a positive outlook on incorporating artificial intelligence into their lessons. The findings suggest that teachers recognize the potential benefits of AI in education and believe that this technology has the capability to enhance students' learning experiences. It is seen that teachers have an opinion that AI-supported tools can make significant contributions in areas such as preparing course materials, evaluating student performance and providing individualised feedback.

In the analyses, it was found that male teachers were more knowledgeable about artificial intelligence than female teachers and had a more positive approach to these technologies. This result shows that men tend to show more interest in technology and adopt new technologies faster. Different studies similar to this one show that men develop more positive attitudes towards the use of artificial intelligence and technology and have higher self-confidence. However, it should be taken into consideration that these differences may vary depending on variables such as education, cultural factors and level of exposure to

technology. Several studies suggest that men have higher self-confidence in the use of technology and therefore their attitudes towards advanced technologies such as artificial intelligence may be more positive. For example, studies on STEM (science, technology, engineering and maths) fields in education reveal that males have more interest and motivation in these fields (Stoet, & Geary, 2018). Gender differences play an important role in self-confidence and attitudes towards technology. Men exhibit higher self-confidence because they are generally more exposed to technology. This may also manifest itself in attitudes towards new technologies such as artificial intelligence (Cassell, 2002).

In the age-based evaluations, there is no significant difference in the age factor in both scales. However, it was observed that younger teachers had higher AI literacy levels, but older teachers had a more positive attitude towards AI. It is thought that younger teachers' better knowledge of technology makes them have a higher level of knowledge, while the positive attitudes of more experienced teachers stem from their professional experience.

Although there was no direct relationship between the time spent in the profession and artificial intelligence literacy, it was revealed that teachers with longer professional experience had a more positive attitude towards artificial intelligence. This situation suggests that experienced teachers are more open to innovations.

Although there was no direct relationship between the time spent in BİLSEM and artificial intelligence literacy, it was observed that the artificial intelligence literacy and attitudes of teachers who worked longer were more positive. This finding indicates that experiences in BİLSEM enable teachers to use artificial intelligence technologies more effectively.

In the evaluations made depending on the level of education, there is no significant difference in the education level factor in both scales. However, it is seen that bachelor's degree graduates draw a slightly more positive picture about artificial intelligence.

In the evaluations made depending on the branches, there is no significant difference in the branches factor in both scales. However, it was determined that teachers working in science and technology approached artificial intelligence more positively than their colleagues in other branches. This can be explained by the fact that these branches are more prone to technology by nature. It is emphasised that the technological competencies of teachers in other branches should be increased.

The findings of the study show that teachers' AI literacy and attitudes are not significantly affected by factors other than gender. It has been observed that gender has a significant effect on technological knowledge and attitudes, and male teachers are more open and predisposed to technology. This situation reveals that female teachers should be supported more in accessing and using technology. Although young teachers have a higher level of knowledge, experienced teachers have more positive attitudes. These findings draw attention to the importance of professional development programmes for teachers to use artificial intelligence technologies more effectively. It shows that the additional courses and experiences that teachers receive during in-service training processes contribute to their being more open to technological innovations.

Artificial intelligence has a great potential in the field of education. However, in order to realise this potential, teachers need to have artificial intelligence literacy. This literacy allows teachers to both improve their own pedagogical approaches and provide a more qualified education to their students. Therefore, it is of great importance to develop programmes and strategies that focus on teachers' AI literacy.

Teachers' attitudes towards artificial intelligence is a factor that directly affects the success of this technology in education. While positive attitudes facilitate the adoption and effective use of artificial intelligence by teachers, negative attitudes can create significant obstacles in integration processes. Therefore, providing the necessary training and support programmes for teachers to develop a positive attitude towards artificial intelligence is of great importance for the full realisation of the potential of artificial intelligence in education.

5. References

Aaker, D. A., Kumar, V., & Day, G. S. (2007). Marketing research (9. Edition). John Wiley & Sons.

Başṭuṙk, S., & Taşṭepe, M. (2013). Evren ve oṙneklem. In S. Başṭuṙk (Ed.), Bilimsel araşṭırma yoṅntemleri (ss. 129–159). Vize Yayıncılık.

Cassell, J. (2002). Genderizing HCI. In The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications (pp. 401-412).

Crompton, H., Burke, D., & Gregory, K. H. (2020). Artificial intelligence in education: Promises and implications for teaching and learning. Educational Technology, 60(1), 31-41.

Hasılogʻlu, S., Baran, T., & Aydın, O. (2015). Pazarlama araştırmalarındaki potansiyel problemlere yönelik bir araştırma: Kolayda örnekleme ve sıklık ifadeli ölçek maddeleri. Pamukkale İşletme ve Bilişim Yönetimi Dergisi, 1, 19–28.

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Center for Curriculum Redesign.

Johnson, L., Smith, R., Willis, H., Levine, A., & Haywood, K. (2017). The 2017 Horizon Report. EDUCAUSE Learning Initiative.

Kaya, F., Aydin, F., Schepman, A., Rodway, P., Yetişensoy, O., & Demir Kaya, M. (2022). The roles of personality traits, AI anxiety, and demographic factors in attitudes towards artificial intelligence. International Journal of Human–Computer Interaction. https://doi.org/10.1080/10447318.2022.2151730

Long, D., & Magerko, B. (2020). What is AI literacy? Competencies and design considerations. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1-16.

Luckin, R. (2017). Towards artificial intelligence-based assessment systems. Nature Human Behaviour, 1(3), 1-3.

Lynch, M. (2020). How Artificial Intelligence Will Impact Education. The Tech Edvocate. Erişim adresi: https://www.thetechedvocate.org

Malhotra, N. K. (2004). Marketing research an applied orientation (4 Edition). Pearson Prentice Hall.

Öztürk, B. (2018). İstatistiksel analiz yöntemleri: ANOVA ve uygulamaları. Bilimsel Yayınevi.

Polatgil, M., Güler, A. (2023). Yapay Zekâ Okuryazarlığı Ölçeğinin Türkçe'ye Uyarlanması. Sosyal Bilimlerde Nicel Araştırmalar Dergisi, 3(2), 99-114.

Schepman, A. & Rodway, P. (2020). Initial validation of the general attitudes towards Artificial Intelligence Scale. Computers in Human Behavior Reports (1), 100014. https://doi.org/10.1016/j.chbr.2020.100014

Schepman, A. & Rodway, P. (2022). The General Attitudes towards Artificial Intelligence Scale (GAAIS): Confirmatory Validation and Associations with Personality, Corporate Distrust, and General Trust. International Journal of Human–Computer Interaction https://doi.org/10.1080/10447318.2022.2085400

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. Computers & Education, 128, 13-35.

Seyrek, M., Yıldız , S., Emeksiz , H., Şahin , A., & Türkmen , M. T. (2024). Öğretmenlerin Eğitimde Yapay Zeka Kullanımına Yönelik Algıları. International Journal of Social and Humanities Sciences Research (JSHSR), 11(106), 845–856. https://doi.org/10.5281/zenodo.11113077.

Singleton, R. A., & Straits, B. C. (2005). Approaches to social research (4th ed). Oxford University Press.

Smith, J., & Brown, L. (2020). Statistical Methods for Data Analysis. Academic Press.

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in STEM education. Psychological Science, 29(4), 581-593. DOI: 10.1177/0956797617741719

Tabachnick, B. G., & Fidell, L. S. (2015). Using multivariate statistics. (sixthed). Allyn & Bacon/Pearson Education. 6. Basimdan (Çeviri: Mustafa Baloglu, Nobel Akademik Yayincilik, Ankara.

Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. Computers & Education, 57(4), 2432-2440.

Tuomi, I. (2018). The Impact of Artificial Intelligence on Learning, Teaching, and Education: Policies for the Future. European Commission, Joint Research Centre (JRC).

Van der Spoel, I., Noroozi, O., Schuurink, E., & van Ginkel, S. (2020). Teachers' online teaching expectations and experiences during the Covid19-pandemic in the Netherlands. European Journal of Teacher Education, 43(4), 623-638.

Xu, W., & Zhang, Y. (2020). Teacher professional development in the era of AI: Opportunities and challenges. Journal of Educational Technology Development and Exchange, 13(1), 33-49.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators? International Journal of Educational Technology in Higher Education, 16(1), 1-27.

Zikmund, W. G. (1997). Business research methods (5 Edition). The Dryden Press.

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 300-325 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Examination of Action Research Articles in the Field of Mathematics Education in Türkiye

Ülkü Özturan Ecemiş [1], Zeynep Filiz Aramış [2], Semiha Kula Ünver [3]

** *Corresponding Author, semiha.kula@deu.edu.tr*

[1] *Ministry of National Education, Türkiye*

[2] *Ministry of National Education, Türkiye*

[3] *Dokuz Eylül University Buca Education Faculty, Türkiye*

Abstract

This study aims to analyze articles containing action research in the field of mathematics education in Türkiye and present them from a holistic perspective. For this purpose, action research articles published between 2007 and 2022 were reviewed in ERIC, Google Scholar, and ULAKBİM databases. Fifty-seven articles were reached due to the review and constitute the research sample. Document review, one of the qualitative research methods, was used. Articles are classified according to the year of publication, publication language, research model, subject, action research type, whether the cycle is specified or not, application period, researcher role, learning areas, study group and size, sampling method, data collection tools, validity and reliability, and data analysis methods. As a result of the research, it was seen that the qualitative research model was mainly used. The studies were primarily conducted with undergraduate students. While geometry is the most preferred learning area, it has mainly been studied in technology-supported learning environments. Interviews and observations were mainly used in data collection, expert evaluation was taken to ensure validity and reliability, and coder agreement was checked. Content analysis, one of the most qualitative techniques, was used to analyze the data obtained. Based on the research results, it is recommended that mixed-pattern action research be conducted and that the number of studies involving students at different education levels and learning areas be increased.

Keywords: Mathematics Education, Action Research, Descriptive Content Analysis.

Citation: Özturan Ecemiş, Ü., Filiz Aramış, Z., & Kula Ünver, S. (2024). Examination of action research articles in the field of mathematics education in Türkiye. *Instructional Technology and Lifelong Learning 5*(1), 300- 325. https://doi.org/10.52911/itall.1544320

Türkiye'de Matematik Eğitimi Alanında Yapılan Eylem Araştırması Makalelerinin İncelenmesi

Özet

Bu araştırmada Türkiye'de matematik eğitimi alanında eylem araştırmalarını içeren makaleleri analiz etmek ve bütüncül bir bakış açısı ile sunmak amaçlanmıştır. Bu amaç doğrultusunda 2007-2022 yılları arasında yayınlanan eylem araştırması makaleleri ERIC, Google Akademik ve ULAKBİM veri tabanlarında taranmıştır. Yapılan tarama sonucunda ulaşılan 57 makale araştırmanın örneklemini oluşturmaktadır. Araştırmada nitel araştırma yöntemlerinden biri olan doküman incelemesi kullanılmıştır. Makaleler yayınlandığı yıl, yayın dili, araştırma modeli, konusu, eylem araştırması türü, döngünün belirtilip belirtilmemesi, uygulama süresi, araştırmacı rolü, öğrenme alanları, çalışma grubu ve büyüklüğü, örnekleme yöntemi, veri toplama araçları, geçerlik ve güvenirlik, veri analiz yöntemleri çerçevesinde sınıflandırılmıştır. Araştırma sonucunda en çok nitel araştırma modelinin kullanıldığı görülmüştür. Çalışmalar en fazla lisans öğrencileri ile yürütülmüştür. Geometri en çok tercih edilen öğrenme alanı iken çoğunlukla teknoloji destekli öğrenme ortamları konusunda çalışılmıştır. Verilerin toplanmasında en çok görüşme ve gözlemlerden faydalanılmış, geçerlik ve güvenirliği sağlamak için uzman değerlendirmesi alınmış ve kodlayıcılar arası uyuşuma bakılmıştır. Elde edilen verilerin analizinde en çok nitel analiz tekniklerinden içerik analizi kullanılmıştır. Yapılan araştırmanın sonuçlarından yola çıkarak karma desenli eylem araştırmalarının yapılması, farklı öğretim kademesindeki öğrenciler ile farklı öğrenme alanlarını içeren çalışma sayısının arttırılması önerilmektedir.

Anahtar Kelimeler: Matematik Eğitimi, Eylem Araştırması, Betimsel İçerik Analizi.

Date of Submission	05.11.2024
Date of Acceptance	05.12.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	This study is the developed version of the paper presented at the 2nd International Science, Education, Art & Technology Symposium hosted by Buca Faculty of Education in Izmir on 23-25 September 2022.
Author(s) Contribution	Özturan Ecemiş, Filiz Aramış, and Kula Ünver contributed equally to the article.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The authors has no conflict of interest to declare.
Complaints	italljournal@gmail.com
Grant Support	---
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Kurt Lewin is often referred to as the father of action research because he emphasizes involving real practitioners at all stages of research conducted within the social sciences (McKernan, 1991). However, evidence suggests that some social reformists preceding Lewin also used action research (Lewin, 1946; McKernan, 1991), and Jacob L. Moreno (1892–1974) is the true originator of action research (Altrichter & Gstettner, 1993; Gunz, 1996). Despite these uncertainties in its origins, action research has been accepted in the field of social sciences and has been used as a research model by many researchers.

Action research typically begins with defining a problem, assessing the effectiveness of efforts to solve this problem, and taking action to solve it again, depending on the situation (O'Brien, 2001). Action research, which provides an understanding of a problem that has arisen or will arise during the implementation process, is also defined as a research approach that includes deliberately collecting and analyzing data to solve the problem (Yıldırım & Şimşek, 2013). Thus, it aims to change the practices of practitioners, their understanding of their practices, and the conditions under which they practice (Kemmis, 2009). In this respect, action research, which is a type of research conducted by a person or persons that helps find a solution to the current situation (Beverly, 1993), is also expressed by many other names such as (a) participatory research, (b) collaborative inquiry, (c) emancipatory research, (d) action learning, and (e) contextual action research (O'Brien, 2001).

Studies are ongoing to produce effective solutions to problems encountered in the classroom or school environment. These studies are sometimes conducted on teachers and administrators and sometimes on students. However, these studies need to be more comprehensive, and teachers themselves need to research them (Stenhouse, 1975). These studies to be conducted by teachers should be based on critical and scientific foundations (Carr & Kemmis, 1986). Stephen Corey (1949) was one of the first researchers to use action research in the field of education, considering the need for educators to participate in research and practice (Kemmis, 1980). The reasons for conducting action research in the field of education were addressed by Johnson (1995) in three categories: (a) to promote personal and professional development, (b) to develop practice to improve student learning, and (c) to advance the teaching profession. For this reason, action research will contribute to the school, the teachers who are practitioners, and the

education process in terms of personal, practice, and evaluation (Çalışkan & Serçe, 2018). Since teachers also take on the role of researchers in this process, action research is also expressed in the literature with terms such as teacher research or classroom research (Mertler, 2021).

Action research is typically a cyclical process (Mertler, 2021). In this context, action research can be used for actions or cycles of actions that group members in a specific environment have taken to address a problem in a specific situation (Herr & Anderson, 2015). McNiff and Whitehead (2010) express the steps of a cycle as observing, reflecting, applying, evaluating, organizing, and moving toward new directions. Mertler (2021) states that when a cycle consisting of the planning, implementation, development, and reflection steps ends, the next cycle begins according to the evaluation made.

The method may vary in action research depending on the researcher's choice (Dickens & Watkins, 1999). Accordingly, qualitative and quantitative analysis methods can be used to analyze the data collected during the research process (Hendricks, 2006). When the studies conducted in the field of education in Türkiye are examined, action research is the least used research method (Göktaş et al., 2012; Karatay & Taş, 2021; Selçuk et al., 2014). In addition, the action research method is less preferred in content analysis studies in the field of mathematics education (Dağ & Horzum, 2022; Ertane et al., 2021; Özey, 2019; Şimşek & Yaşar, 2019; Toptaş & Kuşdemir, 2021). In this direction, it is important to attract the interest of mathematics education researchers, especially teacher researchers, in action research and encourage them.

There are content analysis studies examining doctoral dissertations (Turhan Türkkan et al., 2019) and articles (Çalışkan & Serçe, 2018) containing action research in the field of educational sciences in Türkiye. However, no study has been found examining action research articles in mathematics education. For this reason, examining action research articles published in mathematics education can contribute to the source of action research, determining existing deficiencies and needs and shedding light on future studies. In this context, the study aims to examine action research articles conducted in mathematics education in the Turkish sample and present them holistically. In line with this purpose, the following questions were tried to be answered:

How are action research articles in mathematics education distributed according to;

1. the years they were published?
2. the languages they were published in?

3. research designs?
4. the types of research (quantitative, qualitative, mixed)?
5. whether cycles are specified in action research?
6. the main topics they address?
7. the learning areas they focus on?
8. the participants?
9. the size of the participants?
10. the sampling methods used?
11. the duration of the research?
12. the roles of the researchers?
13. the data collection tools?
14. validity and reliability processes?
15. the data analysis methods used?

2. Method

In this study, document analysis, one of the qualitative research methods, was used to examine action research articles in mathematics education. The document analysis method allows the analysis of various documents such as books, newspaper articles, academic journal articles, and institutional reports (Morgan, 2022). In alignment with the research objective, the study focuses on academic articles.

2.1. Determining the Studies to be examined

To determine the study sample, ERIC (Education Resources Information Center), Google Scholar Database, and National Academic Network and Information Center Database were scanned for one month from 01.05.2022 to 01.06.2022. During the scan, the keywords "eylem araştırması," "aksiyon araştırması", "matematik eğitimi" (in Turkish), "action research", and "mathematics education" were scanned throughout the text. The articles included in the study were determined through criterion sampling, one of the purposive sampling methods. The following criteria were taken into consideration in determining the studies to be included in the study:

- the sample being in Türkiye,
- being an article published in a scientific journal,
- being conducted in the field of mathematics education and
- including action research as a method

In the context of the criteria, articles between 2007 and 2022 were reviewed using keywords. As a result of the scan, 57 articles determined to meet the criteria (see Appendix 1) were examined within the scope of the study.

2.2. Data Collection Process

The document analysis method was used in the data collection process. Document analysis is the process of collecting and reviewing written materials containing information on the topic under investigation, such as official notes, minutes, records, and archival documents. This type of analysis is carried out in five stages: (i) accessing the documents, (ii) checking their originality, (iii) understanding the documents, (iv) analyzing the data, and (v) using the data (Yıldırım & Şimşek, 2016). The research began by reviewing action research articles published in mathematics education between 2007 and 2022. The information on the 57 articles reached was recorded in the Microsoft Excel program by the items in the Classification Form of Action Research Articles Conducted in the Field of Mathematics Education (see Appendix 2). This form primarily aims to determine the year each article was published, the language of publication, its subject, and the learning field it is related to. In addition to these, the method of the study, which action research types were preferred, whether the action research cycle was specified, the size of the study group, the participants, and the sampling method were also examined. In addition, the classification form included data collection tools, the application process, data analysis techniques, validity and reliability, and the role of the researcher. Thus, the data were made ready for the analysis process.

2.3. Data Analysis

The study data were analyzed using descriptive content analysis. The descriptive content analysis method means the in-depth examination and organization of qualitative and quantitative studies conducted independently on a specific subject or field (Ültay et al., 2021). The steps given in Figure 1 were followed in the analysis of the data (Yıldırım & Şimşek, 2016).

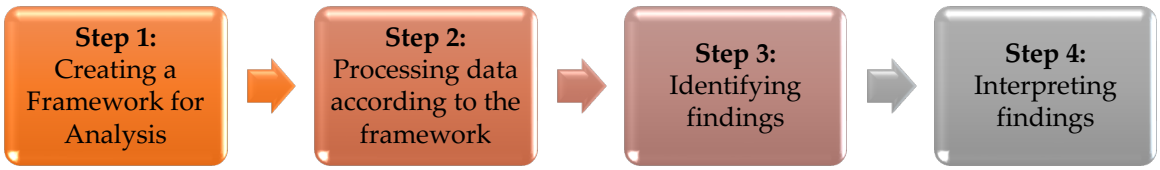


Figure 1. Descriptive Content Analysis Implementation Steps

During the analysis process, the studies included in the research were coded separately by two different coders, and then the codes were compared. The inconsistent parts were discussed, and a common opinion was reached, thus supporting the reliability of the research. The themes created as a result of the coding were presented using tables. The findings were presented in tables by calculating frequencies and percentages.

3. Result

Action research articles conducted in the field of mathematics education in Türkiye have been examined within specific categories, and a general framework has been presented in this section. In this context, the distribution of the studies according to the years they were published is given in Table 1.

Table 1.

Distribution of Articles by Year

Year	f	%
2007	1	1,75
2008	1	1,75
2009	1	1,75
2013	2	3,50
2014	2	3,50
2015	4	7,02
2016	8	14,04
2017	5	8,78
2018	7	12,29
2019	9	15,79
2020	8	14,04
2021	6	10,53
2022	3	5,26

When the distribution of articles by year is examined, there are 57 articles related to action research conducted in the field of mathematics education in our country between 2007-2022. While there were no action research articles in mathematics education in 2010, 2011, and 2012, most of them were published in 2019. The distribution of the action research articles in question according to publication language is presented in Table 2.

Table 2.

Distribution of Articles by Publication Language

Publication Language	**f**	**%**
Turkish	54	94,74
English	3	5,26

It is seen that 54 of the action research articles conducted in Türkiye in the field of mathematics education were published in Turkish and 3 in English. The research topics of these articles were also examined, and the resulting categories are presented in Table 3.

Table 3.

Distribution of Articles by Subject

Subject	f	%
Technology-supported learning environments	14	24,58
Mathematical modeling	8	14,04
Teacher training and professional development	7	12,29
Overcoming student difficulties	6	10,53
Material usage	3	5,26
STEM applications	2	3,50
Concept cartoon-supported learning	2	3,50
Lesson design based on the 5E teaching model	2	3,50
Proof teaching	2	3,50
Other	11	19,30

In mathematics education, action research has been primarily conducted to examine technology-supported learning environments (f=14). The articles on this subject investigated learning environments where software such as GeoGebra, Cabri Geometry, and BCS and technological tools such as interactive e-books, interactive boards, and tablet PCs were used. In addition, studies on mathematical modeling (f=8), teacher education and professional development (f=7), and overcoming student difficulties (f=6) were studied more than other subjects. Two studies were included in the categories of STEM applications, concept cartoon-supported teaching, lesson design based on the 5E teaching model, and proof teaching. In the other category, there were studies on topics such as the flipped classroom model, realistic mathematics education, multiple intelligence theory, mathematical literacy, and mathematical habits of mind. Since there was only one study on these topics, they were included in the other category. Action research articles on mathematics education were also examined according to learning areas (see Table 4).

Table 4.

Distribution of Articles by Learning Areas

Learning areas	f	%
Geometry	13	22,81
Numbers and operations	10	17,54
Numbers and algebra	7	12,29
Analytical geometry	5	8,78
Algebra	3	5,26
Calculus	2	3,50
Statistics and probability	1	1,75
Other	16	28,07

According to Table 4, action research articles in mathematics education are most frequently conducted in the field of geometry (f=13). Action research studies were also conducted in the learning areas of numbers and operations (f=10), numbers and algebra (f=7), analytic geometry (f=5), algebra (f=3), and calculus (f=2). The least number of studies were conducted in the learning area of statistics and probability (f=1). In 14 studies in the category of other, no learning area was selected due to the research subject (STEM, modeling, implementation of professional development program, realistic mathematics education, mathematical literacy, use of materials, etc.). The two studies examined were included in the other category because they included all fifth-grade learning areas. The distribution of action research articles in mathematics education according to the research model is presented in Table 5.

Table 5.

Distribution of Articles by Research Model

Research model	f	%
Qualitative	54	94,74
Mixed	2	3,50

It is seen that 94.74% of the articles used the qualitative research method. The number of articles using the mixed method was two (3.50%). However, action research articles were only found in which the quantitative method was used. The research method needed to be clearly stated in one of the articles. The type of action research in the articles examined within the scope of this study was also examined, and the findings are presented in Table 6.

Table 6.

Distribution of Articles by Action Research Types

Action research types	f	%
Not specified	49	86,00
Technical/scientific/collaborative action research	2	3,50
Participatory action research	2	3,50
Practical action research	2	3,50
Classical and individual action Research	1	1,75
Collaborative action research	1	1,75

The type of action research was not specified in 49 articles (86%). In contrast, the type of action research was mentioned in 8 studies. Two articles were published in technical/scientific/collaborative action research, participatory action research, and practical action research. In addition, classical and individual action research and collaborative action research types were used in one article. While the action research cycle was specified in some of these action research articles conducted in mathematics education, it was not specified in others. In this context, the findings regarding the status of action research cycles in the articles are presented in Table 7.

Table 7.

Distribution of Articles by Action Research Cycle

Action research cycle	f	%
Specified	37	64,91
Unspecified/ Undetermined	20	35,09

In 37 reviewed studies, the action research phases, or action plans, were included, and the research cycle was detailed. In 20 studies, the action research cycle was not included. In these studies, the data collection or implementation process was generally explained, but no information was given about the phases of the research or the action plans implemented. Action research articles conducted in mathematics education were also examined according to the study group, and their distribution is presented in Table 8.

Table 8.

Distribution of Articles by Study Group

Study group	f	%
Student	50	87,72
Elementary school students	3	
Middle school students	17	
High school students	7	
Undergraduate students	22	
Vocational school students	1	
Teacher and student	5	8,78
Mathematics teacher	2	3,50

It was determined that 50 articles (87.72%) were studied with students. These articles were studied with primary school, secondary school, high school students, undergraduate students, and vocational school students. It was determined that most studies were conducted with undergraduate students among these student groups. While five articles were studied with teacher and student groups, only two were studied with high school mathematics teachers. The findings regarding the number of people studied from these study groups are presented in Table 9.

Table 9.

Distribution of Articles by Number of People

Number of people	f	%
1-10 people	9	15,79
11-20 people	13	22,81
21-30 people	8	14,04
31-40 people	13	22,81
41-50 people	6	10,53
51-60 people	4	7,02
61-70 people	2	3,50
71-80 people	1	1,75
Unspecified	1	1,75

The number of participants in the study was coded in groups of ten. Nine articles were determined for the study group with 1-10 participants, eight articles for 21-30 participants, six articles for 41-50 participants, 13 articles for 11-20 participants and 31-40 participants. No study was found where the number of participants in the study group was over 80. However, the sample size was not specified in one study. The sampling method used in action research

articles conducted in mathematics education was also examined. In this context, the distribution of articles according to the sampling method is presented in Table 10.

Table 10.

Distribution of Articles by Sampling Method

Sampling method	f	%
Purposive sampling	24	42,11
Criterion sampling	10	
Convenience sampling	5	
Typical sampling	2	
Maximum variation sampling	2	
Convenience sampling and maximum variation sampling	1	
Unspecified	4	
Convenience sampling	1	1,75
Unspecified	32	56,14

In the articles on action research in mathematics education conducted in our country, the study group is determined using the purposeful sampling method (45.11%). Among the articles where the purposeful sampling method was used, the criterion sampling method was used the most, and the methods of easy-to-reach situation sampling, typical situation sampling, and maximum variation sampling were preferred, respectively. In the four articles where the purposeful sampling method was used, it was not stated which sampling type was used. In 32 of the 57 articles examined (56.14%), no explanation was made regarding the sampling method. The data collection tools used in the action research articles conducted in mathematics education were also examined. As a result of this examination, different data collection tools were used (Table 11).

Table 11.

Distribution of Articles by Data Collection Tools

Data collection tools	f	%
Interviews	32	26,45
Observations	25	20,67
Open-ended questions	15	12,4
Diaries	14	11,57
Worksheets	9	7,44
Tests/Scales	8	6,62
Readiness test	2	
Holistic and analytical thinking scale	1	
Proof test	1	
Mathematical estimation ability level test,	1	
Algebraic reasoning and mathematical reasoning assessment tool	1	
Van Hiele geometric thinking level test	1	
Mathematical literacy test	1	
Project and performance tasks	4	3,3
Activities	4	3,3
Homework	2	1,65
Scenarios	2	1,65
Solution papers	2	1,65
Multiple choice questions	2	1,65
Screen printouts	2	1,65

Interviews (f=32) and observations (f=25) were the articles' most commonly used data collection tools. In most of these articles, video and audio recordings obtained by recording the interviews and observations were also used as data collection tools. Studies were also conducted, and data were collected with open-ended questions, diaries, and worksheets. Data were collected using various tests or scales in eight articles. In addition, project and performance tasks, activities, homework, scenarios, solution papers, multiple choice questions, and screen printouts are among the data collection tools of articles conducted using the action research method in mathematics education.

The implementation periods of action research articles conducted in the field of mathematics education were also considered within the scope of the research. Since these periods were mainly expressed every week, categories were created as weeks (Table 12). However, studies whose implementation periods were specified as course periods, course hours, months, or hours were considered in the other category.

Table 12.

Distribution of Articles by Implementation Duration

Implementation duration	f	%
1-4 weeks	11	19,30
5-9 weeks	9	15,79
10-14 weeks	9	15,79
15-19 weeks	2	3,50
Unspecified	7	12,29
Other	19	33,33

When action research articles conducted in mathematics education were examined in terms of the implementation period, it was seen that the week with the least percentage was 15-19 weeks, and the implementation period with the most percentage was other.

The techniques used in data analysis in action research articles conducted in mathematics education were examined. The analyses were carried out in the context of the types of qualitative and quantitative analysis techniques. In this direction, the distribution of the articles according to data analysis techniques is presented in Table 13.

Table 13.

Distribution of Articles by Data Analysis Techniques

Data analysis techniques	f	%
Qualitative analysis techniques	47	73,43
Content	23	
Descriptive	15	
Unspecified	7	
Other	2	
Quantitative analysis techniques	12	18,75
Frequency/percentage	7	
t-test	3	
Mean/ss	1	
z-test	1	
Qualitative and quantitative data analysis techniques	2	3,13
Unspecified	3	4,69

In some of the action research in mathematics education, qualitative and quantitative analysis techniques were used simultaneously. 73.43% of the articles used qualitative data analysis. The most commonly used qualitative data analysis technique was content analysis, while descriptive analysis was used second. Quantitative data analysis was used in 18.75% of the studies, and frequency-percentage calculations were used the most. The data technique used

was not specified in 4.69% of the studies, and it was determined that both qualitative and quantitative data analysis techniques were used together in two studies.

The validity and reliability measures of action research articles conducted in mathematics education were examined. In this context, the distribution of articles according to validity and reliability measures is presented in Table 14.

Table 14.

Distribution of Articles by Validity and Reliability

Validity and reliability	f	%
Expert opinion	35	31,82
Intercoder agreement	22	20
Pilot application	18	16,36
Method variation	13	11,81
Participant confirmation	3	2,73
Content validity	3	2,73
Construct validity	1	0,91
Reliability coefficient	4	3,64
Kuder-Richardson 20 (KR-20)	2	
Cronbach alpha	1	
Unspecified	1	
Unspecified	11	10

According to Table 14, expert evaluation (f=35) was mainly used, and intercoder agreement (f=22) was examined to ensure validity and reliability in the studies. In addition, validity and reliability measures were taken for the articles using the pilot application, method variation, participant confirmation, or reliability coefficient calculation methods such as KR-20 and Cronbach alpha. In 11 articles, no explanation was made regarding the validity and reliability of studies.

The role of researchers in action research articles conducted in mathematics education was also determined. In this context, the distribution of articles according to the role of the researcher is presented in Table 15.

Table 15.

Distribution of Articles by Role of the Researcher

Role of the researcher	f	%
Teacher	26	45,63
Academician	10	17,54
Observer	1	1,75
Teacher-academician	1	1,75
Unspecified	19	33,33

In almost half of the action research articles (45.63%), the researcher was also a teacher. In 10 articles, the role of the researcher was undertaken by an academic. In 19 of the articles examined, the role of the researcher was not specified.

4. Discussion and Conclusion

This study aims to provide a comprehensive perspective on mathematics education by examining 57 action research articles published in Türkiye between 2007 and 2022. Fifty-four of these articles were published in Turkish and 3 in English. In this context, it is recommended that the number of English studies be increased to contribute to the international field and the contribution made to Turkish literature. Action research articles published in mathematics education were published at least in 2007, 2008, and 2009, and a significant increase was observed in the number of studies in 2016, 2019, and 2020. Similarly, Turhan Türkkan et al. (2019) concluded that the number of studies on action research has increased in the last five years in their content analysis in the field of educational sciences.

This study found that most action research articles in mathematics education use qualitative research methods, while very few use mixed methods. It can be said that this situation is because action research is primarily one of the qualitative research methods (Ferrance, 2000; Kuzu, 2009; Yıldırım & Şimşek, 2016). Similarly, it has been determined that most studies do not specify the type of action research. Çalışkan and Serçe (2018) also found that the type of information is generally not specified in action research articles in the field of education conducted in our country. However, clearly stating the type of action research can support the comprehensibility of the research.

Although the cycle, stage, or action plans of the research are specified in most of the action research studies conducted, some studies need to be clearly specified. In these studies, the data

collection or implementation process is explained, but no information is given about the stages of the research or the action plans implemented. Considering that action research progresses in a particular cycle, clearly stating the action plans to be implemented in each cycle can help other researchers in their implementation.

When action research is examined according to their subjects, most studies are on technology-supported learning environments. In addition, geometry is the field studied the most compared to other learning areas. This situation may be due to the transformation of learning environments from traditional learning environments to new learning environments equipped with technology in recent years and the widespread use of dynamic geometry software. In addition, many studies in the field of mathematics education have stated that most studies are on the geometry learning field (Topuz & Cantürk Günhan, 2021; Yücedağ, 2010). The least studied learning area is seen as statistics and probability. Studies on different learning areas of mathematics, such as statistics and probability, can be conducted, and the deficiencies in the literature can be eliminated.

It was determined that the articles examined within the scope of the study mostly worked with students and that students from all levels except preschool students were included in the study groups. The undergraduate level was the most preferred in these studies. Similarly, Turhan Türkkan et al. (2019) stated that they mostly worked with undergraduate-level students in their content analysis of action research. Considering that preschool education is the fastest development of children and dramatically affects the following periods (Karaoğlu & Çoban Esen, 2019), increasing the number of studies conducted with preschool-level students can contribute to the literature.

When the findings regarding the sample size are examined, the number of participants in the studies conducted is low. This situation is likely because almost all the articles examined are qualitative. More than one data collection tool was used in most articles examined. Among these tools, interviews were used the most. The most preferred data collection tool after the interview was observation. In order to ensure validity and reliability in the studies conducted, expert evaluation was mostly made, and agreement between the coders was applied. Similar findings were also reached in content analyses conducted on action research (Çalışkan & Serçe, 2018; Turhan Türkkan et al., 2019). When the distribution of articles according to data analysis

methods was examined, content analysis, one of the qualitative analysis techniques, was used the most. It can be said that this situation is because the data collection tools used are primarily interviews and observations. Hendricks (2006) also stated that in action research studies, data were analyzed through techniques such as descriptive analysis, content analysis, and inductive analysis.

The following suggestions are made for future research based on the results of the study:

• In addition to qualitative research designs, action research with mixed patterns can be conducted.

• The quality of research can be increased by clearly stating the type of action research, the research cycle, including action plans, the role of the researcher, the sampling method, and the implementation period.

• Research involving students at different education levels and learning areas can be multiplied.

• Different data collection tools and data analysis methods can be used to ensure data diversity. Future studies and articles examining theses conducted with action research may contribute to the literature by expanding the scope of the research.

5. References

Altrichter, H., Gstettner, P. (1993) Action research: A closed chapter in the history of German social science? *Educational Action Research, 1*(3), 329-360.

Beverly, J. (1993). Teacher as Researcher. *ERIC Digest, ERIC Clearinghouse on Teacher Education*, Washington DC.

Çalışkan, M., & Serçe, H. (2018). Action research articles on education in Turkey: A content analysis. *Ahi Evran University Journal of Kırşehir Education Faculty, 19*(1), 57-79.

Carr, W., & Kemmis, S. (1986). Becoming critical: Education, knowledge and action research. Philadelphia, PA: Falmer Press.

Corey, S. M. (1949). Action research, fundamental research, and educational practices. *Teachers College Record, 50*(8), 509-514.

Dağ, Ş., & Horzum, T. (2022). Examination of graduate theses about misconceptions in mathematics education: A systematic review. *e-Kafkas Journal of Educational Research, 9*(1), 434-465.

Dickens, L., & Watkins, K. (1999). Action research: rethinking Lewin. *Management Learning, 30*(2), 127-140.

Ertane Baş, Ö., & Özturan Sağırlı, M. (2021). A content analysis related to the problem themed articles on mathematics education in Türkiye. *Cukurova University Faculty of Education Journal, 50*(2), 778-832.

Ferrance, E. (2000). Action research: themes in education. USA: Northeast and Islands Regional Educational Laboratory at Brown University.

Göktaş, Y., Küçük, S., Aydemir, M., Telli, E., Arpacık, Ö., Yıldırım, G., & Reisoğlu, İ. (2012). Educational technology research trends in Turkey: A content analysis of the 2000–2009 decade. *Educational Sciences: Theory and Practice, 12*(1), 177-179.

Gunz, J. (1996). Jacob L. Moreno and the origins of action research. *Educational Action Research, 4*(1), 145-158.

Hendricks, C. (2006). Improving school's trough action research: a comprehensive guide for educators. Boston: Pearson Education, Inc.

Herr, K., & Anderson, G. L. (2015). The action research dissertation: A guide for students and faculty (2nd ed.). USA: Sage Publications.

Johnson, B. M. (1995). Why conduct action research? *Teaching and Change, 3*(1), 90-104.

Karaoğlu, H., & Çoban Esen, A. (2019). Investigation of graduate theses on the language development in pre-school education in Turkey. *Erzincan University Faculty of Education Journal, 21*(1), 211-229.

Karatay, M., & Taş, M. (2021). The use and importance of action research in education. *OPUS International Journal of Society Researches, 17*(38), 5545-5568.

Kemmis, S. (1980). Action Research in Retrospect and Prospect, ERIC database, 1-22.

Kemmis, S. (2009). Action research as a practice-based practice. *Educational Action Research, 17*(3), 463-474.

Kuzu, A. (2009). Action research in teacher training and professional development. *The Journal of International Social Research, 2*(6), 425-433.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues, 2*(4), 34-46.

McKernan, J. (1991). Action inquiry: Studied enactment. In E. Short (Ed.), Forms of curriculum inquiry. (2nd ed., pp. 309-326). Albany, New York: State University of New York Press.

McNiff, J., & Whitehead, J. (2010). You and your action research project. (3rd Edition). Abingdon: Routledge.

Mertler, C. A. (2021). Action research as teacher inquiry: A viable strategy for resolving problems of practice. *Practical Assessment, Research, and Evaluation, 26*(19), 1-12.

Morgan, H. (2022). Conducting a qualitative document analysis. *The Qualitative Report, 27*(1), 64-77.

O'Brien, R. (2001). An overview of the methodological approach of action research. In Roberto Richardson (Ed.), Theory and Practice of Action Research. João Pessoa, Brazil:

Universidade Federal da Paraíba. http://www.web.ca/~robrien/papers/arfinal.html (Accessed 20/1/2024)

Özey, K. (2019). *Cebir öğrenme alanında yapılan lisansüstü tezlerin incelenmesi: 2010-2018 yılları arası Türkiye örneği.* (Yayınlanmamış yüksek lisans tezi). Bursa Uludağ Üniversitesi Eğitim Bilimler Enstitüsü.

Selçuk, Z., Palancı, M., Kandemir, M., & Dündar, H. (2014). Tendencies of the researches published in education and science journal: Content analysis. *Education and Science, 39*(173), 430-453.

Şimşek, N., & Yaşar, A. (2019). A thematic and methodological review of theses related to GeoGebra: A content analysis. *Turkish Journal of Computer and Mathematics Education, 10*(2), 290-313.

Stenhouse, L. (1975). An Introduction to Curriculum Research and Development. London, UK: Heinemann Publishing.

Toptaş, B., & Kuşdemir, Y. (2021). Analysis of the graduate theses in the field of teaching mathematics education in Turkey. *International Primary Education Research Journal, 5*(2), 171-179.

Topuz, F., & Cantürk Günhan, B. (2021). What is the Trend of Argumentation Studies in Mathematics Education in Turkey? *Mediterranean Journal of Educational Research, 15* (36), 55-80.

Turhan Türkkan, B., Yolcu, E., & Karataş, T. (2019). Analysis of doctoral theses including action research in the field of educational sciences in Turkey. *Bayburt Faculty of Education Journal, 14*(28), 501-524.

Ültay, E., Akyurt, H., & Ültay, N. (2021). Descriptive content analysis in social sciences. *IBAD Journal of Social Sciences,* (10), 188- 201.

Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* (9. bs.). Ankara: Seçkin Yayıncılık.

Yıldırım, A., & Şimşek, H. (2016). *Sosyal bilimlerde nitel araştırma yöntemleri* (10. bs.). Ankara: Seçkin Yayıncılık.

Yücedağ, T. (2010). *2000-2009 yılları arasında matematik eğitimi alanında Türkiye'de yapılan çalışmaların bazı değişkenlere göre incelenmesi.* (Yayınlanmamış yüksek lisans tezi). Selçuk Üniversitesi, Eğitim Bilimleri Enstitüsü, Konya.

Appendixes

Appendix 1. Year, Author and Title Information of the Articles Reviewed

Year	Authors	Title
2007	İsmail Özgür Zembat	The main tenets of direct instruction and constructivism: The Case of Translations
2008	İ. Elif Yetkin Özdemir	Prospective elementary teachers' cognitive skills on using manipulatives in teaching mathematics
2009	Nilüfer Yavuzsoy Köse, Aynur Özdağ	How do the fifth-grade primary school students determine the line of symmetry in various geometrical shapes using Cabri Geometry software?

2013	Tamer Kutluca, M. Faysal Akın	Teaching of mathematics with concrete materials: Qualitative study on using four-quadrant algebraic scales
	Sabri Sidekli, Yasin Gökbulut, Nail Sayar	How to improve the number operations skills
2014	Ayten Pınar Bal, Ahmet Doğanay	Mathematical modelling skills of primary teacher candidates: the practising of fermi problems
	Berna Tataroğlu Taşdan, Adem Çelik	A professional development program prototype towards mathematics teachers
2015	Ali Delice, Gökhan Karaaslan	Investigation of the effects of the dynamic geometry software tasks on students' performance: Lineer equations
	Berna Tataroğlu Taşdan, Adem Çelik	Development of mathematics teachers' knowledge of representations towards function concept
	Ayşe Tekin Dede, Süha Yılmaz	How can the 6th grade students' modelling competencies be developed?
	Güler Tuluk	The evaluation of the concept maps created by future middle school mathematics teachers in regard to the concept of angle
2016	Ebru Aylar, Yeter Şahiner	An analysis of seventh-grade students' proof skills and preferences
	Serdal Baltacı, Adnan Baki	An investigation of the use of the dynamic mathematics software in teaching the translation and rotation transformations in terms of contextual learning
	Bahattin İnam, Işıkhan Uğurel	The difficulties towards proof comprehension tests in a teaching implication and the ways that interfere the process
	Fatma Canan Göksu, Necla Köksal	Teaching the lines, angles and polygons according to constructivism supported by concept cartoons
	Tamer Kutluca, İlhami Bulut, Zülküf Kılıç	An analysis of students' views about the usability of multiple intelligence theory: linear equations and coordinate system
	Bengüsu Uğur, Selin Urhan, Selay Arkün Kocadere	Teaching geometric objects with dynamic geometry software
	Çiğdem Tekin Aytaş, Işıkhan Uğurel	The effects of an instruction practice based on the writing activities on students' learnings in a mathematics class
	Tuba Ada, Aytaç Kurtuluş	Determination of the relative positions of three planes: Action research
2017	Arzu Aydoğan Yenmez	The effects of technology on the mathematical modeling
	Elif Bahadır, İrem Demir	Analyzing of usability of transformation wheel material developed for teaching transformation geometry
	Serdal Baltacı, Adnan Baki	The role of GeoGebra software in constructing a contextual learning environment: The case of ellipse
	Suna Dağdelen, Menderes Ünal	Problems and suggestions in mathematics teaching and learning process
	Burcu Nur Baştürk Şahin, Gökhan Şahin, Menekşe Seden Tapan Broutın	Teaching the concept of prime numbers regarding to the theory of didactical situations: An action research
2018	Zeynep Aydın Aşk, Erdal Bay	Evaluation of authentic task-oriented learning processes in 7th grade mathematics (action research)

	Serdal Baltacı, Adnan Baki	The role of dynamic mathematics software in the development of contextual learning environment during teaching of the parabola concept
	Gözde İşçi, Ayten Erduran	Determination of student opinions on tablet pc use in secondary mathematics courses
	Cennet Gizem Karataş, Elif Bahadır	Analyzing of usability of algebra presentation pad material developed for teaching algebraic expressions
	Seda Özer Şanal, Yalın Kılıç Türel	Teaching "functions" with the interactive e-book developed on the arcs model: Action research
	Emine Nur Ünveren Bilgiç	Investigation of mathematical mind habits of preservice elementary mathematics teacher in problem solving
	Merve Zihar, Alper Çiltaş	An action research on the teaching of the 8th grade exponentials by mathematical modeling
2019	Ercan Atasoy, Mehmed Emre Konyalıhatipoğlu	Investigation of students' holistic and analytical thinking styles in learning environments assisted with dynamic geometry software
	Hasan Altun	Enrichment of teaching secondary mathematics education program: Action research
	Meltem Birinci, Müjgan Baki	Reflections from a secondary school mathematics teacher's professional development: Implementation the skill of noticing in teaching fractions
	Özgül Demir, Aytaç Kurtuluş	The effect of 5E learning model on 7th grade students' Van Hiele transformation geometry levels in teaching transformation geometry
	Beyza Koç, İsa Korkmaz	An action research on teaching addition and subtraction to an illiterate student with Dyscalculia
	Timur Koparan	Examination of perceptions of university students on non-Euclidean geometries and reflections from designed learning environments
	Neslihan Şahin, Ali Eraslan	Middle-school prospective mathematics teachers' opinions on the use of modeling activities at the course of mathematics applications
	Baki Şahin	The effect of the inquiry based mathematics approach on the development of the mathematical thinking processes of prospective teachers: In action research study
	Hanife Şermetoğlu, Müjgan Baki	Investigation of the rate and ratio's teaching process in the context of a mathematics teacher's noticing
2020	Taner Arabacıoğlu, Ersen Yazıcı, Deniz Özen-Ünal	Flipped classroom experiences of preservice teachers: Implications from a mathematics course
	Derya Aygün, Mihriban Hacısalihoğu Karadeniz, Suphi Önder Bütüner	Reflections of concept cartoons applications to 5th grade students' use of mathematical symbols, terms / concepts
	Elif Ertem Akbaş, Adnan Baki	Evaluation of students' learning the subject of "limit-continuity" in a computer-aided environment according to the SOLO Taxonomy: Action research
	Gülay Bozkurt, Melike Yiğit Koyunkaya	How does the level of technology usage of mathematics teacher candidates change with micro-teaching method?
	Erdem Çekmez	Examining the performances of prospective mathematics teachers in constructing the different representations of two-variable inequalities

	Zekeriya Demetgül, Adnan Baki	Reflections on instruction of inequality and absolute value in a technology-equipped classroom: An action research
	Özlem Tomooğlu, Aytaç Kurtuluş	Using the 5E model in area measurement on 6th grade students: An action research
	Mehmet İhsan Yurtyapan, Menekşe Seden Tapan-Broutın, Gül Kaleli-Yılmaz	An action research aligned with the REACT+G teaching approach: "Thales' intercept theorem"
2021	Özde Ceylan, Engin Karahan	The effects of STEM-focused mathematics applications on mathematics attitudes and knowledge of 11th grade students1
	Zeynep Çakmak Gürel, Ahmet Işık	An analysis of pre-service mathematics teachers' behavior on mathematical modeling cycle
	Ayşegül Karakaş, Rıdvan Ezentaş	Planning, implementation and evaluation of mathematical literacy education provided to seventh grade students
	Pelin Kösece, Ahmet Doğanay	An action research to improve prediction skills through realistic mathematics education
	Seyhan Paydar, Adem Doğan	An analysis of primary first grade students' readiness in natural numbers
	Muhammet Şahal, Ahmet Şükrü Özdemir	The contribution of mathematical modeling course to pre-service mathematics teachers' knowledge about the nature of mathematical modeling: An action research
2022	Zeynep Çakmak Gürel, Ahmet Işık	Applications based on atomic supported holistic approach fostering the modeling competencies of preservice mathematics teachers
	Yusuf Erkuş, Cenk Keşan	Use of video simulations to prepare pre-service mathematics teachers for technology-based mathematics teaching
	Şule Koçyiğit, Kürşat Yenilmez	Investigation of students' mathematical reasoning skills in STEM-focused teaching processes

Appendix 2. Classification Form for Action Research Articles Conducted in the Field of Mathematics Education

1. Year
2. Publication language
Turkish English
3. Subject
Technology-supported learning environments Mathematical modeling Teacher training and professional development Overcoming student difficulties Material usage STEM applications Concept cartoon-supported learning Lesson design based on the 5E teaching model Proof teaching Other
4. Learning areas
Geometry Numbers and operations Numbers and algebra

Analytical geometry
Algebra
Calculus
Statistics and probability
Other
5. Research model
Qualitative
Mixed
6. Action research types
Not specified
Technical/scientific/collaborative action research
Participatory action research
Practical action research
Classical and individual action Research
Collaborative action research
7. Action research cycle
Specified
Unspecified/ Undetermined
8. Study group
Student
Elementary school students
Middle school students
High school students
Undergraduate students
Vocational school students
Teacher and student
Mathematics teacher
9. Number of people
1-10 people
11-20 people
21-30 people
31-40 people
41-50 people
51-60 people
61-70 people
71-80 people
Unspecified
10. Sampling method
Purposive sampling
Criterion sampling
Convenience sampling
Typical sampling
Maximum variation sampling
Convenience sampling and maximum variation sampling
Unspecified
Convenience sampling
Unspecified
11. Data collection tools
Interviews
Observations
Open-ended questions

Diaries
Worksheets
Tests/Scales
Readiness test
Holistic and analytical thinking scale
Proof test
Mathematical estimation ability level test,
Algebraic reasoning and mathematical reasoning assessment tool
Van Hiele geometric thinking level test
Mathematical literacy test
Project and performance tasks
Activities
Homework
Scenarios
Solution papers
Multiple choice questions
Screen printouts
12. Implementation duration
1-4 weeks
5-9 weeks
10-14 weeks
15-19 weeks
Unspecified
Other
13. Data analysis techniques
Qualitative analysis techniques
Content
Descriptive
Unspecified
Other
Quantitative analysis techniques
Frequency/percentage
t-test
Mean/ss
z-test
Qualitative and quantitative data analysis techniques
Unspecified
14. Validity and reliability
Expert opinion
Intercoder agreement
Pilot application
Method variation
Participant confirmation
Content validity
Construct validity
Reliability coefficient
Kuder-Richardson 20 (KR-20)
Cronbach alpha
Unspecified
Unspecified
15. Role of the researcher

Teacher
Academician
Observer
Teacher-academician
Unspecified

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 326-339 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Review Article

ISSN: 2717-8307

The Contributions of Musical Practices within Social Responsibility Projects on the Social Development of Children

Sevan NART*[1]

* *Corresponding Author, sevansea@yahoo.com*
[1] *Bartın University, Türkiye*

Abstract

Broadly, education is the whole process that prepares the individual for the social life, providing to gain the required knowledge, skills and behaviors for the development of his personality; in other words, which enables an individual's socialization. Music education, apart from being an educational discipline, has an important role in the socialization of the individual, due to both being a beneficial and convenient educational tool as well as an effective and efficient education method. Because of its importance and role in social life, musical practices applied aside from the school are becoming increasingly common all over the world. Many private and institutional organizations, such as municipalities, universities, schools, foundations and associations, organize these activities on a voluntary basis, under the name of Social Responsibility Projects (SRP), for every child equally regardless of socio-economic status and educational level. The aim is to promote healthy individual and social development through improving the musical ability that every child has in a certain level. It is also about making them happy in their personal and social lives as conscious, creative, productive, sharing, responsible individuals, and provide them the necessary environment and opportunities for this purpose. This study was conducted to investigate and draw attention to the positive role and beneficial impact of the musical practices in the scope of SRP to the social development of the children. The obtained qualitative data through review of literature has been aggregated and presented. This study is expected to lead to furture research and practices on the subject.

Keywords: Children, Music Education, Social Development, Social Responsibility Projects

Citation: Nart, S. (2024). The contributions of musical practices within social responsibility projects on the social development of children. *Instructional Technology and Lifelong Learning*, *5*(2), 326-339 https://doi.org/10.52911/itall.1544388

Sosyal Sorumluluk Projeleri Kapsamında Yürütülen Müzik Çalışmalarının Çocukların Sosyal Gelişimine Katkısı

Özet

Genel olarak eğitim, bireyi toplumsal yaşama hazırlayan; kişiliğinin gelişimi için gerekli bilgi, beceri ve davranışları kazanmasını sağlayan; bir başka deyişle bireyin sosyalleşmesini sağlayan süreçlerin tümüdür. Müzik eğitimi, bir eğitim alanı olmasının yanı sıra, hem yararlı ve kullanışlı bir eğitim aracı hem de etkili ve verimli bir eğitim yöntemi olması nedeniyle bireyin sosyalleşmesinde önemli bir role sahiptir. Toplumsal yaşamdaki önemi ve rolü nedeniyle, okul dışında uygulanan müzik uygulamaları tüm dünyada giderek yaygınlaşmaktadır. Belediyeler, üniversiteler, okullar, vakıflar ve dernekler gibi birçok özel ve tüzel kurum ve kuruluş, bu faaliyetleri gönüllülük temelinde, Sosyal Sorumluluk Projeleri (SSP) adı altında, sosyo-ekonomik statü ve eğitim düzeyine bakılmaksızın her çocuk için eşit olarak düzenlemektedir. Amaç, her çocuğun, belirli bir düzeyde sahip olduğu müziksel yeteneğini geliştirerek, bireylerin sağlıklı bireysel ve toplumsal gelişimini teşvik etmektir. Bununla birlikte, onları bilinçli, yaratıcı, üretken, paylaşımcı, sorumluluk sahibi bireyler olarak kişisel ve toplumsal yaşamlarında mutlu kılmak ve bu amaçla gerekli ortam ve fırsatları sağlamaktır. Bu çalışma, SSP kapsamındaki müzik uygulamalarının çocukların sosyal gelişimine olan olumlu rolünü ve yararlı etkisini araştırmak ve konuya dikkat çekmek amacı ile yürütülmüştür. Literatür taraması yoluyla elde edilen nitel verilerin bir araya getirilerek sunulduğu bu çalışmanın, konuyla ilgili gelecekteki araştırmalara ve uygulamalara ışık tutacağı düşünülmektedir.

Anahtar Kelimeler: Çocuklar, Müzik Eğitimi, Sosyal Gelişim, Sosyal Sorumluluk Projeleri

Date of Submission	05.09.2024
Date of Acceptance	05.12.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	This article is the revised and developed version of the unpublished conference presentation entitled " Sosyal Sorumluluk Projeleri Kapsamındaki Müzik Eğitimi Çalışmalarının Çocuğun Sosyal Gelişimine Katkısı", orally delivered at the Müzed Regional Conference on Music Culture & Education on Silk Road in April 2014, İstanbul.
Author(s) Contribution	**Author1:** Conceptualization, Methodology, Writing- Original draft preparation, Data curation, Reviewing and Editing, Supervision, Validation.
Plagiarism Checks	Yes – Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	italljournal@gmail.com
Grant Support	-
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Broadly, education can be defined as the process of creating a positive change and development in the cognitive, emotional and psychomotor behaviors of the individual and all the kinds of practices guiding that process. According to this definition, education is all the processes that prepare the individual for social life and enable him to acquire the necessary knowledge, skills and behaviors for the development of his personality. According to Aslan, "Education is a process that takes place in society, is affected and shaped by society, and also affects and shapes society. … In that case, … society can be seen as a goal and education as an indispensable tool to achieve this goal" (Aslan, 2001: 25, 28). In this respect, perhaps the most important function of education is to teach the values, social rules and norms of the society (desirable and undesirable) to the individual in various ways, in other words, to ensure the socialization of the individual (Tezcan, 1991: 45).

Turkish Language Association defines the concept of socialization as: "Socialization is the process of preparing the individual for a certain social environment by gaining a personality and integrating with society" and " it is the learning of a person to behave like those who live in his own group or culture" (http://tdk.gov.tr). These two definitions indicate that the individual interacts with two different social environments during the socialization process. The first is the environment consisting of family, teachers, relatives and neighbors, which serves a relatively more controlled and desired social development; The second is the social environment consisting of peer groups with which the individual has uncontrolled and random social interaction. Many studies have focused on the importance of play and peer groups in children's social development. "Especially in studies conducted on small groups, it has been experimentally demonstrated that individuals in a group are affected by the values, thoughts and feelings of other members of the group, and even tend to identify with them" (Tuna, 2008: 45).

Research and practices draw attention to the necessity and importance of music education in processes such as gaining a social function, strengthening communication and social harmony among children between the ages of 7-14 in family and friend groups and, at school. Hargreaves, Marshall, and North (2003), in their studies examining the sociological effects of musical behavior and experiences, present examples from different studies (Parncutt &

McPherson, 2002; Juslin & Sloboda, 2001; Shields, 2021, DeNora, 2000; Sundin, McPherson & Folkestad, 1998; Hallam, 1998; Kemp, 1996; Rauscher, Shaw & Ky, 1995 etc.) and put forward the increasing functions of music in daily life with similar results. "Music has cognitive, emotional and social functions for all of us, and these social functions manifest themselves in three main ways in daily life, namely: self-identity management, interpersonal relationships and mood" (Hargreaves et al. 2003, pp. 149-151). Soley and Köseler (2021) presented the common results of developmental research on the social effects of music by an extensive literature review study. In the research, it was found that the number of music-focused educational programs created for children with the aim of developing social-emotional skills and increasing positive social attitudes and behaviors has increased, but these programs/applications differ in terms of content, target age group, duration and structure; For this reason, it has been stated that the results and effects vary. In addition, since children participating in these programs generally cannot be followed in the long term, they recommended that these programs should be organized and carried out in a longer term, systematic and cross-cultural manner in order to understand their effects on social development. In their research, Kirschner and Tomasello (2010) observed positive and significant improvements not only in the social behavior of children who were involved in music (playing instruments or singing), but also in their individual problem-solving skills. Hospital et al. (2018) also state that musical practices, especially when carried out collectively, contribute to many cognitive and affective skills that affect individual and social development in children and young people, such as self-awareness, self-expression, planned and orderly living, social awareness and sharing. Hallam (2010), investigate the effects of active participation in music on the cognitive, individual and social development of children and young people, reveals that positive effects occur only when musical practices are an enjoyable and rewarding experience. Anshel and Kipper (1988: 146) state that musical practices performed in groups increase self-confidence, self-awareness, emotional relaxation, enjoyment and communication, which can positively affect interpersonal behavior and willingness to cooperate. These findings also coincide with the findings of a study conducted at Cambridge University in 2012 with children aged 8-11. It was observed that children who regularly engaged in musical practices with a group increased their ability to empathize with others (Burns, 2012: BBC News). In a book chapter on music education and social projects, Figueiredo

and Odena (2022) evaluate two separate social projects in Brazil and also provide comprehensive information about the resources and research on the subject.

We can say that every child enjoys taking part in music-related activities (such as listening to music, playing instruments, singing, dancing individually or collective), and although they have different degrees of musical talent, every child has musical abilities that can be improved to a greater or lesser extent (Eskioğlu, 2003). Developing this ability of the child largely depends on creating a suitable educational environment. Due to the place and importance of music in social life as an educational tool, musical practices outside of school, which contribute positively to the social development of children, are becoming increasingly widespread all over the world.

The main problem of this study is to investigate the effect of musical practices within the scope of SRP on the social development of the child. The study is important in terms of drawing attention to the importance of music education, which has positive effects on reducing the tendency of primary school children to negative behaviors and on their growth as individuals in harmony with society. It is hoped that with this study, the place and importance of music education within the scope of SRP out-of-school will be better understood and the value given to music education will increase.

1.1. Children and Music Education

“The Convention on the Rights of the Child [CRC] defines a "child" as a person below the age of 18, unless the relevant laws recognize an earlier age of majority. However, in our society, childhood is defined as between the ages of 0 and 14; The 15-25 age group is called the person in adolescence, that is, young people” (Çelebi, 1990:391).

The children subject to the research in this study are primary school children between the ages of 6-14. The benefits of music for this age child can be listed as follows:

- In the development of the child's auditory skills; It is effective in learning to listen and gaining skills such as perceiving and understanding what is heard.
- In terms of language development and speaking skills, it is effective for the child to learn new words and sentence patterns through singing, to learn how to pronounce words correctly

and to speak clearly, that is, to improve his diction. In addition, nursery rhymes and counting games help the child gain language agility and develop fluent speaking skills and habits.

- Physically, when using instruments and/or moving with music, small and large muscles develop, and the development of body-mind coordination is positively affected.
- With the influence of music, negative emotions and behaviors such as insecurity, timidity, aggression and fear can be transformed into positive emotions and behaviors and the child can be provided with positive development in psycho-social and psycho-motor behaviors.
- Through regular musical practices, the child learns to use his free time correctly, program his life, communicates with his peers, and takes the right examples as a model.
- Through group work, the child learns to relax in a group, to be with others without drawing attention to himself, to experiment without fear of making mistakes, and to communicate effectively. However, a child with special talents may find the opportunity to stand out in the group with his solo work.
- Through group work, students learn to be in harmony with others, the rules of collaboration, and to take responsibility. In this way, he understands the importance of being in harmony with society and acquires the habit of discipline.
- Music enables the child to focus on aesthetics and to be sensitive to the environment he lives in; It develops the child's taste and enables him to distinguish the good and the beautiful.
- Music also motivates the child's creativity, teaches him to be open to innovations and tend to new experiences, and creates opportunities for him to become original.
- Music allows the child to get to know national culture and traditions.

The most important gain provided by music education is undoubtedly the ethical values. Gençaydın stated that art education is a very important resource that affects human development circles and nourishes sensitivity by saying "Uninformed societies become ignorant, but insensitive societies become barbaric". He adds that it is impossible for a person whose emotions are nourished by the pleasure of aesthetic values to move away from ethical values and think of evil and states that the most economical and shortest way to gain sensitivity is through art education (Gençaydın 2002: 29 as cited in Mercin and Alakuş, 2007: 18). Due to its importance, music education, which is one of the main branches of art education, should be

given not only to individuals with artistic talent, but also to those other than these individuals. In this sense, in order for music education to achieve its goals, educational opportunities must be increased and educational environments outside of school must be provided.

1.2. Social Responsibility Projects and Music Education

According to research, the individual both socializes and develops his personality by adopting the behavioral examples and perspective on events of the social group he joins. In this respect, social groups, and especially peer groups in childhood, play an important role in the education of individuals and the formation of their values. It has been demonstrated through various experiments that children are influenced by the values, thoughts and feelings of other members of the group they are in, and even tend to identify with them.

According to Buchanan et al. (1998), school is one of the important institutions that contribute to the socialization of individuals, and if the school cannot fulfill this function for any reason, it will negatively affect the success, development, adaptation to the environment and mental health of the individual. In response to the effectiveness and importance of education that develops the individual and prepares him for life; Incomplete, insufficient and incorrect education can be the source of many problems (Yavuzer, 2006:162). For this reason, education should be considered as a whole, and efforts should be made to raise the child as a whole and at the highest level in terms of cognitive, emotional and psychomotor aspects. For this, it is necessary to provide the child with a modern educational environment that combines science, technique and art education.

Cengiz (2012) states that every child should receive art education and has the right to benefit from the opportunities of art while getting to know life and to express himself through one or more of the branches of art. He continues his statement with the following words mentioned in CRC: "State Parties shall respect and encourage the right of the child to participate fully in cultural and artistic life and shall encourage the provision of appropriate and equal opportunities for children in leisure, recreation and artistic and cultural activities" (Cengiz, 2012).

In another newspaper report by Gökbudak (2013), Prof. Dr. Gülgün Tosun addresses the issue from another perspective and states that the rate of children being pushed into crime is closely related to their educational level, and according to research, the number of children pushed

into crime decreases as their educational level increases. Tosun states that children should have socialization opportunities not only in school but also outside of school, in their neighborhoods with these words: "When we consider the socio-economic conditions of children who cannot access educational opportunities and socialize at school, it becomes easier for them to be pushed into crime. Because these children are children of families with relatively lower socio-economic income levels, the environment and environment in which they grow up is very suitable for this. Therefore, it becomes much more important to increase educational opportunities and create different socialization environments for these children. … Children should be directed to areas where they can improve themselves in socialization activities according to their interests and the subjects they are inclined to".

Like, Dr. Tosun, Yener and Öztürk (2008), who point out that violence and delinquency in children is an important social problem today, emphasize that there is a need for permanent - not temporary- solutions in controlling violence in primary and secondary education institutions and that the issue should be turned into a national project. Their study mentions that giving more emphasis to music education is an extremely important issue. It is recommended to include more social activities, especially musical practices, organizing informative, educational and explanatory events on the concept of music education in educational institutions in order to prevent the phenomenon of violence and gang formation in schools. It is also stated that at least one music teacher position should be provided to all primary and secondary education institutions (p.114).

Similarly, the findings of a study by Apaydınlı (2010) revealed that directing students who have problems at school and tend to engage in negative behaviors to a musical activity will encourage them to become role models for society by reinforcing their sense of respect and love and, will connect them to school. Creedon (2011) defines "art education" as the most effective "preventive pediatric medicine" in preventing, reducing and eliminating the tendency for depression and excessive stress, which are widespread in childhood, and emphasizes that the power of art to create positive emotions is of vital importance for schools. He states that music, dance, drama and visual arts practices are so important that they should be a part of in-school and out-of-school education. Çakmak (2013) states that positive thoughts about the future are formed in children who develop a sense of confidence through collective activities that

encourages cooperation and, also as a result of one-on-one work, these children can be enabled to participate in social life.

At this point, there is a need to popularize music education, which contributes positively to the social development of the individual and/or the child who is the subject of this study, and to organize it for each child. To respond to this need, music education studies outside of school are becoming increasingly widespread all over the world (Çakmak, 2012; Lindgren et al., 2016; Odena, 2023). Many private and legal organizations such as municipalities, universities, schools, foundations and associations give priority to education within the scope of community service practices and SRP, believing that the solution of social problems and the development of the country can only be achieved through education. SRP mentioned here is is organized, carried out and, provided by voluntary institutions and individuals for every person, regardless of age, socio-economic status and education level.

Argüden (2007) explains this phenomenon which is referred to as "corporate social responsibility" in the literature as "the voluntarily contribution of companies to a better society and a better environment". He states that the happiness created in the society by institutions that are compatible with the expectations of the society and show interest in its problems will result in happier employees, happier customers and therefore happier shareholders in the future. Emphasizing that the principles and targets in social responsibility projects should be clearly stated and implemented with serious planning and implementation, Argüden expresses that in line with the principle of "unmeasured performance cannot be improved", the relevant performance criteria should also be determined and monitored regularly. In addition, the author recommends developing collaborations with other organizations and non-governmental organizations while fulfilling social responsibilities and providing opportunities for creative solutions in order to achieve targeted results. He also adds that future leaders who take pioneering activities in this regard should be trained and encouraged (Argüden, 2007: p. 37- 40).

Today, SRP carried out directly by the state or goverments to solve social problems through music education are becoming widespread in the world. The "Gamelan Project" in Indonesia, the "Music Manifesto" in England, and the "El Sistema" movement implemented in Southern Venezuela since 1975 can be given as examples of these projects. Especially, El Sistema has been

taken as an example in many countries and started to be implemented with similar projects (Creech et al., 2013; Lindgren et al., 2016). The "Leading Note" project in Canada is one of them. The common feature of all these studies is that they consist of trainings that are based on volunteering and are carried out in solidarity, without boring the children, without discrimination, without considering social class. The aim is to reveal and use the musical talent that every child has at a certain level to ensure the healthy individual and social development of the children. And, to provide the necessary environment and opportunities to ensure that they are happy in both their personal and social lives as conscious, creative, productive, sharing and responsible individuals. Educational institutions at the primary, high school and higher education levels in Türkiye aim to raise their students as socially sensitive individuals with the "community service courses" they offer within the framework of their education programs, and they fulfill their social responsibilities through studies related to their fields carried out by the students. Again, foundations, associations, banks, institutions and organizations etc. also conduct SRP in many provinces that support education through art and music. For example, the "Music for Peace Foundation", founded in 2005 by Architect Mehmet Selim Baki in Edirnekapı, Istanbul, has removed the obstacles to the right to participate in arts through music education by creating common social and cultural living spaces for thousands of children with limited opportunities. It has become a center of solidarity and sharing with the active participation of children and families (Çakmak, 2013: 50). A recent press briefing by Ercan Evren, founder of Antalya Philharmonic Association (AFD), drew attention to an important point on the subject. Stating that there are no music lessons in primary schools in Türkiye although this field of education has a great impact and importance in childhood, Evren said that a project named "Art Begins in Primary School (ABIPS) is being held in 10 schools in Antalya with the support of Antalya Education Foundation (ANTEV) and Antalya Industrialists' and Businessmen's Association (ANSİAD)" and talks about the work done. However, Evren stated that without the support of state, the work of such non-governmental organizations would be insufficient; that the studies would only be applicable in a single province and selected schools and would not be sustainable and, that the impact of the projects would be limited to just raising awareness (Şehrim Antalya News: https://mobil.sehrimantalya.com/haber/ okullarda-muzik-ogretmeni-yok/23559/).

In the light of all these explanations, it is necessary to emphasize once again the importance of musical practices carried out within the scope of SRP and to draw the public's attention to the impact of music education not only on the education of children but also on the education of societies.

2. Method

In this study, the literature review method was used as a qualitative research design. As Karasar (2016) states, in qualitative research, scanning is a research approach used to understand and describe a specific situation or phenomenon. Data were obtained by scanning the publications that could be accessed on the subject in the literature. Suggestions were presented regarding the compiled and interpreted data.

3. Result

In order for the child to continue and complete his social development in a healthy way, he must be able to adapt to and integrate with the society he lives in and acquire the behaviors that are valid in the society. Apart from being an educational field and educational purpose, music education is also an important and effective educational tool due to its positive effects and contributions to the social development of children. Extensive literature highlights music's pivotal role in enhancing social skills, emotional intelligence, and cooperative behaviors among children aged 7-14. Music education not only improves the cognitive and psychomotor skills of children, but also provides emotional and social benefits, including its capacity to cultivate empathy, self-confidence, and creativity. Music education contributes to children growing up as individuals who are self-confident, enterprising, able to express themselves accurately and beautifully, have high perception, have developed aesthetic value judgments, are sensitive, and at peace with themselves and their environment.

In this sense, in order for music education to achieve its goals, educational opportunities must be increased and every child must be given equal opportunity to benefit from music education, which is their "legal right". It is necessary to contribute to the social development of children who have socio-economic deficiencies, who do not have the opportunity to participate in musical practices at school or outside of school, and/or who need special education, by providing educational environments outside of school and by receiving support from out-of-school music education.

4. Discussion and Conclusion

In this study, music practices within the scope of SRP, which are organized and carried out on a voluntary basis by various private and legal institutions and organizations, which offer every child the opportunity to receive art education outside of school and engage in any branch of art, regardless of socio-economic status and education level were investigated. This study emphasizes the positive role and beneficial impact of these musical practices on the social development of children.

In a process where the Ministry of National Education has indirectly taken away children's right to art education by making art courses in schools optional, the musical practices carried out within the scope of SRP are quite meaningful and functional. SRP can be defined as "the collaboration of public, private and non-governmental organizations for a common purpose and producing and implementing projects for the benefit of society". The target audience in these projects is children. Because generations with qualified education are the future of a country. If we want a livable world consisting of peaceful and sensitive societies, we need to fulfill our social responsibilities both personally and corporately. By integrating music into comprehensive educational frameworks and SRP, societies can nurture socially responsible citizens equipped to navigate and positively contribute to their communities, thereby advancing broader social and cultural goals.

Although SRP are voluntary practices designed with a collaborative approach, the state should also take some regulatory measures in the dissemination of these important services; Supporting laws and regulations for corporate SRP projects need to be established. In this process, first of all, it is necessary to inform and raise the public's awareness by attracting the public's attention about the contribution of art education to the psycho-social development of children, and to implement community-based and society-integrated change programs. However, in order to draw attention to the importance of the subject and create a widespread impact, it may be suggested that the music education studies carried out in our country and around the world within the scope of SRP be shared with more comprehensive and practical research and scientific publications.

4.1. Limitations and Suggestion

Another recommendation is to conduct SRP with children in need of special education and increase its practices. It is stated in the literature that these studies are the subject of "music therapy" and although there are research on music therapy studies with special needs kids (Devroop, 2012; Teachout, 2015), no studies related to SRP have been found. Accordingly, it may be recommended that music therapy studies be carried out within the scope of SRP, which will enable these children to participate in social life through art education and contribute to their development of cognitive, emotional and psychomotor skills.

5. References

Argüden, Y. (2007). Corporate Social Responsibility. In Coşkun Can Aktan (Ed.), *Corporate Social Responsibility, Businesses and Social Responsibility* (pp. 37-44). IGIAD (Economic Enterprise and Business Ethics Association) Publications.

Anshel, A. & Kipper, D. A. (1988). The Influence of Group Singing on Trust and Cooperation. *Journal of Music Therapy, 3,* 145–155.

Apaydınlı, K. (2010). *Examining the relationship between general high school students' tendency to show unruly behavior and music education*. (Doctoral dissertation). Gazi University Institute of Educational Sciences.

Aslan, K. (2001). Social Foundations of Education. *Balıkesir University Social Sciences Journal, 2001* (5), p. 16-30.

Burns, Judith. (12 June 2012) *BBC News. Group Music Sessions 'May Boost Empathy in Children'*. http://www.bbc.com/news/education-18412409

Cengiz, G. (14 December 2012). Evrensel Newspaper, *The Child's Right to Art Education*. http://www.evrensel.net/kose-yazisi/43610/cocugun-sanat-egitimi-hakki.html

Creech, A., Gonzales-Moreno, P., Lorenzino, L. & Waitman, G. (2013). *El Sistema and Sistema-Inspired Programmes: A Literature Review of research, evaluation and critical debates*. Sistema Global. Retrieved from http://sistemaglobal.org/literature-review/full/

Creedon, D. W. (2011). Fight the stress of urban education with the arts. *Phi Delta Kappan, 92*(6), 34-36. https://doi.org/10.1177/003172171109200607

Çelebi, N. (1990). Youth and Cultural Integration, Cultural Values and Social Change. In (Eds.) Beylü Dikeçligil & Ahmet Çiğdem, *Aile Yazıları 2,* Science Series 5/2 (p. 391). T.C. Presidential Family Research Institute.

Devroop, K. (2012). The social-emotional impact of instrumental music performance on disadvantaged South African students. *Music Education Research, 14*(4), 407-416.

Eskioğlu, I. (2003). Müzik eğitiminin çocuk gelişimi üzerindeki etkileri. Ed. Cemal Yurga, *Cumhuriyetin 80. yılında müzik eğitimi sempozyumu tam metin kitapçığı* içinde, 116-123. İnönü Üniversitesi Yayınları.

Figueiredo, S. & Odena, O. (2022). The impact of music education in social projects. In *Music and Social Inclusion: International Research and Practice in Complex Settings*, Ed. Oscar Odena. Londra: Routledge. https://doi.org/10.4324/9781003188667 Retriewed from https://books.google.com.tr/

Gökbudak, T. E. (07 January 2013). İhlas News Agency, Gündem [Agenda], Children are being pushed into crime, http://www.iha.com.tr/cocuklar-suca-itiiyorum-gundem-257517

Hallam, S. (2010). The power of music: Its impact on the intellectual, social and personal development of children and young people. *International Journal of Music Education, 28(*3) 269–289. http://doi.org/10.1177/0255761410370658

Hargreaves, David J. , Marshall, Nigel A. and North, Adrian C. (2003). Music education in the twenty-first century: A psychological perspective. *British Journal of Music Education, 20*, 147-163.

Hospital, M. M., Morris, S. L., Wagner, E.F. & Wales, E. (2018). Music education as a path to positive youth development: An el sistema-inspired program. *Journal of Youth Development, 13* (4), 149-163. http://doi.org/10.5195/jyd.2018.572

Karasar, N. (2016). *Bilimsel araştırma yöntemi.* Nobel Yayıncılık.

Kirschner, S. & Tomasello, M. (2010). Joint music making promotes prosocial behavior in 4-year-old children. *Elsevier Evolution and Human Behavior*, *31*, 354–364.

Lindgren, M., Bergman, Å., & Sæther, E. (2016). The construction of social inclusion through music education: Two Swedish ethnographic studies of the El Sistema programme. I: Nordic Research in Music Education. *Yearbook 17*, 65-81. Retriewed from http://hdl.handle.net/11250/2474144

Mercin, L. & Alakuş A. O. (2007). The Necessity of Art Education for Individuals and Society. D.U. Ziya Gökalp Faculty of Education Journal 9, 14-20.

Odena, O. (2023). The role of music in social projects: an introduction to its well-being benefits. *Mental Health and Social Inclusion, 27*(3), 210-219.

Shields, C. G. (2001) Music education and mentoring as intervention for at-risk urban adolescents: Their self-perceptions, opinions, and attitudes. *Journal of Research in Music Education, 49(*3), 273-286.

Şehrim Antalya News (11.0.2024). https://mobil.sehrimantalya.com/haber/okullarda-muzik-ogretmeni-yok/23559/

Teachout, D. J. (2005). The impact of music education on a child's growth and development. In D. A. Hodges (Ed.), *Sounds of learning*. Carlsbad, CA: International Foundation for Music Research. Retrieved from: http://www.uncg.edu/mus/soundsoflearning.html

Tuna, M. (2008) The *Role of Popular culture in the socialization of primary school children (Isparta Example).* Unpublished Master's Thesis, Süleyman Demirel University, Social Sciences Institute, Department of Sociology, Isparta.

Yener, S. and Öztürk E. (2008). The importance of music education in preventing violence in primary and secondary education institutions. *Atatürk University Faculty of Fine Arts Journal, (14)*, 111-115.

Yavuzer, H., (2006). *Children and Crime (11th Edition)*. Remzi Bookstore.

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 340-370 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Investigation of Turkish Teacher Candidates' Listening Comprehension Skills Using the Cornell Note-Taking Technique

Ali Haydar AKPOLAT *[1], Sevda KOÇ AKRAN [2]

* *Corresponding ah.akpolat@alparslan.edu.trl*
[1]*Muş Alparslan University, Türkiye*
[2]*Siirt University, Türkiye*

Abstract

The main purpose of this research is to determine the listening comprehension skills of Turkish teacher candidates using the Cornell Note-Taking Technique. The study group of the research based on case design consists of 29 students studying in the third grade of the Department of Turkish Language Teaching at the Faculty of Education at Muş Alparslan University. In the study, semi-structured interview forms and documents regarding student activities were used as data collection tools. In the study, 12 training sessions were given to the participants using the Cornell note-taking technique. At the end of the training, the participants' opinions about the Cornell Note-Taking Technique were obtained with a semi-structured interview form. These opinions of the participants were subjected to content analysis. As a result of the study, the participants expressed the Cornell Note-Taking Technique as a technique for planned study, meaningful learning and listening skills. With this technique, the participants' effective listening, distinguishing information, using time effectively, critical thinking, creative thinking and problem-solving skills were developed. The participants experienced problems in the recording step, abbreviation step, reflection step and summarization step during the Cornell note-taking technique training process. In solving the problem, the participants offered suggestions such as carrying out activities aimed at application, associating new information with previous information, using time effectively and selecting appropriate texts. Participants explained that environmental and individual factors affected their listening skills during the implementation of the Cornell note-taking technique.

Keywords: Listening Skills, Note Taking, Cornell Note Taking Technique

Citation: Akpolat, A.H., & Koç Akran, S. (2024). Investigation of Turkish teacher candidates' listening comprehension skills using the Cornell note-taking technique. *Instructional Technology and Lifelong Learning, 5(2)*, 340 - 370. https://doi.org/10.52911/itall.1591878

Türkçe Öğretmen Adaylarının Cornell Not Alma Tekniği ile Dinlediğini Anlama Becerilerinin İncelenmesi

Özet

Bu araştırmanın temel amacı, Cornell Not Alma Tekniği ile Türkçe Öğretmen adaylarının dinlediğini anlama becerilerini belirlemektir. Durum desenine dayalı araştırmanın çalışma grubunu, Muş Alparslan Üniversitesi Eğitim Fakültesi Türkçe Öğretmenliği üçüncü sınıfta öğrenim gören 29 öğrenci oluşturmaktadır. Araştırmada veri toplama araçları olarak yarı yapılandırılmış görüşme formu ve öğrenci etkinliklerine yönelik dokümanlar kullanılmıştır. Araştırmada katılımcılara Cornell Not Alma Tekniği kullanılarak 12 oturumluk eğitim verilmiştir. Eğitim sonunda yarı yapılandırılmış görüşme formuyla katılımcıların Cornell Not Alma Tekniğine ilişkin görüşleri alınmıştır. Katılımcılara ait bu görüşler içerik analizine tabi tutulmuştur. Araştırma sonucunda katılımcılar, Cornell Not Alma Tekniğini planlı çalışma, anlamlı öğrenme ve dinleme becerilerine yönelik bir teknik olarak ifade etmiştir. Bu teknikle katılımcıların etkili dinleme, bilgiyi ayırt etme, zamanı etkili kullanma, eleştirel düşünme, yaratıcı düşünme ve problem çözme becerileri gelişmiştir. Katılımcılar, Cornell not alma tekniği eğitimi sürecinde kaydetme basamağı, kısaltma basamağı, yansıtma basamağı ve özetleme basamağında problemler yaşamıştır. Problemin çözümünde katılımcılar, uygulamaya yönelik etkinliklerin yapılması, yeni bilgilerin önceki bilgilerle ilişkilendirilmesi, zamanın etkili kullanılması ve uygun metinlerin seçilmesi önerilerini sunmuştur. Katılımcılar, Cornell not alma tekniğinin uygulanması sürecinde çevresel ve bireysel faktörlerin dinleme becerilerine etki ettiğini açıklamıştır.

Anahtar Kelimeler: Dinleme Becerisi, Not Alma, Cornell Not Alma Tekniği

Date of Submission	26.11.2024
Date of Acceptance	26.12.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	This study was carried out with the permission decisions taken by the Siirt University Ethics Committee with session number 444 dated 15.08.2022.
Acknowledgments	This article is extracted from my master thesis entitled "Opinions of Turkish pre-service teachers on the listening comprehension skills: Example of Cornell note-taking technique", supervised by Sevda Koç Akran (Master's Thesis/, Siirt University, Siirt, 2023).
Author(s) Contribution	**Akpolat:** Conceptualization, Methodology, Data curation, Writing-Original draft preparation. **Koç Akran:** Methodology, Writing-Original draft preparation, Writing- Reviewing and Editing.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	italljournal@gmail.com
Grant Support	-
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Since the day they came into being, people have transferred their knowledge and experiences to each other through language for generations. The Turkish Language Association (2023) defines the concept of language as people expressing their feelings and thoughts through words or some signs and conveying them to the other person. Language is the most effective tool that provides communication between people (Demir, 2020). Human beings have been trying to realize their dreams by using this tool since their existence until today (Çalıcı, 2019). While doing this, they use voice, writing, body language, and express their values, thoughts, and feelings in individual and social areas (Oruç, 2016). Language is a social phenomenon and is based on the principle of causality. It constitutes the common denominator of individuals who make up society. It is a systematic and national institution used by individuals living together to form a healthy society (Sevimli, 2015). Here, the individual tries to use listening, speaking, reading, and writing skills (Köprü, 2020). The aim is to acquire new information based on basic language skills. For example, the individual acquires the skill of understanding through listening, seeing and reading. The messages are tried to be understood through the texts read and listening exercises (Calp, 2010). In this skill, which the individual uses from a young age, it is important to understand and interpret verbal language (Hagtvet, 1998). In listening, which has a different place among other skills, the individual tries to understand what he/she hears from the moment he/she is born (Özbay, 2013).

The listening skill presented to the individual during the prenatal process becomes meaningful with the active use of sensory organs (Demir, 2020). The individual uses listening skills to improve his/her vocabulary at school, at home, and in his/her immediate environment and to solve problems encountered in human relations (Bulut, 2013). In other words, listening is an "indispensable" skill for the preservation of social order and continuity (Okur and Beyce, 2013). Certain stages should not be overlooked in this skill, which should be used in lifelong learning. These are perceiving the sounds occurring in the environment through the auditory organs, that is, hearing, decoding and interpreting the message heard, understanding the sounds selected and of interest, remembering previously learned information, evaluating messages, and responding to the speaker (Gürel, Tat, and Özşenler, 2018). All these stages are offered to the individual in schools, which start in the family environment and have a formal education framework. Listening, which is among the basic learning tools in the school period, constitutes

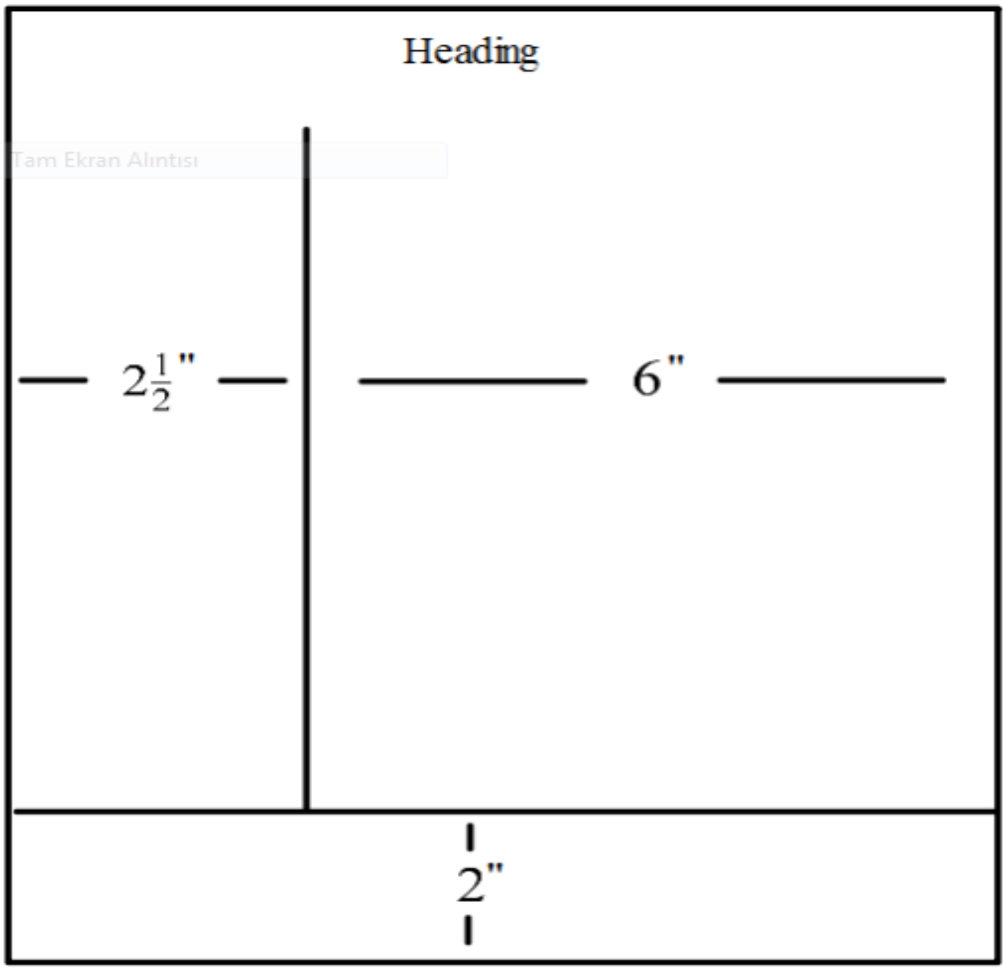
the priority of language education (Çelenk, 2005). In fact, the most used word by teachers in in-class practices is "listen" (Özbay, 2013). Because one of the primary problems of classroom discipline is students' failure to listen. There may be many reasons for this. One of the reasons for not listening is that children have acquired this skill informally in the family environment before starting school. Since children create a flexible learning environment in their immediate environment, they continue to use this skill in daily life in a more formal environment. Another reason is that teachers are reluctant to use listening strategies. They think that listening skills will take time (Doğan, 2011; Tüzel and Keleş, 2013; Tayşi, 2014). In order to avoid such situations in teaching activities in and outside the classroom, teachers are expected to use certain techniques. One of these techniques is the Cornell Note-Taking Technique, which is involved in quantum learning.

Note taking is a very useful practice in terms of remembering and not forgetting information (Kardaş, 2018). Note taking is writing down the parts of the verbal expression in a text that are deemed appropriate for the purpose. It is summarizing the information and noting it for future use (Tabak and Karadüz, 2016). It is the meaningful coding of mental information (Simonet and Simonet, 1995). Note-taking, which should not be confused with taking notes, is summarizing the information and drawing attention to the parts listened to. In taking notes, the individual transfers all the information he/she listens to and reads to writing. In note taking, not all of the information listened to and read is written, but only the important parts (Türk, 2016). For this reason, not taking prevents distraction during the listening process. It helps the individual study in exams. It ensures that important information is repeated and not forgotten. It gives the individual the habit of writing. It helps the subject to be understandable (Özbay, 2012; Özçakmak, 2015).

Cornell, which is among the note-taking techniques, improves the individual's critical reading and increases academic success (Ahmad, 2019; Quintus, Borr, Duffield, Napoleon, & Welch, 2012). It was developed by Walter and Pauk in 1949 to support the comprehension skills of students at Cornell University. The technique, which provides more effective results than traditional note-taking methods, includes a specific worksheet (Sholikhah, Sumani, & Rahmasari, 2019).

Figure 1.

Cornell Note-Taking Technique Worksheet (Pauk, 2001; 239)



As seen in Figure 1, in the Cornell Note-Taking Technique, the left column constitutes one-third of the page and the right column constitutes two-thirds of the page (Faber, Morris, & Lieberman, 2000). Notes are taken in the right column, and attempts are made to capture the narrator's ideas and facts. What is to be noted during the note-taking phase may vary from student to student. For this reason, the student includes his/her own sentences in the right column. The main points and keywords are in the left column. The aim is to benefit from clues in learning. The meanings of questions/keywords are clarified, relationships emerge, continuity is provided and the connection between the diagrams is strengthened, with clues. In the lower section, a summary is made about the subject. The student repeats with the summarized information. The student can more easily see their shortcomings and success points (Quintus et al., 2012). In short, the Cornell Note-Taking Technique page structure consists of four sections. The subject/title is written at the top. Notes are taken on the right. The left side is the

marking column. A summary is made about the subject at the bottom (Broe, 2013; Saputri, 2020).

The Cornell Note-Taking Technique, which consists of three sections, has certain stages. These are recording, reducing, reciting, reflecting, reviewing and sampling (Maulidia, Bahri ve Silviyanti, 2021; Kardaş, 2018; Saputri, 2020). In the recording stage, special and effective information is addressed. Here, not every word heard is written. In the reducing stage, short notes are kept. In reciting, detailed notes are associated with keywords. In reflecting, new ideas are examined and written. It is the stage where creative thinking skills are used. In reviewing, statements representing all information are written. In the sampling stage, information is reinforced with different examples (Akçay, 2018). In other words, meaningful learning occurs with the Cornell Note-Taking Technique. Apart from meaningful learning, many scientific studies mention the effect of the Cornell Note-Taking Technique on the learning-teaching process. These studies examined the Cornell Note-Taking Technique's development of text summarization skills (Karatay, Kaya, & Tekin, 2020), listening comprehension (Kurudayıoğlu & Soysal, 2016), its effect on listening comprehension and recall (Şahin, Aydın, & Sevim, 2011), text reading (Kalb, 2003), achievements (Williams, 2004), active participation in the lesson (Boelter, 2010), grammar learning (Davoudi, Moattarian, & Zareian, 2015), and reading instruction (Sholikhah, Sumani, & Rahmasari, 2019; Saputri, 2020). Studies were conducted on secondary school, high school, English language learning students and university students. In this study, the listening comprehension skills using the cornell note-taking technique of turkish teacher candidates, who are future teachers, were tried to examine. It is thought that the study will contribute to the literature due to the lack of domestic research. In this regard, answers are sought to the following questions:

1. What are the opinions of Turkish teacher candidates about the Cornell note-taking technique?

2. What are the opinions of Turkish teacher candidates about the contribution of the Cornell note-taking technique to listening skills?

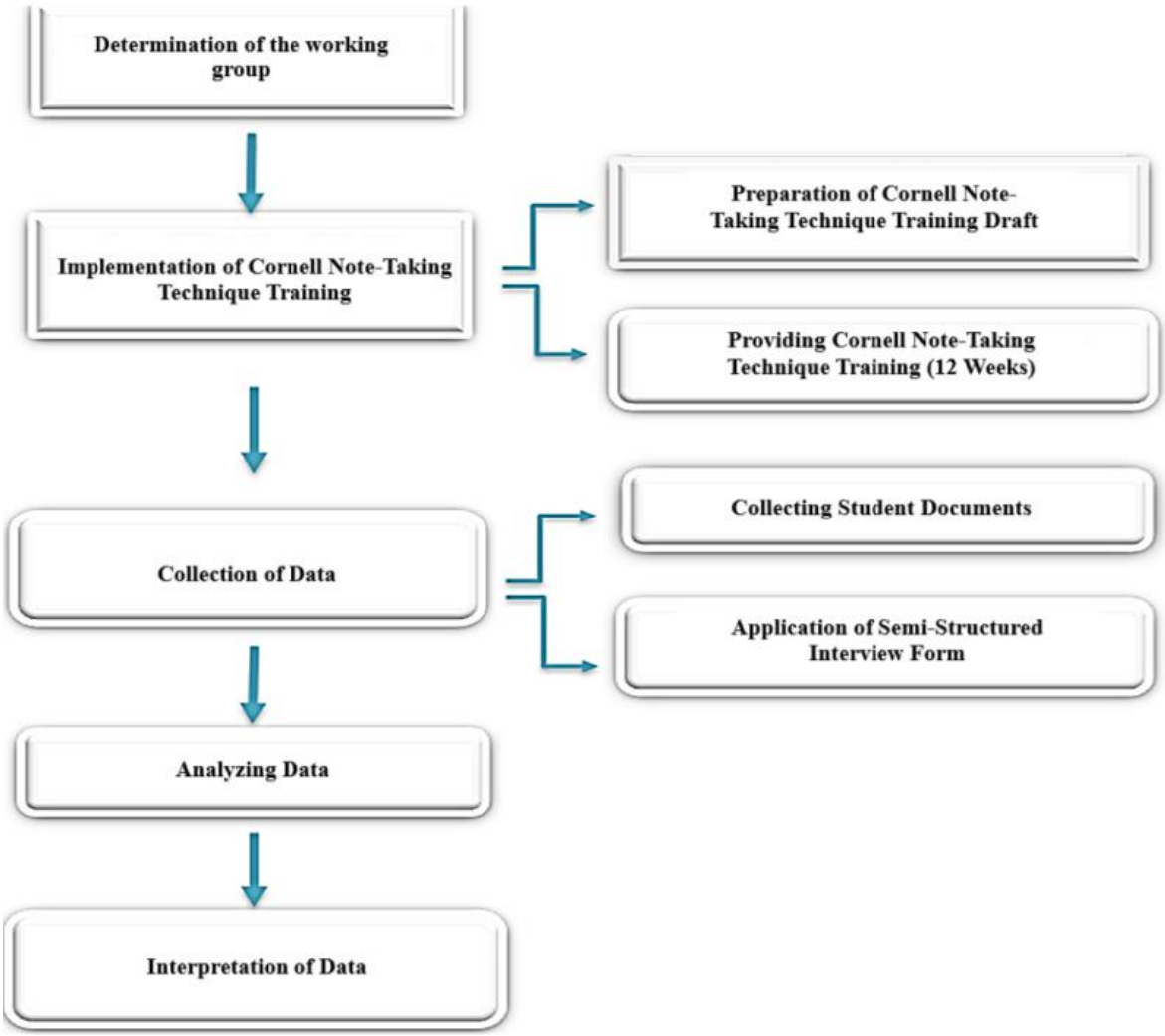
2. Method

2.1. Research Model

The casstudy method, one of the qualitative research designs, was used in the study. A case study is the examination of the subject in a natural environment without any control or intervention. In the examination conducted in the case study, data is systematically collected and analyzed (Aytaçlı, 2012) (See: Figure 2). Different case designs can be used in the analysis process. Since the Cornell Note-Taking Technique was handled with a holistic approach in this study, a holistic single case design was used. The single case design examines unusual or unique situations where there is a single unit of analysis and contributes to the testing of a well-formulated theory (Subaşı and Okumuş, 2017).

Figure 2.

Implementation Process of the Research



As seen in Figure 2, the case design was used in the study by considering five stages. In the first stage, the study group was determined. The research was conducted with 29 students studying in the 3rd grade of Turkish Language Teaching. In the second stage, the implementation of the Cornell Note-Taking Technique training was started. Here, student and expert opinions were taken to create the training content. Afterwards, the text types were determined. Then, the training draft was presented to expert opinion and took its final form. Finally, the students were given a 12-week Cornell Note-Taking Technique Training. In the third stage, data were collected. In this stage, the worksheets that the students worked on during the Cornell Note-Taking Technique training process were collected. Then, a semi-structured interview form was applied as a result of expert opinions. In the fourth stage, the data were analysed. In the last stage, the data were interpreted.

2.2. Study Group

The study group of the research consists of 29 teacher candidates who are studying in the third grade of Department of Turkish Language Teaching at Faculty of Education at Muş Alparslan University and were determined by easily accessible case sampling. In the easily accessible case sampling, which provides speed and practicality to the research, the researcher selects a group that is easy to reach (Yıldırım and Şimşek, 2016). The participants consist of a total of 29 people, 23 (79.3%) of whom are girls and 6 (20.7%) of whom are boys. While 7 (24.1%) of the participants read books regularly on a daily basis, 22 (75.9%) of whom sometimes read. It was observed that there were no participants who never read books. 5 (17.2%) of the participants stated that they read 10-20 pages, 7 (24.1%) of whom read 21-30 pages, 6 (20.7%) of whom read 31-40 pages, 4 (13.8%) of whom read 41-50 pages, and 7 (24.1%) of whom read 51 or more pages. While 23 (79.3%) of the participants listened to articles, stories, books, etc. that were voiced, 6 (20.7%) did not. While 16 (55.2%) of the participants received training on developing listening skills, 13 (44.8%) did not. 13 (44.8%) of the participants preferred the critical listening type the most among the listening types. The factor affecting the listening process of the participants was the physical environment with 41.4%. The text type that the participants listened to the most was poetry with 48.3%.

2.3. Data Collection Tools

In the study, data were collected through semi-structured interview form and document analysis. A literature review was conducted for the semi-structured interview form. A draft form was created after the literature review. The draft interview form was presented to expert faculty members working at Gazi University and Muş Alparslan University. One of these experts is an expert in Measurement and Evaluation, two in Curriculum and Instruction, and one in Turkish Education. A pilot application was conducted with a group of five prospective teachers in line with the expert opinions. After the pilot application, final corrections were made in line with the suggestions of the prospective teachers and the interview form was created. There are six questions in the interview form. Document analysis is materials that contain information about the subject being researched (Yıldırım and Şimşek, 2011). It is used to examine and evaluate all documents, including printed and electronic materials (Kiral, 2020). It consists of the following stages: (1) Accessing documents, (2) Checking originality, (3) Understanding documents, (4) Analyzing data, (5) Using data. In the study, while the listening skills of the participants were determined with the Cornell Note-Taking Technique, firstly the opinions of experts and students were taken on the texts (such as jokes, essays, stories, articles, novels). Attention was paid to the texts being between 5-10 minutes. While selecting the subjects of the texts, the opinions of 71 undergraduate students were sought via Google Forms. Later, the opinions on the Cornell note-taking worksheet and the visual texts they wanted to tell were re-evaluated by the researcher and interpreted in the findings section.

2.4. Analysis of Data

The data obtained in the study were subjected to content analysis. Content analysis, which addresses the relationships between concepts in the interpretation of data (Yıldırım and Şimşek, 2013), analyzes many forms of communication such as documents, papers, books, case studies, photographs, web pages, surveys and answers to interview questions (Sallan Gül and Kâhya Nizam, 2021). In the analysis, stages such as coding the data, finding themes, coding the data and organizing it according to themes, and interpreting the findings are taken into consideration. While coding the data in the study, the answers given by the participants to the interview questions were transferred to the computer and organized. In the first stage, the answers to all questions were read several times and codes were created. The codes were then

collected under certain themes. The themes were separated according to their similarities and differences, and the data obtained from here are shown in tables in the findings section. The code "K1, K2…K29" was used when quoting participant opinions under the tables.

2.5. Validity and Reliability

In qualitative studies, detailed explanation of the data and process are among the important criteria of validity. Validity of data can be ensured by fulfilling the criteria of credibility, transferability, consistency and confirmability (Yıldırım and Şimşek, 2011). It is recommended to have a long interaction with the study group for credibility. In the study, data were collected from the participants in the classroom where they were educated and after a long interaction process of 12 sessions. For the transferability criterion, the data should be presented to the reader without any comments in the findings section (Yıldırım and Şimşek, 2011). In addition, the method suggested by Miles and Huberman was used to calculate the reliability of the data in order to fulfill the transferability criterion. According to this method, the aim is for the agreement between the coders to be over 70% (Miles and Huberman, 1994). In this respect, the opinion forms of 29 participants were examined by a second researcher and it was seen that the agreement between the researchers was at an acceptable level (82%>70%). Since it is difficult to replicate the research in qualitative studies, the concept of consistency is used instead. In this study, the researcher(s) implemented each session regularly in accordance with the purpose of the study. After the sessions, documents were distributed to the participants, the texts were read and the data were analyzed. The analysis of the documents collected with the participants was repeated in accordance with the confirmability criterion.

3. Findings

3.1. Opinions of Turkish Teacher Candidates About the Cornell Note-Taking Technique

Participants' opinions about the Cornell Note-Taking Technique were examined under the headings of definitions, problems, solution suggestions for problems, and factors affecting listening skills during the implementation process.

Table 1.

Participants' Opinions on the Description of the Cornell Note-Taking Technique

Question	Theme	Codes		Coding Density
				f
How do you define the Cornell note-taking technique?	A technique for planned study	Enables practical note-taking (f=12)	K1, K2, K5, K6, K7, K8, K12, K13, K15, K18, K26, K27	36
		Creating a page layout within the framework of certain criteria (f=15)	K2, K5, K6, K8, K12, K14, K16, K17, K19, K20, K21, K24, K26, K27, K29	
		Provides concise and clear information (f=1)	K14	
		Prevents writing every sentence and ensures important information is recorded (f=5)	K1, K7, K13, K25, K27	
		Effective use of time (f=3)	K9, K13, K28	
	A technique for meaningful learning	Ensuring long-term learning (f=18)	K1, K2, K3, K5, K6, K7, K8, K9, K11, K12, K13, K14, K15, K16, K20, K26, K28, K29	30
		Keywords are recorded (f=5)	K21, K24, K25, K27, K29	
		Facilitates distinguishing key concepts (f=1)	K3	
		Engages students actively in the learning process (f=1)	K11	
		Ensures analytical thinking (f=2)	K10, K11	
		Enables distinguishing information (f=3)	K13, K21, K27	
	A technique for listening skills	Summarizes what the speaker says with short notes and keywords (f=3)	K4, K21, K22	9
		Listens to the speaker while taking notes (f=4)	K7, K9, K13, K20	
		Understands what is read and heard (f=2)	K16, K17	
			TOTAL	75

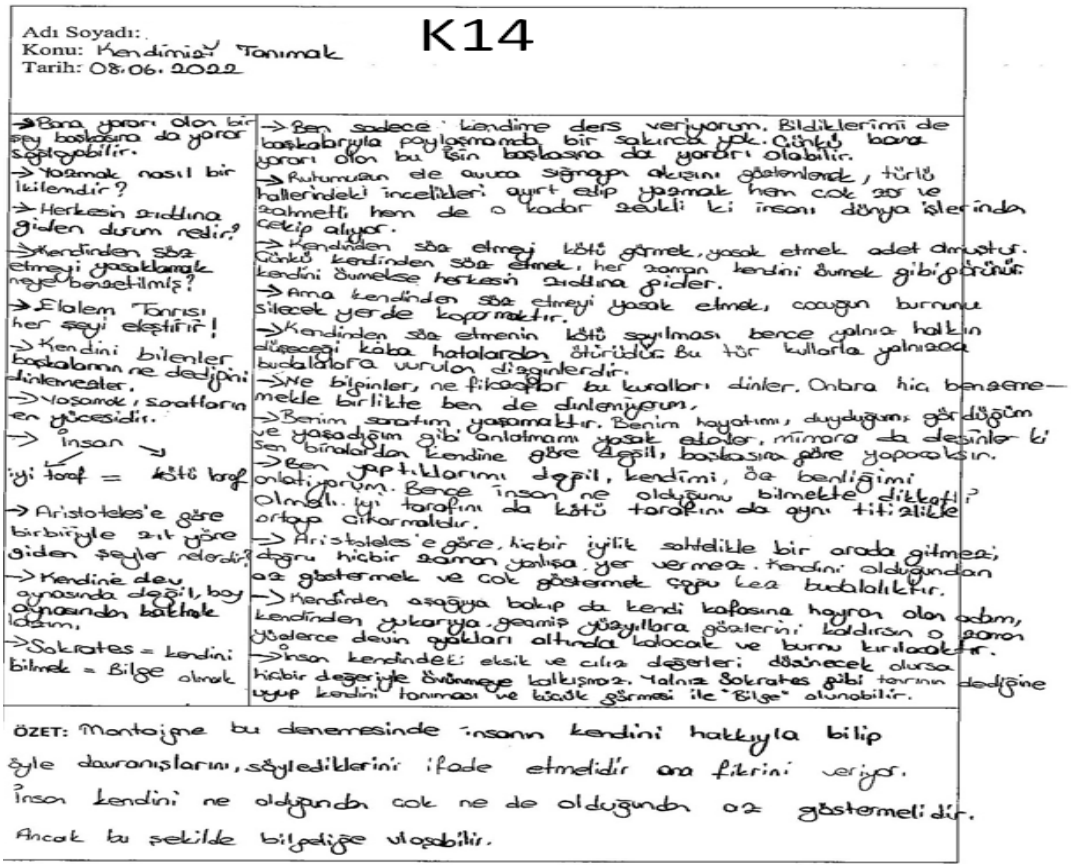
As seen in Table 1, three themes were created based on the participants' opinions about the definition of the Cornell Note-Taking Technique: "a technique for planned study, a technique for meaningful learning, and a technique for listening skills". The most emphasized codes among these themes are, respectively, creating the page layout within the framework of certain criteria (f=15), ensuring long-term learning (f=18), listens to the speaker while taking notes (f=4). Some quotes from the participants' views on the codes are given below.

It is the process of drawing a line on the left side of a page by the listener about a topic being explained, taking notes on the right side, writing key words, questions and symbols to remind the notes on the left side and writing a summary of the topic at the bottom (K14).

K14's opinion is supported by his/her activity below.

Figure 3.

K14 Participant's Cornell Note-Taking Worksheet Example

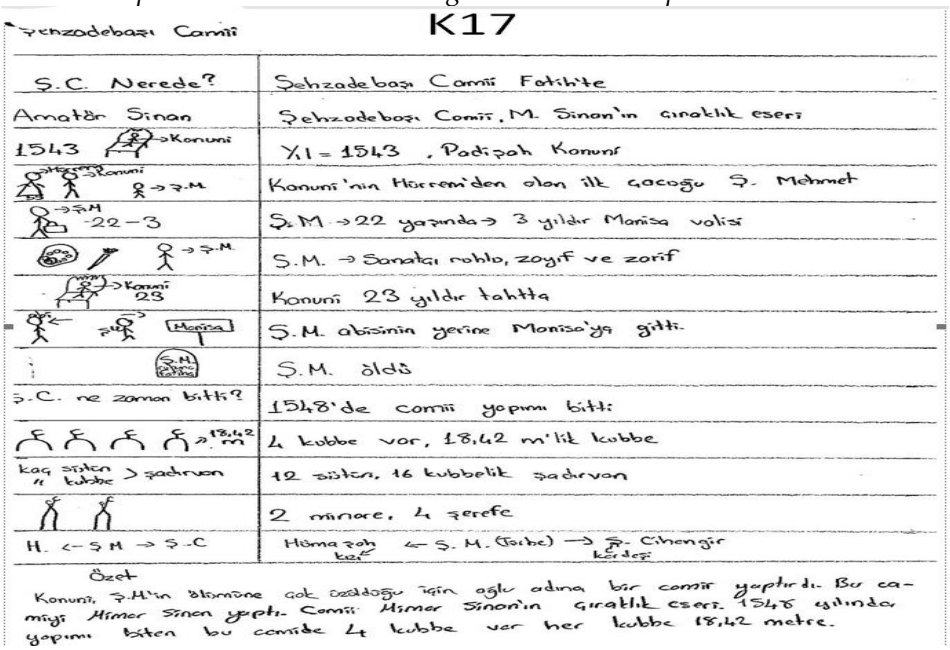


A line is drawn on the left side of the paper. Notes are taken on the right side of the paper. Key words, questions and words that represent these notes are written on the left side. The subject is summarized in the person's own sentences at the bottom (K17).

K17's opinion is supported by his/her activity below.

Figure 4.

K17 Participant's Cornell Note-Taking Worksheet Example



Şehzadebaşı Camii	K17
Ş.C. Nerede?	Şehzadebaşı Camii Fatihte
Amatör Sinan	Şehzadebaşı Camii, M. Sinan'ın ciraklık eseri
1543 Konuni	Y.1 = 1543 . Padişah Konuni
Konuni Ş.M	Konuni'nin Hürrem'den olan ilk çocuğu Ş. Mehmet
Ş.M 22 – 3	Ş.M → 22 yaşında → 3 yıldır Manisa valisi
Ş.M.	S.M. → Sanatçı ruhlu, zayıf ve zarif
Konuni 23	Konuni 23 yıldır tahtta
Manisa	Ş.M. abisinin yerine Manisa'ya gitti.
Ş.M	S.M. öldü
Ş.C. ne zaman bitti?	1548'de camii yapımı bitti
18,42 m	4 kubbe var, 18,42 m'lik kubbe
kaç sütun > şadırvan	12 sütun, 16 kubbelik şadırvan
	2 minare, 4 şerefe
H. ← Ş.M → Ş.C	Hürrem Sah ← Ş.M. (Şehzade) → Ş. Cihangir Kardeşi

Özet

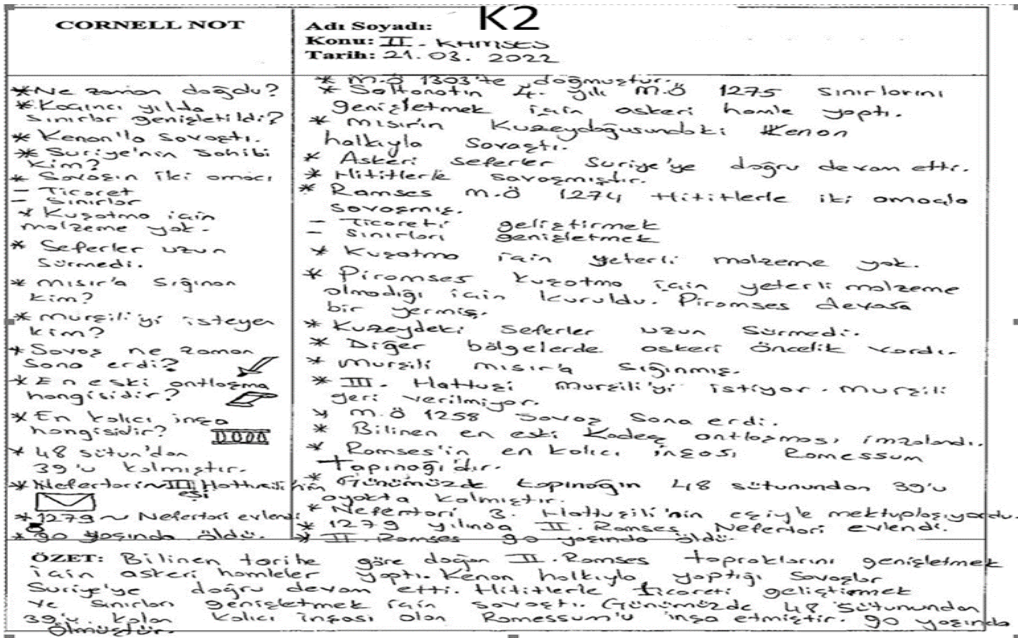
Konuni, Ş.M'in ölümüne çok üzüldüğü için oğlu adına bir camii yaptırdı. Bu camiyi Mimar Sinan yaptı. Camii Mimar Sinan'ın ciraklık eseri. 1548 yılında yapımı biten bu camide 4 kubbe var her kubbe 18,42 metre.

Thanks to this technique, we provide permanent learning (K1).

Thanks to this technique, information becomes permanent. This technique allows us to be practical in remembering information (K2).

Figure 5.

K2 Participant's Cornell Note-Taking Worksheet Example



CORNELL NOT	Adı Soyadı: K2 Konu: II - KHMSES Tarih: 21.03.2022
*Ne zaman doğdu? *Kaçıncı yılda sınırlar genişletildi? *Kenon'la savaştı. *Suriye'nin sahibi kim? *Savaşın iki amacı – Ticaret – Sınırlar *Kuzeyde için malzeme yok. *Seferler uzun sürmedi. *Mısır'a sığınan kim? *Mursili'yi isteyen kim? *Savaş ne zaman sona erdi? *En eski antlaşma hangisidir? *En kalıcı inşa hangisidir? *48 sütun'dan 39'u kalmıştır. *Nefertari – III. Hattuşili *1279 ~ Nefertari evlendi *90 yaşında öldü.	*M.Ö 1303'te doğmuştur. *Suriye'nin 4. yılı M.Ö 1275 sınırlarını genişletmek için askeri hamle yaptı. *Mısırın Kuzeydoğusundaki Kenon halkıyla Savaştı. *Askeri Seferler Suriye'ye doğru devam ettir. *Hititlerle savaşmışlardır. *Ramses M.Ö 1274 Hititlerle iki amaçla savaşmış. – Ticareti geliştirmek – Sınırları genişletmek *Kuzeyde için yeterli malzeme yok. *Piramses kuzeyde için yeterli malzeme olmadığı için kuruldu. Piramses devasa bir yermiş. *Kuzeydeki Seferler uzun sürmedi. *Diğer bölgelerde askeri üstünlük kurdu. *Mursili Mısır'a sığınmış. *III. Hattuşi Mursili'yi istiyor. Mursili geri verilmiyor. *M.Ö 1258 Savaş sona erdi. *Bilinen en eski Kadeş antlaşması imzalandı. *Ramses'in en kalıcı inşası Ramessum Tapınağıdır. *Günümüzde tapınağın 48 sütunundan 39'u ayakta kalmıştır. *Nefertari 3. Hattuşili'nin eşiyle mektuplaşıyordu. *1279 yılında II. Ramses Nefertari evlendi. *II. Ramses 90 yaşında öldü.
ÖZET: Bilinen tarihe göre doğan II. Ramses toprakların genişletmek için askeri hamleler yaptı. Kenon halkıyla yaptığı Savaşlar Suriye'ye doğru devam etti. Hititlerle ticareti geliştirmek ve sınırları genişletmek için savaştı. Günümüzde 48 sütunundan 39'u kalan kalıcı inşası olan Ramessum'u inşa etmiştir. 90 yaşında Ölmüştür.	

This technique allows for effective note-taking by capturing what the narrator means (K9).

K9's opinion is supported by his/her activity below.

Figure 6.

K9 Participant's Cornell Note-Taking Worksheet Example

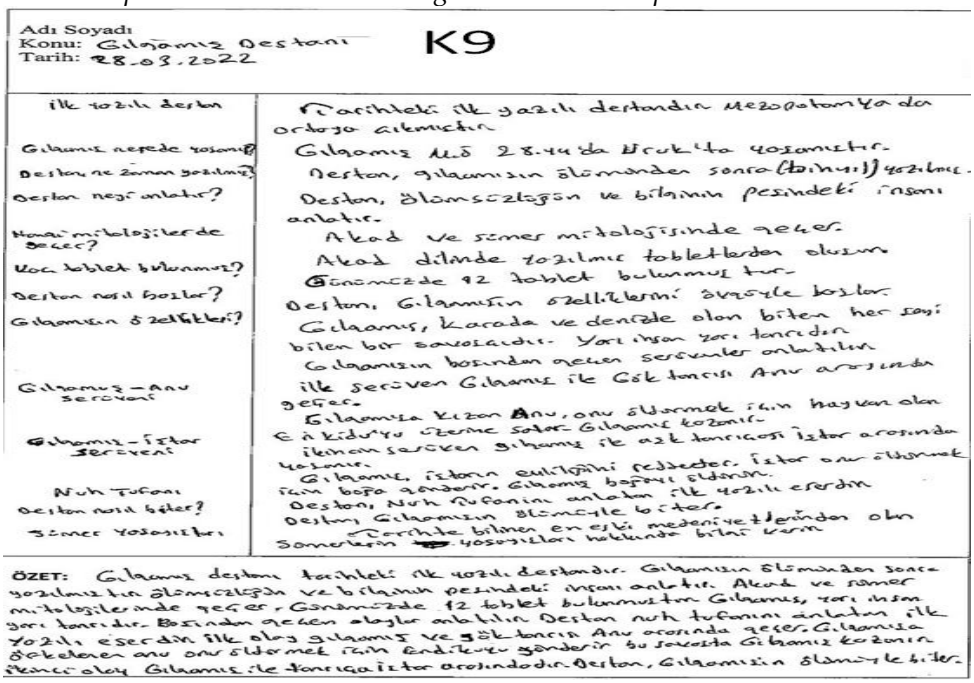


Table 2.

Participants' Opinions on the Problems They Encountered in the Cornell Note-Taking Steps

Question	Theme	Codes		Coding Intensity
				f
What problems do you encounter in the steps of Cornell note-taking?	Recording Information	Difficulty focusing on the given texts during the recording stage (f=7)	K2, K6, K7, K8, K9, K14, K16	18
		Inability to keep up with what is heard during the recording stage (f=11)	K5, K6, K7, K8, K11, K13, K14, K18, K19, K26, K28	
	Reducing Information	Difficulty placing abstract information (f=6)	K1, K3, K7, K9, K12, K13	21
		Problems forming questions, keywords, and clues related to paragraphs during the reducing step (f=15)	K1, K3, K4, K9, K10, K12, K16, K17, K18, K20, K21, K23, K24, K27, K29	
	Reflecting Step	Difficulty evaluating the text based on personal views using keywords and abbreviations (f=3)	K19, K22, K25	3
	Summarizing	Writing the topic using personal expressions (f=3)	K15, K17, K29	3
			TOTAL	45

As seen in Table 2, four themes were created based on the participants' opinions about the problems they encountered while using the Cornell Note-Taking Technique: "recording

information, reducing information, reflection step and summarizing". The most emphasized codes among these themes are, respectively, Inability to keep up with what is heard during the recording step (f=11), Problems forming questions, keywords, and clues related to paragraphs during the reducing step (f=15), Difficulty evaluating the text based on personal views using keywords and abbreviations (f=3), and writing the topic using personal expressions (f=3). Some excerpts from the participants' views on the codes are given below.

> *The part I had the most difficulty with was the reducing step. Because of reductions are not explanatory and comprehensive enough, they will not be effective. (K17).*
>
> *I had difficulty in reducing information and choosing keywords. Because sometimes the reduced information had more content than it should have. I was undecided about how to reduce the information to be shortened or the subject of the text (K18).*
>
> *I had difficulty finding abbreviations and symbols that fit the sentence. This may be due to the fact that I read few books (K23).*
>
> *While taking notes, I had difficulty finding keywords, symbols, and questions that fit the sentence (K24).*
>
> *K24's opinion is supported by his/her activity below.*

Figure 7.

K24 Participant's Cornell Note-Taking Worksheet Example

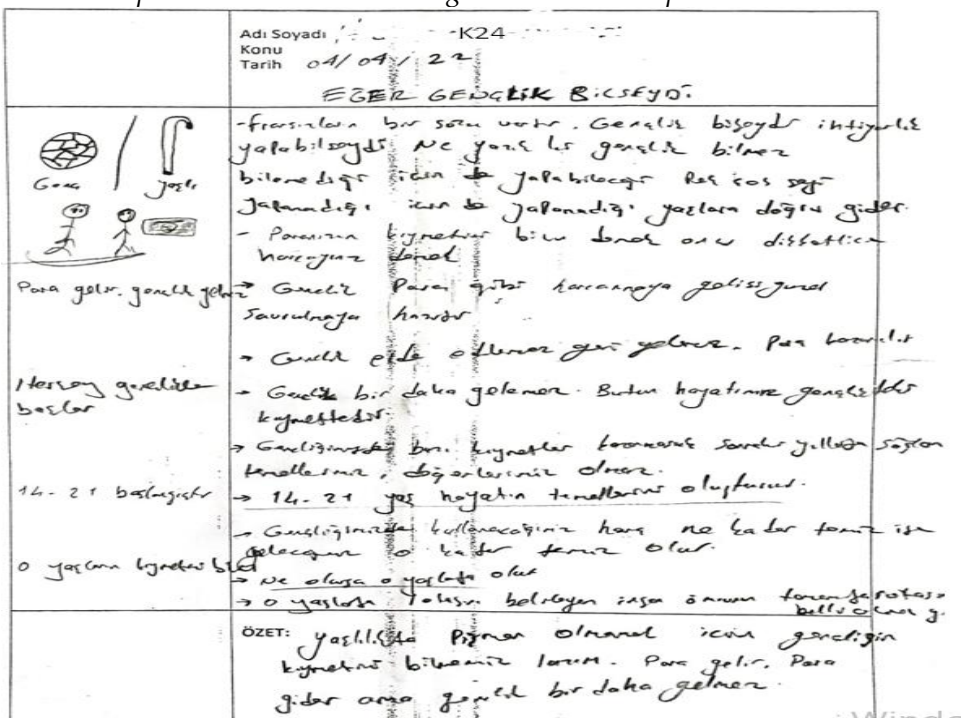


Table 3.

Solution Suggestions for the Problems Encountered by the Participants

Question	Theme	Codes		Coding Intensity
				f
What are your solution suggestions for these problems?	Practice-oriented activity	Conducting listening exercises (f=7)	K6, K8, K11, K12, K19, K21, K22	26
		Practicing more (f=15)	K1, K4, K5, K8, K9, K12, K15, K17, K19, K22, K23, K24, K25, K27, K29	
		Writing the reducing section immediately after recording (f=4)	K2, K3, K10, K13	
	Connecting old and new information	Coming to class prepared (f=2)	K5, K8	3
		Being aware of the subject (f=1)	K5	
	Using time effectively and text selection	Not choosing very long texts (f=5)	K14, K17, K26, K28, K29	8
		Paying attention to text selection (f=3)	K7, K14, K16	
			TOTAL	37

As seen in Table 3, based on the participants' views on proposing solutions to the problems they encountered while using the Cornell Note-Taking Technique, three themes were created: "practice-oriented activity, connecting old and new information, using time effectively, and text selection." The most emphasized codes among these themes are, respectively, practicing more (f=15), coming to class prepared (f=2), and not choosing very long texts (f=5). Some excerpts from the participants' views on the codes are given below.

> *By starting education at an early age, more experience and success are gained. In this way, more practice is done (K23).*
>
> *Education should be given at an early age so that the technique can be developed by providing more practice (K24).*
>
> *I think that the problems can be minimized by constantly applying the technique (K25).*
>
> *The number of pages can be chosen depending on the length of the topics (K14).*
>
> *The texts should be clearer and more concise, away from figures of speech, simple and short, and free from details (K18).*

Table 4.

Participants' Opinions on the Factors Affecting Listening Skills During the Implementation of the Cornell Note-Taking Technique

Question	Theme	Codes		Coding Intensity
				f
What are the factors affecting your listening skills during the implementation of the Cornell note-taking technique?	Environmental Factors	Temperature of the classroom, the amount of light in the classroom, the ventilation of the classroom/the amount of oxygen per student (f=16)	K3, K5, K6, K7, K9, K11, K16, K17, K18, K19, K20, K21, K25, K27, K28, K29	44
		Class being crowded and noisy (f=9)	K1, K2, K10, K16, K18, K21, K24, K25, K29	
		Teaching method and technique (f=2)	K4, K5	
		Teacher/speaker's attitude during the lesson (f=5)	K2, K5, K12, K13, K22	
		Speaker's tone of voice (f=10)	K1, K3, K4, K7, K9, K13, K15, K20, K25, K26	
		Text type (f=2)	K1, K18	
	Individual Factors	Student's interest in the lesson (f=1)	K29	17
		Students' psychological state (f=10)	K2, K8, K10, K11, K14, K19, K22, K23, K27, K28	
		Students' readiness level (f=2)	K18, K20	
		Motivation (f=1)	K7	
		Health problems (f=3)	K5, K15, K20	
			TOTAL	61

As seen in Table 4, based on the participants' views on the factors affecting listening skills during the application process of the Cornell Note-Taking Technique, two themes were created as "environmental and individual factors". The most emphasized codes within these themes are, respectively, the temperature of the classroom, the amount of light in the classroom, the ventilation of the classroom/the amount of oxygen per student (f=16), and students' psychological state (f=10). Some excerpts from the participants' opinions on the codes are given below.

> *The physical environment of the classroom, the amount of light, the correct adjustment of the light, the temperature of the classroom and the fact that it is crowded affect me (K16).*
>
> *The environment is very important for me when listening. I pay a lot of attention to heat, light, sound or noise. The attention factor, where note-taking and attention are done together, is very important. When these factors are not present, listening and note-taking are insufficient. Or they are disconnected (K17).*

It is very important for the classroom to be clean and sufficiently ventilated. There should be no objects that distract attention. The comfort of the seat and the noise in the environment affect me (K18).

The most important thing is that when my psychological state is not comfortable, I cannot focus on the lesson no matter how good the speaker is. My mind needs to be very relaxed. If my body is in the classroom and my mind is wandering in different realms, this psychological factor affects me a lot (K2).

If the student is not in a good psychology, he/she will not listen to the lesson. The most important factor that affects me is the student's psychology. If the student's psychology is not good, his/her physical presence in the classroom is not important (K8).

The factors that affect listening are my mood, absent-mindedness, thinking about other issues and not being able to focus on the text. As a result, the text I listen to affects my taking wrong notes (K10).

3.2. Opinions of Turkish Teacher Candidates on the Contribution of Cornell Note-Taking Technique to Listening Skills

In the second sub-problem of the research, the participants' suggestions regarding the contribution of the Cornell Note-Taking Technique to listening skills and the skills developed by the technique will be examined.

Table 5.

Participants' Opinions on the Contribution of Cornell Note-Taking Technique to Listening Skills

Question	Theme	Codes		Coding Intensity
				f
What is the contribution of the Cornell note-taking technique to listening skills?	Contribution to Effective Listening	Both listening and note-taking (f=11)	K1, K3, K5, K6, K7, K8, K12, K13, K19, K28, K29	22
		Contributing to finding the main idea (f=8)	K3, K5, K7, K8, K13, K15, K17, K25	
		Providing visualization of information (f=3)	K25, K26, K29	
	Contribution to distinguishing information	Concentrating on information during the listening process (f=13)	K2, K9, K10, K14, K17, K19, K20, K21, K22, K23, K24, K26, K29	43
		Understanding selected information and thoughts (f=12)	K1, K3, K4, K9, K15, K16, K17, K20, K21, K26, K27, K29	
		Establishing connections between information (f=1)	K2	
		Organizing and evaluating information (f=5)	K2, K9, K11, K16, K22	
		Processing what is heard mentally (f=12)	K2, K5, K8, K9, K14, K16, K21, K23, K24, K25, K28, K29	
	Using time effectively	Not wasting time taking notes (f=4)	K6, K7, K8, K28	4
			TOTAL	69

As seen in Table 5, based on the participants' opinions about the contribution of the Cornell Note-Taking Technique to listening skills, three themes were created: "contribution to effective listening, contribution to distinguishing information and using time effectively". As seen in Table 5, based on the participants' opinions about the contribution of the Cornell Note-Taking Technique to listening skills, three themes were created: "contribution to effective listening, contribution to distinguishing information and using time effectively". The most emphasized codes within these themes are, respectively, both listening and note-taking (f=11), concentrating on information during the listening process (f=13), and not wasting time taking notes (f=4). Some excerpts from the participants' opinions on the codes are given below.

With the Cornell note-taking technique, we can both listen and take notes (K1).

It contributed to the skill of taking notes while listening (K3).

We can also take notes of the information we listen to (K5).

It allows the information listened to to be taken notes at the same time (K6).

We can also take notes of the information we listen to (K7).

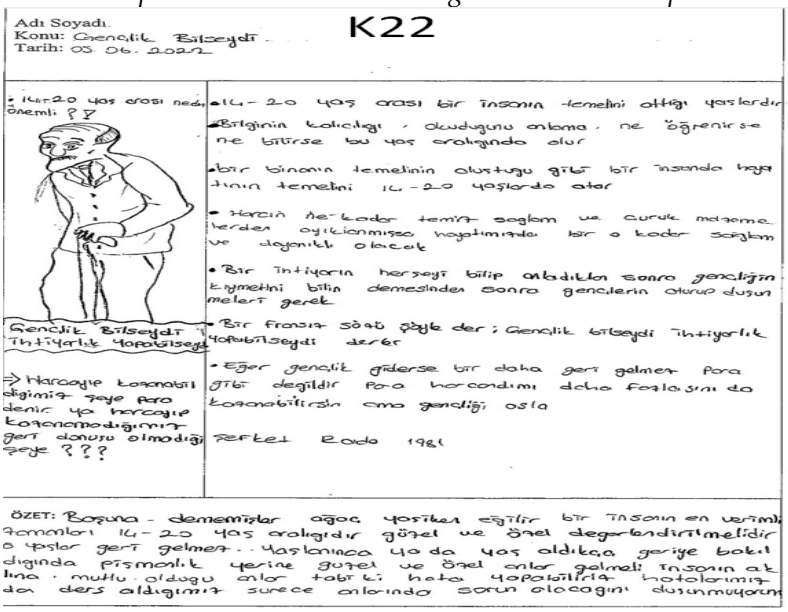
The individual focuses on the conversations according to his/her preference, interest and attention. This technique strengthens attention and focus. During the listening process, attention is focused on the selected information (K21).

It develops the skill of receiving important information, listening more carefully and selectively (K22).

K22's opinion is supported by the activity below.

Figure 8.

K22 Participant's Cornell Note-Taking Worksheet Example



…..It is useful for taking quick notes (K6).

K7's opinion is supported by the following activity.

Figure 9.

Participant K7's Cornell Note-Taking Worksheet Example

Table 1.

Participants' Opinions on the Skills Developed by the Cornell Note-Taking Technique

Question	Theme	Codes		Coding Intensity
				f
Which skills did the Cornell note-taking technique develop in you?	Critical Thinking	Commenting by listening (f=8)	K3, K12, K17, K18, K19, K20, K25, K28	54
		Establishing logical connections between information (f=3)	K3, K16, K19	
		Interpreting the text through clues (f=9)	K4, K9, K12, K14, K16, K17, K20, K21, K29	
		Getting rid of unnecessary details (f=4)	K5, K10, K21, K28	
		Learning to take correct notes (f=13)	K5, K6, K7, K8, K11, K18, K19, K20, K21, K22, K25, K27, K29	
		Not getting caught up in unnecessary details (f=12)	K6, K7, K8, K10, K16, K17, K18, K19, K20, K21, K22, K29	
		Thinking deeply (f=5)	K10, K11, K18, K26, K29	
	Creative Thinking	Developing creative ideas (f=9)	K3, K12, K14, K16, K18, K20, K23, K26, K27	17
		Taking creative notes (f=1)	K2	
		Explaining the listened text with original expressions (f=7)	K1, K3, K9, K13, K19, K20, K29	
	Problem Solving	Solving complex problems (f=4)	K2, K12, K18, K29	14
		Organizing complex information (f=4)	K2, K9, K19, K24	
		Producing solutions to encountered problems (f=6)	K9, K15, K17, K19, K20, K29	
			TOTAL	85

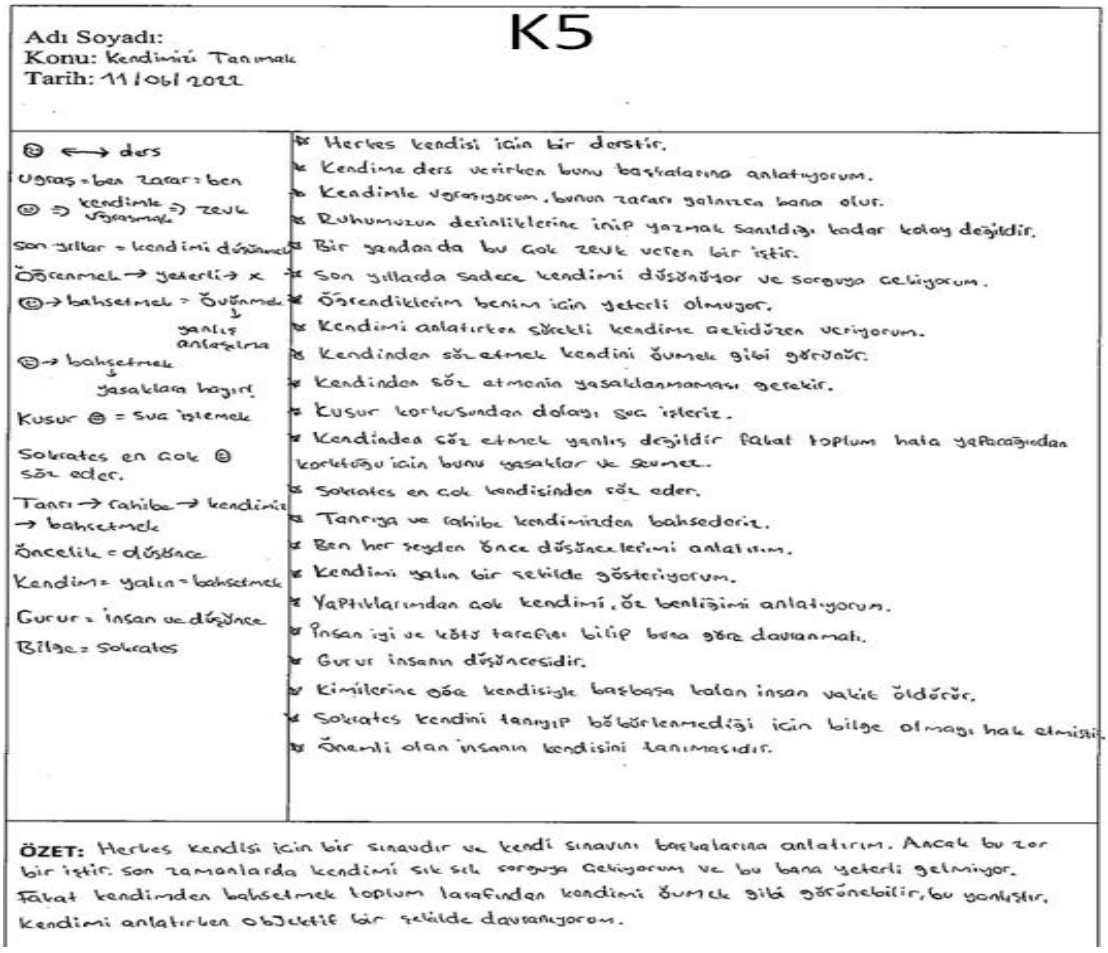
As seen in Table 6, three themes were created based on the participants' opinions about the skills developed by the Cornell Note-Taking Technique: "critical thinking, creative thinking and problem solving". The most emphasized codes within these themes are learning to take correct notes (f=13), developing creative feelings (f=9), and producing solutions to encountered problems (f=6). Some excerpts from the participants' opinions on the codes are given below.

I can also take notes while listening (K5).

K5's opinion is supported by the following activity..

Figure 10.

Cornell Note-Taking Worksheet Example for Participant K5



It enabled me to produce more aesthetic products by thinking about abstract concepts (K3).

My creative thinking skills improved. We were able to produce new ideas on the subject (K12).

My creative thinking skills improved. I learned to derive completely different meanings from different words (K14).

I was able to produce more effective solutions to problems… (K15).

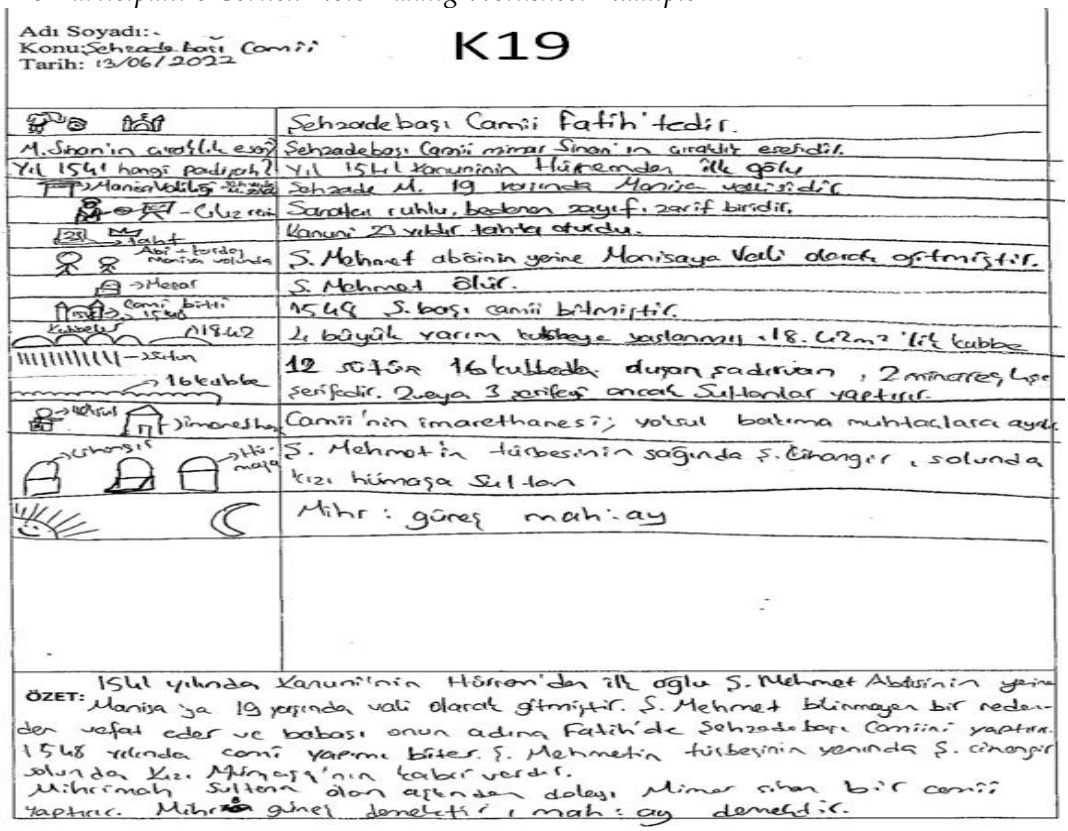
My problem solving, analysis and solution development skills improved… (K17).

My problem understanding and solution development skills improved (K19).

K19's view is supported by the activity below.

Figure 11.

K19 Participant's Cornell Note-Taking Worksheet Example



As can be seen, the participants have positive opinions about the Cornell Note-Taking Technique. It was observed that their high-level skills regarding the technique improved and they explained the factors affecting their listening skills.

4. Discussion and Conclusion

In the study, the participants' opinions about the Cornell Note-Taking Technique were obtained. The opinions were examined under the titles of definitions, problems, solution suggestions for problems and factors affecting listening skills in the application process. When the participants defined the Cornell Note-Taking Technique, the concepts they used most were

seen as "a planned technique", "a technique for learning" and "a technique that prioritizes listening". As it is known, the technique presents all the concepts to the individual together. While learning the concepts, the individual structures his/her knowledge in an organized manner by taking into account the page structure of the technique. According to Faber, Morris and Lieberman (2000), the Cornell Note-Taking Technique consists of two columns. The left column of the technique covers one third of the page and the right column covers two thirds of the page. Pauk (2001) defined this technique as a note column, a hint column and a summary area for taking notes and reviewing. Learning is constantly reviewed in this way, and every piece of information listened to is analyzed conceptually. With the analyses made, the information is encoded into long-term memory. There are studies in the literature supporting this idea. For example, Maulidia and Silviyanti (2021) stated in their study that with the Cornell Note-Taking Technique, note-takers interpret new materials and encode information in the text. Custer (2014), stating that the Cornell Note-Taking Technique is not a technique in which students only record notes, emphasized that with the technique, students think deeply, use cognitive processes well, and focus on application studies. Williams (2004) explained in his/her study that the technique provides rapid learning. Students prepare better for exams by taking notes. As Meydan (2018) stated, the aim here is to ensure that the concepts are understandable. The keywords learned and conceptually internalized are used in solving problems encountered in the learning process. In other words, unlike traditional methods, problems are solved with scientific processes (Şahin et al. 2011).

According to the participants, some problems are encountered in the process of using the Cornell Note-Taking Technique. These problems are recording the information, reducing the information and summarizing it. In the recording phase, the participants could not complete the information they listened to, could not prepare questions for the paragraph in the reducing phase, encountered different problems in creating keyword-clues and writing the subject with personal expressions. Since writing and listening are carried out together, the participants stated that they could not use the technique effectively in structuring the correct information and writing the appropriate keywords. The study by Karatay, Kaya, and Tekin (2020) supports this result. The study concluded that the Cornell Note-Taking Technique is time-consuming, cannot always be used in complex texts, the individual misses the main meaning of the text when reading and taking notes at the same time, sticking to a template for summarizing the

text will limit the individual, teacher candidates who finish summarizing the text early have to wait for other candidates who summarize, and they have difficulty choosing the keywords of important parts of the text. Eggen and Kauchak (1999) drew attention to the fact that the biggest problem students experience when taking notes on a subject is not being able to see the difference between the information. The participants had some suggestions regarding these problems they encountered in the use of the technique. These are; carrying out activities aimed at practice, connecting with old information, using time effectively, and selecting appropriate texts. The teaching processes that are effective in using the technique are the simple and understandable texts in selecting the activities, making preparations before coming to the lesson, having prior knowledge about the subject, including little information, using visual materials and focusing on the notes to be taken in the lesson (Safran and Kiriş, 2011). According to Syafii (2019), the teacher factor is also effective in applying the technique. The teacher is a guide in all these processes. He/she is the person who gives feedback to the student about the texts listened to. He/she is the educational element that knows the student most closely.

Another result obtained in the study is that environmental and individual factors affect the listening skills of the participants in the Cornell Note-Taking Technique. For example, it was concluded that the temperature of the classroom, the amount of light, ventilation and the psychological state of the participants affect their listening skills. Indeed, it is a known fact that psychological, physical and biological factors affect an individual's learning. This result is supported by the study conducted by Çiftçi (2001). According to Çiftçi (2001), the negative factors affecting listening include physiological (reasons arising from the person's possible health disabilities), physical (the crowdedness of the educational environment and the seating arrangement of the students, etc.), mental (the individual's cognitive memory not being kept alive, the individual being distant from education, etc.), social (the individual being pushed to passive listening by receiving negative feedback from his/her social environment), and psychological (the negative mood of the students, uninteresting topics and negativities originating from the speaker, etc.) variables. According to Kargın (2013), the physical environment affects learning. In this environment, the temperature, amount of light, color, noise level, size, accessibility, seating arrangement and amount of stimulation of the classroom directly affect children's learning. In addition to the elements mentioned, status, gender and

cultural differences affect the individual's listening in psychological elements and increase self-confidence skills.

The study includes participants' opinions about the contribution of the Cornell Note-Taking Technique to listening skills. The technique contributes to the skills of distinguishing information and using time effectively. At the same time, with the technique, participants gain the ability to listen and take notes at the same time, to concentrate on the information during the listening process, and not to waste time while taking notes. It is known that the main purposes of the technique, which provides positive contributions to the individual in terms of managing time effectively and establishing relationships between information, include distinguishing information, focusing, synthesizing information, and ensuring that what is listened to/watched is easily understood and remembered (Boelter, 2010; Gündüz and Şimsek, 2014; Şahin, Aydın, and Sevim, 2015). Thus, students' academic skills regarding listening skills increase. In other words, it is observed that students who receive training with the Cornell Note-Taking Technique have increased success levels compared to students who do not (Evans and Shively, 2019; Kurudayıoğlu and Soysal, 2016; Şahin, Sevim, and Aydın, 2011; Tsai and Wu, 2010). These increases develop the individual's critical thinking, creative thinking, and problem-solving skills. For example, while taking notes in the study, the participants learned how to take notes correctly for the important information they would need and found new and different ideas for solving problems. They concretized the subjects especially with keywords and visuals and meaningful learning took place. This result is supported by the research results of Davoudi, Moattarian and Zareian (2015). Davoudi, Moattarian and Zareian (2015) stated in their study that the Cornell Note-Taking Technique encourages students to think critically. In short, the Cornell Note-Taking Technique ensures that information is stored meaningfully. It is an important technique for students to be successful in the course (Fender, 2003). Taking notes helps develop mental functions (Şahin, Aydın, Sevim, 2009). By taking notes, the individual looks at the subjects from multiple perspectives, learns in depth, discusses, questions and makes new definitions (Anarsit and Aryuliva, 2017).

4.1. Suggestions

- Cornell Note-Taking Technique can be applied at different levels of education and in different courses.

- The contribution of Cornell Note-Taking Technique to students' academic skills can be investigated.
- In this study, in which listening comprehension skills are determined with Cornell Note-Taking Technique, a qualitative design was used. Mixed designs related to the technique can be used in different studies.
- The contribution of Cornell Note-Taking Technique to the individual's four basic language skills can be investigated.

5. References

Ahmad, S. Z. (2019). Impact of Cornell notes vs. REAP on EFL secondary school students' critical reading skills. *International Education Studies, 12*(10), 60–74.

Akçay, A. (2018). *Dinleme/izleme eğitimi.* Ankara: Nobel Akademik Yayıncılık.

Anarsit, Y., & Aryuliva, A. (2017). The use of Cornell note-taking technique to improve listening comprehension of senior high school students. *Journal of English Language Teaching, 6*(1), 9–15.

Aytaçlı, B. (2012). Durum çalışmasına ayrıntılı bir bakış. *Adnan Menderes Üniversitesi Eğitim Fakültesi Eğitim Bilimleri Dergisi, 3*(1), 1–9.

Aytan, T. (2011). Aktif öğrenme tekniklerinin dinleme becerisi üzerindeki etkileri. (Yayımlanmamış doktora tezi). Selçuk Üniversitesi Eğitim Bilimleri Enstitüsü, Konya.

Boelter, J. (2010). How does the use of Cornell Notes as a peer reflection tool actively engage students and create better listeners? (Master's thesis). Southwest Minnesota State University.

Broe, D. (2013). The effects of teaching Cornell Notes on student achievement. (Master's thesis). Minot State University, North Dakota.

Bulut, B. (2013). Etkin dinleme eğitiminin dinlediğini anlama, okuduğunu anlama ve kelime hazinesi üzerine etkisi. (Yayımlanmamış yüksek lisans tezi). Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü, Aydın.

Calp, M. (2010). *Özel eğitim alanı olarak Türkçe öğretimi.* Ankara: Nobel Yayın Dağıtım.

Custer, H. H. (2014). WICOR. Retrieved from http://blogs.4j.lane.edu/levy_d/files/2017/12/hed_reviewofliterature.pdf

Çalıcı, M. A. (2019). Ters yüz sınıf yönteminin 6. sınıf öğrencilerinin dinlediğini anlama becerisine etkisi. (Yayımlanmamış yüksek lisans tezi). Yıldız Teknik Üniversitesi Sosyal Bilimler Enstitüsü, İstanbul.

Çelenk, S. (2005). *İlk okuma yazma programı ve öğretimi.* Ankara: Anı Yayınları.

Çiftçi, M. (2001). Dinleme eğitimi ve dinlemeyi etkileyen faktörler. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 2*(2), 165–177.

Davoudi, M., Moattarian, N., & Zareian, G. (2015). Impact of Cornell note-taking method instruction on grammar learning of Iranian EFL learners. *Journal of Studies in Education, 5*(2), 252–265.

Demirel, Ö. (1999). *İlköğretim okullarında Türkçe öğretimi.* İstanbul: Milli Eğitim Bakanlığı Yayınları.

Demir, G. (2020). Türkçe öğretmeni adaylarında okuduğunu ve dinlediğini anlama becerilerinin karşılaştırılması. (Yayımlanmamış yüksek lisans tezi). Düzce Üniversitesi Sosyal Bilimler Enstitüsü, Düzce.

Doğan, Y. (2011). *Dinleme eğitimi.* Ankara: Pegem Akademi Yayıncılık.

Eggen, P. D., Kauchak, D. P., & Eggen, K. P. (1999). *Estrategias docentes: Enseñanza de contenidos curriculares y desarrollo de habilidades de pensamiento.* Fondo de Cultura Económica.

Evans, B., & Shively, C. (2019). Using the Cornell note-taking system can help eighth grade students alleviate the impact of interruptions while reading at home. *Journal of Inquiry & Action in Education, 10*(1), 1–35.

Faber, J. E., Morris, J. D., & Lieberman, M. G. (2000). The effect of note-taking on ninth grade students' comprehension. *Reading Psychology, 21*, 257–270.

Fender, G. (2003). *Öğrenmeyi öğrenmek* (Çev. O. Akınbay). İstanbul: Sistem Yayıncılık.

Gündüz, O., & Şimşek, T. (2014). *Dinleme eğitimi.* Ankara: Grafiker Yayınları.

Gürel, E., Tat, M., & Özşenler, D. (2018). Diyaloğa dayalı dinleme: Diyalojik dinleme. *Researcher, 6*(3), 57–72.

Hagtvet, B. E. (1998). Preschool oral language competence and literacy development. In P. Reitsma & L. Verhoeven (Eds.), *Problems and interventions in literacy development* (pp. 63–80). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Kalb, N. (2003). The effects of using Cornell Notes while reading advanced placement history textbooks. (Yayımlanmamış yüksek lisans tezi). University of California, California.

Karatay, H., Kaya, S., & Tekin, G. (2020). Cornell tekniğinin metin özetlemeye etkisi. *Gelecek Vizyonlar Dergisi, 4*(3), 13–22.

Kardaş, M. N. (2018). Dinleme eğitiminde not tutma. In A. Akçay (Ed.), *Dinleme/İzleme Eğitimi* (pp. 148–181). Ankara: Nobel Akademik Yayıncılık.

Kargın, T. (2013). Okul öncesinde öğretimin bireyselleştirilmesi ve öğretimsel uyarlamalar. In B. Sucuoğlu & H. Bakkaloğlu (Eds.), *Okul Öncesinde Kaynaştırma* (pp. 142–149). Ankara: Kök Yayıncılık.

Kiral, B. (2020). Nitel bir veri analizi yöntemi olarak doküman analizi. *Siirt Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 8*(15), 170–189.

Köprü, U. M. (2020). Ortaokul öğrencilerinin dinleme becerilerine ilişkin karşılaştıkları sorunlar üzerine bir inceleme. (Yayımlanmamış yüksek lisans tezi). Türkçe ve Sosyal Bilimler Eğitimi Anabilim Dalı, Van.

Kurudayıoğlu, M., & Soysal, T. (2016). Cornell not alma tekniğinin 6. sınıf öğrencilerinin dinlediklerini anlama düzeylerine etkisi. *9. Uluslararası Türkçenin Eğitimi-Öğretimi Kurultayı*, 243–254.

Maulidia, K., Bahri, S., & Silviyanti, M. (2021). Using Cornell note-taking to improve listening comprehension. *Research in English and Education Journal, 6*(2), 52–61.

Meydan, H. (2018). Anlamlı öğrenme öz-farkındalık ölçeğinin geliştirilmesi. *Değerler Eğitimi Dergisi, 16*(36), 95–118.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook.* Thousand Oaks, CA: Sage.

Okur, A., & Beyce, E. (2013). Dinleme becerisinin kültürümüzdeki yeri ve dinleme eğitiminin önemi: Kutadgu Bilig örneği. *Turkish Studies, 8*(4), 1099–1110.

Oruç, Ş. (2016). Türkçede ana dil ve ana dili. *Littera Turca Journal of Turkish Language and Literature, 2*(1), 311–322.

Özbay, M. (2012). *Anlama teknikleri II: Dinleme eğitimi.* (3. Baskı). Ankara: Öncü Kitap.

Özbay, M. (2013). *Türkçe özel öğretim yöntemleri I.* Ankara: Öncü Basımevi.

Özçakmak, H. (2015). Türkçe öğretmeni adaylarının not alarak dinlemede özetleme stratejilerini kullanma becerileri. (Yayımlanmamış yüksek lisans tezi). Gazi Üniversitesi, Ankara.

Pauk, W. (2001). *How to study in college.* Boston: Houghton Mifflin Company. Retrieved from https://archive.org/details/howtostudyincoll00pauki1/page/n17/mode/2up

Quintus, L., Borr, M., Dufffield, S., Napoleon, L., & Welch, A. (2012). The impact of the Cornell note-taking method on students' performance in a high school family and consumer sciences class. *Journal of Family & Consumer Sciences, 30*(1), 27–38.

Safran, M., & Kiriş, A. (2011). Tarih öğretiminde anahat ve matris not alma tekniklerinin kullanılmasının önemi. *Milli Eğitim Dergisi, 41*(189), 187–200.

Sallan Gül, S., & Kâhya Nizam, Ö. (2021). Sosyal bilimlerde içerik ve söylem analizi. *Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 42*(1), 181–198.

Saputri, A. (2020). Applying Cornell note-taking strategy on students' reading comprehension of narrative text. (Yayımlanmamış yüksek lisans tezi). Syarif Hidayatullah State Islamic University, Jakarta.

Sevimli, F. (2015). Katılımlı dinlemenin ortaokul 5. sınıf öğrencilerinin dinlediğini anlama becerisi üzerindeki etkisi. (Yayımlanmamış yüksek lisans tezi). Dumlupınar Üniversitesi Eğitim Bilimleri Enstitüsü, Kütahya.

Sholikhah, S. A., Sumani, S., & Rahmasari, B. S. (2019). Teaching reading through Cornell notes strategy. *English Teaching Journal: A Journal of English Literature, Language and Education, 7*(2), 75–78.

Simonet, R., & Simonet, J. (1995). *Not alma teknikleri* (Çev. P. Kurt). İstanbul: Arion Yayınevi.

Subaşı, M., & Okumuş, K. (2017). Bir araştırma yöntemi olarak durum çalışması. *Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 21*(2), 419–426.

Syafii, A. (2019). Students' response of using Cornell note-taking system (CNTS) in listening class. *Journal of English Language Teaching and Islamic Integration, 2*(1), 131–145.

Şahin, A., Aydın, G., & Sevim, O. (2011). Cornell not alma tekniğinin dinlenilen metni anlamaya ve kalıcılığa etkisi. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 29,* 1–15.

Tabak, G., & Karadüz, G. (2016). Türkçe öğretmeni adaylarının dinlerken not alma stilleri. *Ana Dili Eğitimi Dergisi, 4*(1), 73–83.

Tayşi, K. E. (2014). Öğrenme stiline dayalı eğitiminin ortaokul öğrencilerinin dinlediğini anlama becerilerine ve dinlemeye yönelik tutumlarına etkisi. (Yayımlanmamış doktora tezi). Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

TDK. (2023). *Türkçe sözlük.* Ankara: Türk Dil Kurumu.

Tsai, T., & Wu, Y. (2010). Effects of note-taking instruction and note-taking languages on college students. *New Horizons in Education, 58*(1), 120–132.

Türk, E. (2016). İlköğretim 8. sınıf öğrencilerinin not alma alışkanlıklarının ve stratejilerinin değerlendirilmesi. (Yayımlanmamış yüksek lisans tezi). Erciyes Üniversitesi Eğitim Bilimleri Enstitüsü, Kayseri.

Tüzel, S., & Keleş, E. (2013). Dinleme öncesi ve dinleme sonrası verilen soruların 5. sınıf öğrencilerinin dinlediğini anlama beceri düzeyine etkisi. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 10*(23), 27–45.

Williams, G. T. (2004). Assessment of 8th grade students' attitudes and perceptions of Cornell's note-taking system. (Doctoral dissertation). Union University.

Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri.* (9. Baskı). Ankara: Seçkin Yayıncılık.

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 371-398 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Expanding on Knowledge of Student Thinking through Mathematics Teachers' Engagement in Lesson Study

Aytuğ Özaltun Çelik [1], Esra Bukova Güzel *[2]

* *Corresponding Author, esra.bukova@deu.edu.tr*
[1]*Dokuz Eylul University, Türkiye*
[2]*Dokuz Eylul University, Türkiye*

Abstract

This study aims to expand on knowledge of student thinking by examining the practices of mathematics teachers engaged in a lesson study process designed to enhance their knowledge of student thinking. Conducted as a qualitative case study, the research involved three high school mathematics teachers as participants. The primary data sources for the study are the collaborative planning meetings conducted by mathematics teachers involved in the lesson study process and their classroom teaching practices. In this context, twenty-two hours of lesson observations served as the core dataset, supplemented by field notes documenting the entire process. Teachers' discourses and actions regarding student thinking were systematically analyzed using the constant comparison method. The main components of knowledge of student thinking were (a) building on students' mathematical ideas, (b) promoting students' thinking of mathematics, (c) triggering and considering divergent thoughts, (d) engaging students in mathematical learning, (e) evaluating students' understanding, (f) motivating students' learning, (g) considering students' misconceptions and errors, (h) considering students' difficulties, and (i) estimating students' possible ideas and approaches. The 47 subcodes identified within these categories elucidate the specific actions undertaken by teachers to consider and respond to student thinking within their classroom practices. This framework, encompassing components related to teachers' knowledge of student thinking, is proposed as a valuable tool for research on the professional development of both pre-service and in-service teachers.

Keywords: Knowledge Of Student Thinking, Lesson Study, Mathematics Teacher, Pedagogical Content Knowledge, Professional Development, Qualitative Case Study.

Citation: Özaltun Çelik, A., & Bukova Güzel, E. (2024). Expanding on knowledge of student thinking through mathematics teachers' engagement in lesson study. *Instructional Technology and Lifelong Learning, 5(2)*, 371- 398. https://doi.org/ 10.52911/itall.1576727

Matematik Öğretmenlerinin Katılımıyla Gerçekleştirilen Ders İmecesi ile Öğrenci Düşüncesi Bilgisinin Detaylandırılması

Özet

Bu çalışmanın amacı, öğretmenlerin öğrenci düşüncesine ilişkin bilgilerini geliştirmek için tasarlanmış bir ders imecesi sürecinde matematik öğretmenlerinin uygulamalarına dayalı olarak öğrenci düşüncesi bilgisini detaylandırmaktır. Bu nitel durum çalışmasının katılımcıları üç lise matematik öğretmenidir. Ders imecesi sürecini gerçekleştiren matematik öğretmenlerinin işbirliğine dayalı yürüttükleri planlama toplantıları ve gerçekleştirdikleri sınıf içi öğretim uygulamaları araştırmanın temel veri kaynaklarıdır. Bu kapsamda yirmi iki saatlik ders gözlemlerinden elde edilen verilere odaklanılmış ve tüm sürece ilişkin alan notları ile bu veriler zenginleştirilmiştir. Sürekli karşılaştırmalar yoluyla öğretmenlerin öğrenci düşüncesi bilgisi ile ilişkili olan söylemleri ve eylemleri analiz edilmiştir. Bu analizlere dayalı olarak, öğrenci düşüncesi bilgisinin temel bileşenleri (a) öğrencilerin matematiksel fikirlerini dayanak alıp onları geliştirme, (b) öğrencilerin matematik düşünmeye teşvik etme, (c) farklı düşünceleri ortaya çıkarma ve dikkate alma, (d) öğrencilerin matematik öğrenmeye katılımlarını sağlama, (e) öğrenci anlayışlarını değerlendirme, (f) öğrencileri öğrenmeye motive etmek, (g) öğrencilerin kavram yanılgılarını ve hatalarını dikkate alma, (h) öğrencilerin zorluklarını dikkate alma ve (i) öğrencilerin olası fikirlerini ve yaklaşımlarını tahmin etme olarak kategorilendirilmiştir. Bu kategoriler altında ortaya çıkarılan 47 alt kod öğretmenlerin sınıf içi uygulamalarında öğrenci düşüncelerini dikkate alıp onlara yanıt verme eylemlerini detaylandırmaktadır. Öğrenci düşüncesi bilgisi ile ilgili bileşenleri içeren bu çerçevenin hem öğretmen adaylarının hem de öğretmenlerin mesleki gelişimlerine odaklanan araştırmalarda kullanılabileceği düşünülmektedir.

Anahtar Kelimeler: Alan Öğretimi Bilgisi, Ders İmecesi, Matematik Öğretmeni, Mesleki Gelişim, Nitel Durum Çalışması, Öğrenci Düşüncesi Bilgisi.

Date of Submission	31.10.2024
Date of Acceptance	12.12.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	This article is extracted from the first author's master thesis entitled "Professional development of mathematics teachers: Reflection of knowledge of student thinking on teaching", supervised by the second author (Master's Thesis, Dokuz Eylul University, İzmir/Turkiye, 2014).
Author(s) Contribution	**Author1:** Conceptualization, Methodology, Data curation, Writing- Original draft preparation. Author2: Conceptualization, Methodology, Data curation, Writing- Original draft preparation, Supervision.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	italljournal@gmail.com
Grant Support	The author(s) acknowledge that they received no external funding in support of this research.
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Several educational reform documents advocate for a transition from teacher-centered to student-centered paradigms in instructional practices (Wilson et al., 2013). The report "Principles and Standards for School Mathematics" by the National Council of Teachers of Mathematics (NCTM, 2000) underscores the importance of understanding students' existing knowledge, their learning needs, and the support required to enhance their conceptual understanding. It clearly asserts that an effective mathematics teaching approach necessitates a focus on students and their cognitive processes. Mathematics educators are expected to utilize their specialized mathematical knowledge, taking into account students' individual needs, to implement effective teaching strategies.

A teacher's understanding of their students' learning of a specific mathematical concept is closely linked to their knowledge of content and student. Hill et al. (2008) emphasized that "knowledge of content and students, or teachers' knowledge of students' mathematical thinking and learning, which is a subset of pedagogical content knowledge, widely believed to be an important component of teacher knowledge" (p. 373). Similarly, Rowland et al. (2005) conceptualized mathematical content knowledge as an integration of subject matter knowledge and pedagogical content knowledge. They empirically developed the Knowledge Quartet framework to capture the complexities of teacher knowledge in mathematics education. In this framework, the dimension of contingency, which encompasses the consideration of students' thinking, involves an approach to responding to students' ideas. According to Franke and Kazemi (2001), emphasizing students' mathematical thinking is a critical component for integrating knowledge of teaching, mathematics, and student understanding. Implementing teaching practices that prioritize student thinking involves considering multiple factors, such as students' existing knowledge, potential areas of misconception, and preferred learning methods. Such teachers' knowledge encompasses an awareness of students' thinking processes and their comprehension of the subject matter (Schilling et al., 2007). Within this framework, teachers' 'Knowledge of Student Thinking (KoST)' plays a crucial role.

The KoST enables teachers to interpret students' errors, misconceptions, and conceptual understandings, as well as to recognize interactions that can enhance students' cognitive processes and promote more effective learning (Empson & Junk, 2004). In their study,

Brendefur et al. (2013) elucidate that KoST pertains to the pedagogical knowledge that enables teachers to anticipate potential student solution strategies, foresee common misconceptions, and interpret students' mathematical ideas. An et al. (2004) identify four key components of KoST, which include addressing students' misconceptions, building on students' mathematical ideas, engaging students in mathematical learning, and promoting students' thinking mathematically. Lee (2006) investigated teachers' understanding of students' mathematical thinking and further expanded this framework to include components such as questioning that triggers divergent thinking, motivating student learning, evaluating student understanding, and using prior knowledge. Researchers and policymakers in mathematics education emphasize the importance of teachers' awareness of students' existing knowledge and cognitive processes related to specific mathematical concepts, as this is crucial for fostering deeper student understanding (National Board for Professional Teaching Standards, 1997; NCTM, 2000). Therefore, it is essential that teachers develop an awareness of the significance of KoST and its reflection in teaching practices.

Numerous researchers have examined teachers' understanding of students' mathematical thinking (Corey et al., 2021; Moon, 2023; Van Zoest et al., 2010), while others have emphasized the development of teachers' knowledge and instructional practices informed by students' mathematical thinking (Gehrtz et al., 2022; Fernández et al., 2012; Liang, 2023). Corey et al. (2021) conducted an analysis of ten written instructional products to examine how these materials conveyed knowledge of student mathematical thinking. The findings revealed that the most effective instructional products were those that explicitly addressed specific tasks or mathematical topics, incorporated diverse explanations of multiple solution strategies or reasoning pathways, and provided detailed information that was practical and actionable for teachers. Moon (2023) investigated how pre-service teachers develop their understanding of students' thinking regarding big ideas in algebra. The study revealed that while pre-service teachers were able to design contextualized tasks to engage students, they struggled to articulate strategies for using these tasks to foster the development of big ideas by connecting multiple representations. Van Zoest et al. (2010) conducted their study with 16 qualified mathematics teachers who participated in a one-day focus group session designed to serve as a professional development opportunity. Subsequently, at least two lessons taught by six of these teachers were observed over three consecutive days. The study identified the primary

objectives of the teachers in eliciting student thinking as fostering classroom engagement and enhancing students' mathematical understanding. These objectives were achieved by providing students with opportunities to compare diverse solutions and engage in questioning each other's reasoning.

Gehrtz et al. (2022) highlighted a significant gap in the literature regarding how instructors leverage student thinking in undergraduate STEM education and the factors that enable them to do so effectively. The study revealed that even if the courses identified as student-centered, they failed to genuinely embody student thinking centered practices. Similarly, Liang (2023) examined a teacher's KoST. She provided an in-depth analysis of the cognitive processes underpinning the teacher's learning from student thinking. Drawing on Piagetian learning theories, the study elucidated the mechanisms through which the teacher developed knowledge in response to student thinking.

Considering that this knowledge is most effectively discerned through processes in which teachers systematically reflect on their students' understanding and continuously enhance their capacity to notice and interpret students' thinking, it becomes imperative to articulate the components of this knowledge. Furthermore, it is essential to delineate the aspects and dimensions of teaching where this knowledge is manifested. Such detailing must be situated within the context of a dynamic and evolving teaching process, as this approach ensures a more precise and coherent framework for understanding and application. In this study we aimed to expand on KoST by examining the practices of mathematics teachers engaged in a lesson study process designed to enhance their KoST. We hypothesized that this process would facilitate a deeper examination of their approaches to KoST and allow for the extension of its content throughout the lesson study process.

Lesson Study

Teachers' continuous engagement in professional development plays a crucial role in shaping their teaching effectiveness. According to the National Council of Teachers of Mathematics (NCTM, 2000), professional development processes are essential for enhancing teachers' understanding of students' mathematical thinking and instructional strategies. Borko (2004) emphasized that the primary goal of these programs is to enable teachers to deepen their understanding and refine their instructional practices to improve the quality of teaching. The

National Comprehensive Center for Teacher Quality (2011) identifies five key purposes of high-quality professional development:

1. complying with the other professional learning activities including aims of school, state standards and assessments and formative teacher assessments,

2. focusing on the foundation of domain and on the model of teaching strategies related to the domain,

3. including the opportunities to actively learn current teaching strategies,

4. providing opportunities for collaboration with teachers and,

5. including continuous feedback.

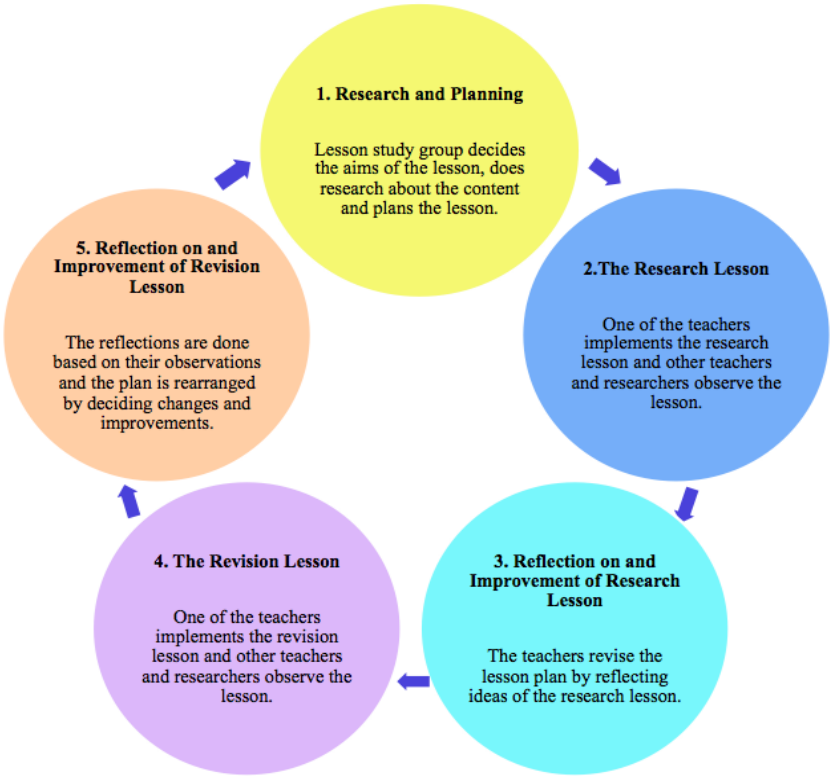
Lesson study, recognized as an effective model for enhancing teachers' professional development, embodies many characteristics of high-quality professional development programs that emphasize teacher collaboration (Perry & Lewis, 2009). Hurd and Licciardo-Musso (2005) describe lesson study as a cyclical process that involves teachers in the stages of planning, observing, and revising a research lesson. Yoshida (1999) elaborates on this process, suggesting that it includes the development of lesson plans, their implementation in real classroom settings, careful observation, and subsequent reflection. This cyclical nature of lesson study can be conceptualized as a series of expert-led meetings aimed at refining teaching practices. Throughout this process, students' learning and cognitive processes are considered integral to all stages, including planning, observation, and revision. Furthermore, teachers have the opportunity to gain valuable insights into the effectiveness of their teaching by observing students within classroom settings. It is therefore considered essential that mathematics educators adopt a critical stance towards their own instructional practices as well as those of their peers. Huang and Shimizu (2016) argue that lesson study can facilitate the development of an inquiry-based approach and enhance teachers' critical reflection on their methodologies. Similarly, White and Lim (2008) suggest that lesson study supports the design of high-quality lessons and fosters a deeper understanding of student learning processes. Moreover, according to Lewis et al. (2012), by observing lessons from the students' perspective, teachers can also enhance their KoST and gain motivation to refine their instructional strategies. Given the characteristics of lesson study, we posit that participation in such a framework can aid

mathematics teachers in the advancement of their KoST, which can be articulated through an examination of their pedagogical actions.

We adopted a five-stage lesson study cycle (see Figure 1) to provide the teachers with the opportunity to develop their KoST.

Figure 1.

The cycle of lesson study used in the study



The cycle consisted of (1) research and planning, (2) implementing the research lesson, (3) reflecting and improving the research lesson, (4) implementing the revision lesson, and (5) reflecting and improving the revision lesson. In the initial stage, teachers collaboratively examined the key concepts, deliberately considering potential student thinking during the lesson planning process. During planning and revision meetings, they engaged in discussions about how students might conceptualize and interact with the material, exploring various strategies to facilitate meaningful learning. This process culminated in the development of a research lesson. In the second stage, one teacher implements the collaboratively designed lesson plan, while the remaining team members observe with a particular focus on student responses and thinking during the lesson. In the third stage, the team reconvenes to analyze the research lesson, reflecting on student engagement and their observations to refine and

further develop the lesson plan. Following these discussions, the revised lesson is implemented in the fourth stage, after which the team meets again in the fifth stage to evaluate and further improve the revised lesson. This iterative, collaborative cycle fosters a culture of mutual support among the teachers, thereby contributing to their professional growth and enhancing the overall effectiveness of the lesson study process.

2. Method

This study employed a qualitative case study methodology based on a nine-month lesson study. Throughout the duration, the focus was on analyzing teachers' actions and discourses in response to their students' thinking. The examination of these teacher actions during the lesson study facilitated the development of dynamically new approaches related to the KoST.

Participants

The participants consisted of three mathematics teachers from the same high school, selected through typical-case sampling. We assumed that engaging these teachers within a single school setting would facilitate effective meetings and encourage interaction among them, enabling them to observe each other's lessons. Additionally, the participants had a shared history, having graduated from the same university and worked together in the same school for an extended period, although they had not previously engaged in professional discussions with one another. They also had an established relationship with the researchers, stemming from years of collaboration through school-based mentoring of pre-service teachers from our university and participation in workshops and seminars organized by the research team. The genders, educational backgrounds and professional experiences were given in Table 1. Due to T3 being assigned to a different school, her participation was limited to the first lesson study cycle.

Table 1.

The information of participants

Participant	Gender	Educational background	Professional experience
T1	Male	Master	13
T2	Female	College	13
T3	Female	College	13

Data Collection

The data consisted of video recordings of the lessons and meetings. Before the lesson study, we observed two-hour lessons of each teacher. During the lesson study, twelve-hour lessons, including research and revision lessons in the three lesson study cycles, were observed. After the lesson study, we observed two-hour lessons of two teachers. During all the class observations, we took detailed field notes by considering the KoST and videotaped the lessons to capture the teachers' and students' discourses/actions/gestures by two cameras. While one of them focused on the board, the other focused on the students. We also videotaped the meetings and took field notes to support the results of the study. The purpose of the lesson observations and video recordings was to identify instances that could serve as evidence of the teachers' KoST. Video transcriptions of the meetings were utilized to enhance the field notes and strengthen the findings of the study. Throughout the process, the field notes taken during these meetings were consistently referenced to expand the framework with a focus on student thinking. We aimed to maintain the contextual integrity by integrating the transcripts of lesson observations and meetings with the field notes collected throughout the process The triangulation of data was crucial for ensuring validity in the process of refining and expanding the KOST categories (Creswell & Miller, 2000).

Procedure

We first conducted semi-structured interviews and observed the participants' lessons to establish a baseline understanding prior to the lesson study process. Notably, the teachers did not observe each other's lessons. One of the objectives of this initial phase was to assess the participants' KoST prior to engaging in the lesson study. Following these initial observations and interviews, we provided a seminar for the teachers. This seminar aimed to introduce the research purposes, the lesson study process, and the concept of KoST.

In the initial cycle, teachers planned instructional topics on radical expressions for 9th-grade students, and subsequently, in the following cycles, they focused on 'trigonometric ratios in a right-angled triangle' and 'coterminal angles and the unit circle' for 10th-grade students. During the implementation of the lesson study process, we engaged in discussions with the teachers, examining the sections related to the evidence of KoST that had been previously identified through the transcriptions. We asked some questions to the teachers with the aim of

supporting their improvement. We guided teachers through reflective questions such as: "Which sections of the lesson were most effective according to your plan?", "What challenges did students have during the learning process?", "What changes would you make to this lesson if given the opportunity?", "Which practices do you consider most and least effective in terms of fostering KoST?", "What actions did you take, or could you have taken, to assess whether students learned the material?", "Why was the allocated time insufficient to implement all activities?", "What strategies would you employ to gain a deeper understanding of student thinking as a teacher?", and "Given the student's statement, what might their thoughts be?" Through these discussions, we aimed to more effectively and thoroughly explore instances related to KoST. Following the completion of all cycles, we observed teachers' lessons to draw inferences about their KoST.

Data Analysis

We attended all lessons and meetings to become thoroughly familiar with the data. Initially, we transcribed all video recordings verbatim. We then independently examined these transcriptions, segmenting them into contextual parts that included both teacher discourses and interactions between teachers and students, reflecting students' thinking. Following this initial analysis, we convened to reach a consensus by comparing and discussing the segmented parts. After this first meeting, we individually proceeded with a detailed analysis of the segments in three distinct stages. In the first stage, key terms were identified that described different aspects of students' thinking, such as prior knowledge, mistakes, varied representations, and different thought processes. In the second stage, we examined teachers' actions in relation to these keywords. For instance, teachers utilized different representations to address misconceptions and posed questions to identify students' errors. These actions were consistently compared to identify the main components. In connection with the teachers' objectives, a specific action related to the same keyword could be categorized under different main components. For example, the use of representations was not a standalone component; rather, teachers' implementation of this action varied—sometimes used to correct mistakes and at other times to assist with overcoming students' difficulties. To categorize the teachers' actions, we carefully considered students' thinking. This methodological approach facilitated the identification of key components in the data. An excerpt from the data analysis process is provided below.

Table 2.

An excerpt from the data analysis process

Excerpt		Keywords	Teacher actions	Main Component
Teacher:	$\sqrt[12]{2^{13}}$ is a response to a question. But this response was not included in the choices. How can you find the response? What can you do?	Different thoughts Different responses	Challenging the students' expressions Asking them to explain their thoughts Triggering students to give different responses	Triggering and considering divergent thoughts
Student 1:	$2^{\frac{13}{12}}$			
Teacher:	This is not such an answer in the choices, also.			
Student 2:	$2^{\frac{26}{24}}$			
Student 3:	I simplify.			
Teacher:	You cannot simplify $\frac{13}{12}$			
Student 4:	$6\sqrt[12]{2}$			
Student 5:	Is it $\sqrt{4}$?			
Teacher:	I am listening, what else?			
Student 6:	$6^{\sqrt[12]{2}}$			

We conducted this process by analyzing the first two lessons, forming an initial code list that included main components and sub-components. We then treated each lesson study cycle as a unit of analysis. By examining the transcriptions of lessons from subsequent cycles in a similar manner, we revised the code list through a process of constant comparison, adding new components and sub-components as needed. This iterative approach led to the development of a final code list. Through retrospective analysis, we re-examined all lessons comprehensively.

3. Result

During the lesson study, nine primary components and forty-eight sub-components related to KoST were identified (see Appendix 1). The main components were (1) building on students' mathematical ideas, (2) promoting students thinking mathematics, (3) triggering and considering divergent thoughts, (4) engaging students in mathematical learning, (5) evaluating students' understanding, (6) motivating students learning, (7) considering students' misconceptions and errors, (8) considering students' difficulties, (9) estimating students' possible ideas and approaches. These components were integrated throughout the teaching

processes. The results present the content within these components as reflected in the teachers' actions, followed by evidence drawn from lesson excerpts during the lesson study.

KoST Components

Building on students' mathematical ideas involved an in-depth understanding of their prior knowledge, current understanding, interests, and deficiencies, as well as a consideration of mathematical concepts, their interconnections, representations, and the associated rules and procedures. This approach integrated all these elements into the teaching process to enhance students' understanding and conceptual development. Teachers' actions related to this component emerged through their efforts to build upon students' mathematical thinking and to design instruction that takes into account the students' thought processes. When teachers acknowledge students' prior knowledge and address their deficiencies, they facilitate a more conceptual learning experience for students. In the process of conceptual development, teachers encouraged students to relate new concepts to their existing cognitive frameworks. This approach demonstrated an acknowledgment of students' prior knowledge and engaged their mental processes. By integrating students' existing knowledge into the teaching process, it directed their attention to the new concepts, fostering a more active mental participation. The students' motivation and interest in learning mathematical concepts were heightened, which in turn increased their engagement and participation in lessons. When learning tasks captured students' interest, they were more likely to articulate their ideas and thought processes, thereby enhancing their understanding and identifying the critical aspects of the concepts being taught.

Promoting students' thinking mathematics involved several strategies, including the use of questioning, engaging learning tasks and activities, and employing diverse representations. This approach encouraged students to relate mathematical concepts to real-life scenarios and provides sufficient time for them to process and respond to questions. Observations indicated that certain teachers' actions were effective in fostering students' thinking processes. Teachers prompted students to engage with mathematical ideas by having them work through problems and make estimations. These interactions were instrumental in guiding teachers in formulating and utilizing questions effectively. Furthermore, the purposeful use of various representations—such as algebraic, figural, tabular, and graphical—helped students develop a more holistic understanding of mathematical ideas. By integrating different types of

representations, teachers were able to tap into different cognitive processes among students. This approach highlights the importance of using multiple representations to support and enhance students' mathematical thinking in diverse contexts.

Triggering and considering divergent thoughts involved various methods such as exploring different solution strategies, presenting contradictory examples, comparing students' ideas, and encouraging students to question their peers and teachers. This component emerged from the teacher's actions at moments when diverse student thinking became apparent. Given the varying mental processes among students in the classroom, teachers acknowledged these differences to support student learning. Throughout the study, participants showed interest in students' diverse ideas and approaches in multiple ways. As lesson study cycles progressed, the teachers exhibited rich actions related to this component. They recognized that diverse thoughts were essential to the learning process and sought to bring them to light through discussions with one another and with researchers. Questioning was a fundamental action utilized by teachers, particularly in the context of triggering and considering divergent thoughts. This action included encouraging students to think differently, explore various solutions, provide different explanations, and engage with opposing viewpoints. By prompting students to reconsider and evaluate their own ideas, teachers were able to stimulate new and divergent thinking.

Engaging students in mathematical learning involved designing tasks, using different representations, connecting students' prior knowledge, giving examples of mathematical ideas, providing students to understand their difficulties. Focusing on the moments in which the students actively participated in the lessons revealed this component. Observations indicated that students were actively engaged in the lessons when working on tasks, with teachers using concrete examples to bridge abstract concepts and prevent passive learning. Additionally, students were more engaged when prompted to reflect on their difficulties and supported in overcoming them. The use of different representations was found to be particularly effective in fostering student focus and learning.

Evaluating students' understanding involved assessing their approaches, including how they comprehend, learn, and execute instructions. Teachers assessed students' interpretations while they were engaged in task-related activities and answering questions. During the observation

of student work, teachers posed targeted questions to gauge their understanding. These observations were conducted both after individual work at their desks and during students' presentations and problem-solving on the board.

Motivating students' learning involved providing positive reinforcement when appropriate thoughts were expressed, offering guidance and advice, connecting concepts to real-world scenarios, presenting the historical development of mathematical ideas, and emphasizing the importance and relevance of the concepts. Comparing different solution approaches also served to enhance motivation. Furthermore, relating concepts to everyday life experiences was shown to improve students' reasoning and critical thinking skills.

Considering students' misconceptions and errors involved identifying, estimating, diagnosing, and preventing these issues. Teachers observed students' challenges, discussed their underlying reasons, and explored strategies for overcoming these difficulties during the lesson study process. During lesson planning, they also took into account students' potential ideas, solution strategies, and approaches. Teachers employed questioning techniques, provided hints, clarified problems step by step, and emphasized procedural understanding within the lessons.

The Teachers' Actions regarding KoST during the Lesson Study

Before the lesson study, one of the teachers taught on "finding the greatest common divisor (GCD) and least common multiple (LCM) of two or more polynomial functions". He first asked the students to find GCD and LCM of two natural numbers and after then to express GCD and LCM of two polynomials.

Teacher: Now we find GCD and LCM of two or more polynomials. I am writing these polynomials: $P(x)=x^2-2x-3$ and $Q(x)= x^2-9$.
How do you find GCD and LCM of these polynomials? [As the students did not respond, he explained by referring to the method related to GCD and LCM of two real numbers].

	24	18	2
$A=2^3.3$	12	9	2
$B=3^2.2$	6	9	2
	3	9	3
	1	3	3
		1	

$GCD\ (A, B)=2^1.3^1$
$LCM\ (A, B)=3^2.2^3$

$P(x)=x^2-2x-3$	(x-3)(x+1)	(x-3)(x+3)	(x-3)
$Q(x)= x^2-9$	(x+1)	(x+3)	(x+3)

	(x+1)	1	(x+1)
P(x)=(x-3)(x+1)	1		
Q(x)=(x-3)(x+3)			

LCM(P(x),Q(x))=(x-3)(x+1)(x+3)
GCD(P(x),Q(x))=(x-3)

The teacher considered students' prior knowledge and used an example related to their prior knowledge to support them to construct new concepts (1a and 4d, see in Appendix 1). He thought that the students would understand the new concept by connecting the concepts in their minds. Thus, he supported the students to connect by using a representation which the students could relate to prior knowledge (1f). This example provided the students to remember how GCD and LCM of two expressions would be found. As he used this representation, finding GCD and LCM of two polynomials were meaningful for the students' cognition. Beyond connecting to a concrete model, using different representations (1f-4b) or analogies were significant for building on students' ideas and engaging students in mathematical learning. There was a necessity to identify how the models, representations or analogies were used in the teaching processes. The excerpt also showed the evidence related to the sub-component of "using concepts or definitions to provide understanding" (1c). The teacher explained the definitions of GCD and LCM of two natural numbers; he supported the students to understand the meaning of GCD and LCM of two polynomials.

In the research lesson of the first lesson study cycle, the teacher asked questions related to exponential and radical expressions decided to ask in the planning meetings and he tried to understand the students' prior knowledge whether their prior knowledge was lacking.

Teacher: [He wrote radical expressions on the board.] What do you know about radical expressions?

Student 1: A radical expression is a number. The result is the number which multiplied with itself.

Teacher: Is there anyone else who has another idea?

Student 2: When we square a number and write it in a root, it becomes the same number again.

Teacher: For instance, what are the numbers of which the square is 4?

Students: 2 and -2

Teacher: Today, we will use the numbers which are squared. You worked on this concept at the level of secondary school. Right?

Students: Yes.

Teacher: For example, do you know √4?

Students: Yes, 2.

Teacher: 16=?

Students: 4

Teacher: Ok, very well.

Based on the question what radical expressions mean, the students remembered their knowledge regarding radical expressions, and they related a radical expression to squaring a number or multiplying a number with itself. "Considering the deficiencies of their prior knowledge" (1b) was important in building on students' mathematical ideas.

In the revision meeting, the teachers decided that students were bored and were not actively engaged in the lesson because the content of the lesson was intensive. Thus, they revised the plan by extending with information about the historical development of the symbol of root to motivate the students. So, the teacher gave an example regarding historical information of the radical expressions and asked the students to interpret it.

Teacher: If we write the degree of roots as $\sqrt[3]{}$ $\sqrt{}$ $\sqrt[4]{}$, beforehand, while square root was √ in the expression of these, they made three the number of this line (√) as v√

Students: Wow..

Teacher: They noticed that the number of these zigzags increased as the degree was getting greater.

Students: And then?

Teacher: They couldn't pull off and considered it appropriate to write just 2, 3, 4, 5 above them.

When the teacher presented this information to the students, the students' attention was attracted to the lesson. In this process, discussing with the students on the historical development of the concept motivated them and supported the students to think about the meaning of the concept (6d).

In the research lesson of the second cycle, the teacher first focused on students' prior knowledge on trigonometric ratios of a right triangle. And then, the teacher asked the students to think whether the trigonometric ratios would change when the right triangle was bigger or smaller without changing any angles as seen in the following excerpt.

Teacher: What if we make the triangle bigger or smaller? Will the trigonometric ratios change?

Student 1: No.

Student 2: Yes.

Student 3: Will the ratio change?

Teacher: If we decrease the size of the triangle some more, how will the ratio change?

Student 4: It will not change.

Teacher: It will not change, because?

Student 4: It's a ratio.

Student 5: Similar triangles.

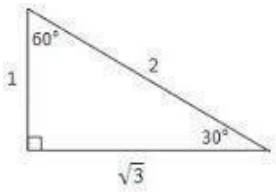
Teacher: In fact, yes, it is the best sentence. These are similar triangles.

The teacher asked the students to explain the reasons for their responses (3c) and triggered them to think about the related concept. Encouraging the students to explain the reasons for ideas and creating a discussion environment became effective actions in revealing different students' thinking. However, he immediately confirmed a student who gave a response in accordance with his expectation. And ignored the student who related the question to the

concept of ratio. Thus, he prevented the students from thinking about the question more and funnelled them in the direction of his own thinking. This excerpt presented the evidence in the context of triggering different responses and questioning the students even if it was interpreted that the teacher had actions in accordance with his own thoughts.

In the planning meeting, the teachers thought that the students could easily find the ratios in a triangle with angles of 30^o-60^o-90^o but that they did not question the underlying reasons before. They decided to ask students what the ratios in a triangle with angles of 30^o-60^o-90^o were with the aim of determining the students' prior knowledge and to improve their students' ideas with this question. As seen in the following excerpt, the teacher asked the student in the board to explain the response.

Board:



Teacher: Well, where did you find 1,2,√3?

Student 1: After his own heart.

Teacher: Why is 1,2,√3?

Student 1: Isn't this a rule? It results from the hypotenuse.

Teacher: Let us calculate it in a different way. Why aren't the sides 1,√5,√6, but 1,2,√3? That's what I am asking.

Student 2: That's a rule.

Student 3: Is it related to the unit circle?

ooo

Teacher: Why are the sides 1,2,√3? at the 30°-60°-90° triangle, 30°-60°-90° not 1,√5,√6.

Student 5: 1 is opposite to the angle, 30°.

Student 6: Equilateral triangle.

Teacher: Who said equilateral triangle?

Student 6: Me.

Teacher: Come and draw us an equilateral triangle.

Board: (Drawing of the student on the board)

When the student wrote the numbers of 1, 2, 3 for the sides of the right triangle, the teacher pushed the student to explain the reason (1b-3a-3d). All students in the classroom thought about this question to justify these values. They focused on the equilateral triangle in the direction of a student's response during the classroom discussion (3b) and the teacher provided the students to understand the reason why the side lengths are 1, 2, 3 (2e) and to improve their existing thoughts. The teacher also asked the students to estimate this question (2b). This process which was unexpected for the students provided them to reason about the relationship among 1, 2 and 3 and prompted them to think mathematically.

In the revision lesson of the second cycle, there were several questions to encourage the students to think. The teacher asked students to find the points whose coordinates on the unit circle were integers.

Teacher: Are there points whose coordinates on the unit circle are integers?

Student 1: Why not? There might be.

Teacher: Well done. For example, which ones?

Student 2: (1,0), (-1, 0)

Teacher: Are there points whose coordinates on the unit circle are integers?

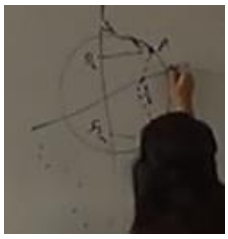
Student 1: Why not? There might be.

Teacher: Well done. For example, which ones?

Student 2: (1,0), (-1, 0)

Teacher: Where is the point whose coordinate is (1,0)?

Student 2: (she showed each one on a unit circle one by one)



Teacher: Yes, these points are on the circle, are there other points which both coordinates are integers?

How many elements does the solution of the equation $x^2+y^2=1$ in the set of integers?

Student 1: 4 points. The points of (0,1) and (0,-1) are also possible.

The teacher asked a follow-up question to improve students' understanding and encourage them to think (2c). Additionally, the teacher promoted students to use graphical representations and to connect graphical and algebraic representations while they were determining these points (2d). This was a promoting-thinking action because the question included the relation among the concepts of equation, trigonometric equation, and sets of numbers and unit circle. In other words, by this question, the students related different concepts to each other and developed their understanding by thinking about their existing understanding.

The teachers' discussions about the students' possible misconceptions and mistakes in the meetings affected the teacher's actions during the teaching process. In the revision lesson of the second cycle, the teacher gave a value of sine and asked students to express what the value of cosine would be equal to.

Student 1: $\sin\alpha=310$

Teacher: What's ?

Student 1: Since it is exact opposite $\cos\alpha=103$

Teacher: This is one of the most common mistakes... if tangent is reciprocal of cotangent, why not cosine would be the reciprocal of sine just like cotangent and tangent. You can evaluate this response by examining the right triangle.

Student 1: Cosine is found on the adjacent side over the hypotenuse.

Teacher: Aren't cosine and sine the reciprocal of each other, are they?

Student 2: No, different sides affect this ratio.

When the teacher expressed the value of sinus and asked the value of cosine, a student gave the response of 10/3 which was reciprocal. The teacher stated that this response might be related to students' common mistakes and asked the students to think about the meaning of ratios on the right triangle. The teachers estimated this inappropriate thinking in the planning meetings (9a), and knowing the mistake (7a) and relating the concept with the triangle to eliminate the mistake (7e-7f) were significant for improving the students' learning and thinking.

4. Discussion and Conclusion

In this study, teachers collaboratively engaged in the teaching processes by planning and reflecting on these plans after their implementation. They were exposed to a variety of students, different from those in their own classrooms, and actively shared their ideas regarding content and student thinking with one another. Our interactions with them during meetings, as knowledgeable facilitators (Pehlivan & Bukova Güzel, 2020; Takahashi, 2014), contributed to the enhancement of their mathematical knowledge for teaching. Specifically, the study focused on improving their KoST.

Through the lesson study process, teachers had the opportunity to observe and critically analyze different lessons, thereby individually supporting the development of their teaching actions related to KoST. For instance, discussions on questions such as how to prompt students to think about concepts, how to uncover their incomplete understandings, or how to encourage them to think differently fostered the teachers' perspectives on teaching and learning. As they considered student thinking and discussed lesson plans across three lesson study cycles, their approaches in the classroom were increasingly influenced by these evolving perspectives.

The lesson study process facilitated the extension of actions regarding KoST. Through careful planning that centered on understanding students' thought processes, and through post-lesson evaluation meetings, the teachers were able to refine their instructional strategies. These discussions allowed them to anticipate student thinking, thereby enabling them to employ more effective methods to enhance students' conceptual understanding. It is essential for teachers to have a clear understanding of students' pre-existing knowledge prior to a lesson, as well as the intended learning outcomes (Kelting-Gibson, 2013). During the planning phase, teachers engaged in discussions about potential student ideas and adjusted the lesson content accordingly based on their predictions of student thinking.

During the lesson implementation phases, teachers encouraged students to engage in reasoning about the concepts and guided their learning processes by following their own thought processes. As the lesson study process advanced, teachers took more effective actions to support students' learning. These included activities such as estimation, relating ideas, sharing insights, considering diverse perspectives, and posing questions. These actions reflected an improvement in their knowledge of students' thinking (KoST), as evidenced by their alignment with established frameworks (An, et al., 2004; Cengiz, 2007; Lee, 2006). Furthermore, when teachers employed questions and activities designed to prompt student estimation, they were able to observe students' thinking more clearly and create a learning environment that centered on student-centered thinking. Teachers also questioned the concepts and underlying ideas during the planning stages, thereby encouraging students to engage in similar questioning in the classroom, even when they had only a procedural understanding. The effect of the lesson study cycle on teachers' actions was evident, with improvements in KoST becoming apparent as the lesson study process progressed across cycles. This process provided a productive framework for examining and conceptualizing teachers' KoST components.

The KoST components serve as an analytical framework for mathematics teachers to enhance their instructional practices. These components were developed by analyzing real classroom interactions, providing a detailed description of contexts in which teachers can consider students' thinking. They offer a range of possible instructional strategies to support the development of students' mathematical thinking (Corey et al., 2021; Van Zoest et al., 2010). By utilizing evidence from categorized components, discussions can be initiated with teachers. Even if they are not directly involved in the professional development program, these findings

can be used to evaluate and reflect on real classroom practices, thereby enhancing their development and awareness. The findings provide specific examples that help teachers understand the extent of their own knowledge of student thinking within their practices. A teacher who has engaged with this framework, can personally reflect on its categories in her/his own teaching practices. Introducing this framework to teachers serves as a valuable guide in this regard. Additionally, mathematics teacher education programs could incorporate the KoST framework to better prepare student teachers.

Limitations

This study involved three mathematics teachers working with a large group of students. Observing the teachers' KoST in crowded classrooms posed certain challenges; however, it also allowed for the identification of diverse instructional strategies. Additionally, the participation of only three teachers within a single school could be considered a limiting factor in the lesson study process. Conducting a lesson study cycle with a larger number of teachers from different schools could enable researchers to implement a broader professional development program, offering insights into a wider range of teacher practices related to KoST.

We encountered some limitations in coordinating in-person meetings with teachers. In future studies, an online environment for the lesson study program could be explored to examine how this approach supports teachers' professional development. Additionally, this study did not focus on student learning. Given that teachers with a strong KoST are better equipped to address students' needs and create opportunities to enhance their understanding (Asquith et al., 2007), subsequent research could investigate how students' understanding evolves as teachers' KoST actions improve."

5. References

An, S., Kulm, G., & Wu, Z. (2004). The pedagogical content knowledge of middle school mathematics teachers in China and the U.S. *Journal of Mathematics Teacher Education, 7*(2), 145–172. https://doi.org/10.1023/b:jmte.0000021943.35739.1c

Asquith, P., Stephens, A., Knuth, E., & Alibali, M. (2007). Middle school teachers' understanding of core algebraic concepts: Equal sign and variable. *Mathematical Thinking and Learning, 9*(3), 249–272. https://doi.org/10.1080/10986060701360910

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special. *Journal of Teacher Education, 59*(5), 389–407. https://doi.org/10.1177/0022487108324554

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15. https://doi.org/10.3102/0013189x033008003

Brendefur, J. L., Thiede, K., Strother, S., Bunning, K., & Peck, D. (2013). Developing mathematical thinking: Changing teachers' knowledge and instruction. *Journal of Curriculum and Teaching, 2*(2), 62–75. https://doi.org/10.5430/jct.v2n2p62

Cengiz, N. (2007). What allows teachers to extend student thinking during whole group discussions? [Unpublished doctoral dissertation]. Western Michigan University.

Corey, D. L., Williams, S., Monroe, E. E., & Wagner, M. (2020). Teachers' knowledge of student mathematical thinking in written instructional products. *Journal of Mathematics Teacher Education, 24*(6), 613–639. https://doi.org/10.1007/s10857-020-09476-y

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice, 39*(3), 124–131. https://doi.org/10.1207/s15430421tip3903_2

Empson, S. B., & Junk, D. (2004). Teachers' knowledge of children's mathematics after implementing a student-centered curriculum. *Journal of Mathematics Teacher Education, 7*(2), 121–144. https://doi.org/10.1023/b:jmte.0000021786.32460.7f

Fernández, C., Llinares, S., & Valls, J. (2012). Learning to notice students' mathematical thinking through online discussions. *ZDM Mathematics Education, 44*(6), 747–759. https://doi.org/10.1007/s11858-012-0425-y

Franke, M. L., & Kazemi, E. (2001). Learning to teach mathematics: Focus on student thinking. *Theory into Practice, 40*(2), 102–109. https://doi.org/10.1207/s15430421tip4002_4

Gehrtz, J., Brantner, M., & Andrews, T. C. (2022). How are undergraduate STEM instructors leveraging student thinking? *International Journal of STEM Education, 9*(1), 1–20. https://doi.org/10.1186/s40594-022-00336-0

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education, 39*(4), 372–400. https://doi.org/10.5951/jresematheduc.39.4.0372

Huang, R., & Shimizu, Y. (2016). Improving teaching, developing teachers and teacher educators, and linking theory and practice through lesson study in mathematics: An

international perspective. *ZDM, 48*(4), 393–409. https://doi.org/10.1007/s11858-016-0795-7

Hurd, J., & Licciardo-Musso, L. (2005). Lesson study: Teacher-led professional development in literacy instruction. *Language Arts*, *82*(5), 388–395. https://doi.org/10.58680/la20054415

Kelting-Gibson, L. (2013). Analysis of 100 years of curriculum design. *International Journal of Instruction*, *6*(1), 39–58.

Kung, D., & Speer, N. (2009). Mathematics teaching assistants learning to teach: Recasting early teaching experiences as rich learning opportunities. *Journal of Graduate and Professional Student Development*, *12*, 1–23.

Lee, K. (2006). Teachers' knowledge of middle school students' mathematical thinking in algebra word problem solving [Unpublished doctoral dissertation]. Oregon State University.

Lewis, C., Perry, R. R., Friedkin, S., & Roth, J. R. (2012). Improving teaching does improve teachers: Evidence from lesson study. *Journal of Teacher Education, 63*(5), 368–375. https://doi.org/10.1177/0022487112446633

Liang, B. (2023). Mental processes underlying a mathematics teacher's learning from student thinking. *Journal of Mathematics Teacher Education,* 1–26. https://doi.org/10.1007/s10857-023-09601-7

Moon, K. (2023). Developing knowledge of student thinking: Understanding big ideas behind students' difficulties with connecting representations in algebra. *International Journal for Mathematics Teaching and Learning, 24*(1), 1–16. https://doi.org/10.4256/ijmtl.v24i1.439

National Board for Professional Teaching Standards. (1997). *State and local action supporting National Board Certification.* Retrieved from https://www.nbpts.org

National Comprehensive Center for Teacher Quality. (2011). *High-quality professional development for all teachers: Effectively allocating resources.* Research & Policy Brief.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* National Council of Teachers of Mathematics.

Pehlivan, C., & Bukova Guzel, E. (2020). Development of mathematics teachers' moves that support students' higher order thinking skills through lesson study. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 11*(3), 774–813. https://doi.org/10.16949/turkbilmat.683535

Perry, R. R., & Lewis, C. C. (2009). What is successful adaptation of lesson study in the U.S.? *Journal of Educational Change, 10*(4), 365–391. https://doi.org/10.1007/s10833-008-9069-7

Rowland, T., Thwaites, A., & Jared, L. (2011, July). Triggers of contingency in mathematics teaching. In B. Ubuz (Ed.), *Proceedings of the 35th Conference of the International Group for the Psychology of Mathematics Education* (pp. 73–80). Ankara, Turkey.

Schilling, S. G., Blunk, M., & Hill, H. C. (2007). Test validation and the MKT measures: Generalizations and conclusions. *Measurement, 5*(2–3), 118–128. https://doi.org/10.1080/15366360701487146

Takahashi, A. (2014). The role of the knowledgeable other in lesson study: Examining the final comments of experienced lesson study practitioners. *Mathematics Teacher Education and Development, 16*(1), 4–21.

Van Zoest, L. R., Stockero, S. L., & Kratky, J. L. (2010). Beginning mathematics teachers' purposes for making student thinking public. *Research in Mathematics Education, 12*(1), 37–52. https://doi.org/10.1080/14794800903569832

White, A. L., & Lim, C. S. (2008). Lesson study in Asia Pacific classrooms: Local responses to a global movement. *ZDM, 40*(6), 915. https://doi.org/10.1007/s11858-008-0138-4

Wilson, P. H., Mojica, G. F., & Confrey, J. (2013). Learning trajectories in teacher education: Supporting teachers' understandings of students' mathematical thinking. *The Journal of Mathematical Behavior, 32*(2), 103–121. https://doi.org/10.1016/j.jmathb.2012.12.003

Yoshida, M. (1999). Lesson study: A case study of a Japanese approach to improving instruction through school-based teacher development [Unpublished doctoral dissertation]. University of Chicago.

6. Appendix The main components and sub-components of KoST.

Components	Sub-components
1-Building on students' mathematical ideas	(1a) Knowing prior knowledge related to concept and connect them to new knowledge (1b) Determining students' prior knowledge and consider their deficiencies (1c) Using concepts or definitions to provide understanding (1d) Focusing on rules and procedures to support/reinforce/improve the mathematical knowledge (1e) Attracting students' interests to subject/concept (1f) Using representations/analogies/concrete models defining concepts explicitly
2-Promoting students thinking mathematics	(2a) Asking questions and design tasks/examples for students to think (2b) Having students estimate about questions/problems (2c) Asking questions and design tasks to develop students' existing understanding (2d) Asking students to product mathematical thoughts by representations such as figural/tabular/graphical (2e) Providing students opportunities to think and respond questions (2f) Relating examples/questions/problems to real life
3-Triggering and considering divergent thoughts	(3a) Asking questions to elicit students' ideas (3b) Creating class discussion about a student's idea/solution/question or any thoughts (3c) Asking students to produce thoughts or to explain about teacher's expressions (3d) Asking students to explain/expand/interpret about ideas proposed by them (3e) Asking students to express each other's explanations in different ways (3f) Asking students to give contradictory examples (3g) Encouraging students to produce different solutions (3h) Explaining/expanding students' ideas
4-Engaging students in mathematical learning	(4a) Arranging activities to activate students (4b) Using different representations of concepts (4c) Giving example of mathematical ideas (4d) Knowing prior knowledge related to concept and connect them to new knowledge (4e) Allowing students to understand their difficulties/obstacles/failures while reflecting on instructions and strategies
5-Evaluating students' understanding	(5a) Evaluating how students understand the instructions, how they learn and how they perform during teaching
6-Motivating students learning	(6a) Praising students when they provide appropriate thoughts (6b) Giving students motivational advice when they struggle or fail (6c) Relating examples/questions/problems to real life (6d) Giving the historical development of concept

	(6e) Addressing the importance and necessity of concept
7-Considering students' misconceptions and errors	(7a) Knowing students' misconceptions and errors (7b) Determining students' misconceptions and errors (7c) Focusing on concepts/rules/procedures to prevent misconceptions and errors (7d) Using different representations to prevent misconceptions and errors (7e) Focusing on concepts/rules/procedures to remove misconceptions and errors (7f) Using different representations to remove misconceptions and errors (7g) Giving students clues to realize their misconceptions/errors (7h) Ensuring students' understanding of the problems/questions
8-Considering students' difficulties	(8a) Estimating students' difficulties (8b) Simplifying/Explaining step by step what students have difficulties (8c) Recognizing students' difficulties (8d) Asking questions to determine the reasons of students' difficulties (8e) Giving students clues to overcome difficulties (8f) Focusing on concepts/rules/procedures to overcome difficulties (8g) Using different representations to overcome difficulties
9-Estimating students' possible ideas and approaches	(9a) Estimating possible thoughts to be produced by students (9b) Estimating students' solutions related to questions/problems

Instructional Technology and Lifelong Learning Vol. 5, Issue 2, 399-420 (2024)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Factors Affecting Teachers' Acceptance of Artificial Intelligence Technologies: Analyzing Teacher Perspectives with Structural Equation Modeling

Özlem Gökçe Tekin *

* *Corresponding Author, ogokcetekin@gmail.com*

Abstract

Recent advances in artificial intelligence (AI) technologies have brought to the agenda how to encourage the use of these technologies in education. Teachers' acceptance of AI technologies has an important place. This study, based on the Technology Acceptance Model (TAM), investigates the factors affecting teachers' acceptance of AI technologies. A five-structure structural model for AI technology was proposed by adding Self-Efficacy and Anxiety to TAM. A trial form consisting of 21 items was prepared and 18 items were confirmed. Structural Equation Modeling (SEM) was used to analyze the data. In the proposed model, 7 hypotheses related to Self-Efficacy (SE), Artificial Intelligence Anxiety (AIA), Perceived Ease of Use (PEU), Perceived Utility (PU) and Behavioral Intention (BI) were tested. A significant negative effect was obtained with H1, H2 and H7; a significant positive effect was obtained with H3, H4 and H6, while H5 was not confirmed. The effect of teachers' perceived ease of use on perceived usefulness (H3) and the effect of perceived usefulness on behavioral intention (H6) were the strongest positive effects in the model. The effect of AI anxiety on perceived ease of use (H2) was the strongest negative effect. It was found that teachers' acceptance of using AI technologies in teaching is predictable by teachers' self-efficacy towards AI, AI anxiety and perceived usefulness. The results of this study contributed to the extension of TAM. This study presents a TAM study on AI technologies. In addition, the results can help future educational planning in the use of educational technologies.

Keywords: Artificial intelligence anxiety, Self-efficacy, Technology acceptance model, Structural equation model, Teachers

Citation: Tekin, Ö.G. (2024). Factors affecting teachers' acceptance of artificial intelligence technologies: Analyzing teacher perspectives with structural equation modeling. *Instructional Technology and Lifelong Learning, 5(2)*, 399 - 420. https://doi.org/10.52911/itall.1532218

Öğretmenlerin Yapay Zekâ Teknolojilerini Kabulünü Etkileyen Faktörler: Yapısal Eşitlik Modeli ile Öğretmen Bakış Açılarının Analizi

Özet

Yapay zekâ teknolojilerindeki hızlı ilerlemeler, eğitimde bu teknolojilerin kullanımının nasıl teşvik edileceğini gündeme getirmiştir. Öğretmenlerin yapay zekâ teknolojilerini kabulü bu bakımdan önemli bir yere sahiptir. Teknoloji Kabul Modeli'ne (TKM) dayanan bu çalışma, öğretmenlerin yapay zekâ teknolojilerini kabulünü etkileyen faktörleri araştırmaktadır. Bu amaçla TKM'ye Öz-yeterlik ve Kaygı eklenerek yapay zekâ teknolojisine yönelik beş yapılı bir yapısal model önerilmiştir. Verilerin toplanması için 21 maddeden oluşan bir ölçek hazırlanmıştır. 18 madde Doğrulayıcı Faktör Analizi ile doğrulanmıştır. Verilerin analizinde Yapısal Eşitlik Modeli kullanılmıştır. Önerilen modelde, Öz-yeterlik (ÖY), Yapay Zekâ Kaygısı (YZK), Algılanan Kullanım Kolaylığı (AKK), Algılanan Fayda (AF) ve Davranışsal Niyet (DN) ile ilgili 7 hipotez test edilmiştir. Hipotezlerden H1, H2 ve H7 ile anlamlı bir negatif etki; H3, H4 ve H6 ile ise anlamlı bir pozitif etki elde edilirken H5 doğrulanmamıştır. Öğretmenlerin Algılanan kullanım kolaylığının Algılanan faydası üzerindeki etkisinin (H3) ve Algılanan Faydasının Davranışsal niyeti üzerindeki etkisinin (H6) sırasıyla modeldeki en güçlü olumlu etkiler olduğu tespit edilmiştir. Yapay zekâ kaygısının Algılanan kullanım kolaylığının üzerindeki etkisinin (H2) ise en güçlü negatif etki oldğu tespit edilmiştir. Çalışmada öğretmenlerin öğretimde yapay zekâ teknolojilerini kullanmayı kabullerinin, öğretmenlerin yapay zekâya yönelik öz-yeterliği, yapay zekâ kaygısı ve algılanan faydası tarafından tahmin edilebilir olduğu tespit edilmiştir. Bu çalışmanın sonuçları TKM'nin genişletilmesine katkıda bulunmuştur. Bu çalışma Türkiye'de alanyazındaki önemli bir boşluğu doldurarak yapay zekâ teknolojilerini konu alan bir TKM çalışması sunmaktadır. Ayrıca çalışmanın sonuçları, eğitim teknolojilerinin kullanılmasında gelecekteki eğitim planlamalarına yardımcı olabilecek niteliktedir.

Anahtar Kelimeler: Yapay zekâ kaygısı, Öz-yeterlik, Teknoloji kabul modeli, Yapısal eşitlik modeli, Öğretmenler

Date of Submission	12.08.2024
Date of Acceptance	26.12.2024
Date of Publication	31.12.2024
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Author(s) Contribution	Author: Conceptualization, Methodology, Writing- Original draft preparation, Data curation, Writing- Reviewing and Editing.
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	italljournal@gmail.com
Grant Support	-
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Technology, one of the products of change and development today, renews itself day by day. This adventure, which started with simple technologies, progresses towards very complex structures. The emergence of computers, one of the technological devices, has shown that machines with intelligence-related capabilities can be made (Çetin & Aktaş, 2021). The type of intelligence offered through these machines is characterized as artificial intelligence (Güzey et al., 2022). The concept of artificial intelligence was first introduced by McCarthy in 1956 as "the science and engineering of making intelligent machines" (Hamet & Tremblay, 2017). Artificial intelligence technology is utilized in many areas of daily life. For example, optimizing drivers' route on Google Maps, ordering emails into a user's spam mail folder, recommending products that might be liked in an e-commerce environment, and supporting automated driving (Antonenko & Abramowitz, 2023).

Artificial intelligence, one of the innovations of technology, has started to gain a place in education while progressing rapidly in social life. In this context, creating smart learning environments, innovating smart education models, improving teacher training and developing management skills have been emphasized (Ma & Lei, 2024). Artificial intelligence is an undeniable technology that contributes to education for reasons such as helping lesson to be expertly, interesting and fun, finding the appropriate teaching materials for students, and ensuring the persistence of learning by making learning processes easier (Nabiyev & Erümit, 2020). Artificial intelligence enables personalization of courses in education, organization of curriculum, identification of knowledge gaps, provision of rapid feedback to students, increase of efficiency of instructors and training of future innovators (Nuangchalerm & Prachagool 2023).

Technology Acceptance Model

TAM was created to determine the adopting and using new communication technologies by individuals (Venkatesh & Bala, 2008). The TAM states that individuals' behavioral intention to use a communication technology is determined by two beliefs and assumes that this behavioral intention predicts actual use (Heerink et al., 2014). These are perceived usefulness and perceived ease of use (Venkatesh & Bala, 2008). Also in TAM, behavioral intention is a determinant of technology adoption and use (Al-Adwan, et al., 2023).

TAM helps researchers to find out factors that have the potential to drive the adoption or acceptance of a particular technology (Lee et al., 2019). In recent years, TAM-based studies have been conducted to identify the factors that shape teachers' and pre-service teachers' perspectives on the use of technology in education. These studies were carried out by integrating different instructional technologies into TAM. Web-based e-learning systems, mobile learning technologies, Metaverse-based learning platforms and artificial intelligence technologies are some of them (Al-Adwan, et al., 2023; Chen & Tseng, 2012; Chen, et al., 2023; Mac Callum et al., 2014; Wang, et al., 2022). In this study, TAM was used to determine the factors affecting teachers' acceptance of AI technologies.

Self-efficacy

According to Bandura (1997), self-efficacy is the belief in one's capacity to organize and perform the activities required to achieve certain outcomes. Self-efficacy focuses on performance abilities rather than personal qualities such as physical or psychological characteristics of the individual and judges the individual's ability to fulfill the given task, not who he/she is or how he/she feels about himself/herself" (Zimmerman, 2000). Self-efficacy guides behavior by influencing people's activity choices, efforts and determination in the face of challenges. High self-efficacy increases continuous participation in activities and success (Schunk, 1981). Self-efficacy, which can be adapted to different fields (Bandura, 1997), has been discussed in many contexts such as technology self-efficacy (Durak, 2018), computer self-efficacy (Işıksal & Aşkar, 2003), internet self-efficacy (Kim & Glassman, 2013).

In this study, Artificial Intelligence Self-Efficacy was used to determine teachers' perceptions of their ability to use artificial intelligence technologies. There are studies showing that self-efficacy is an important factor in technology adoption (Abdullah et al., 2016; Chahal & Rani, 2022). Individuals who are more confident in their learning skills related to the use of technology tend to see using technology as easy and useful compared to those who are less confident (Venkatesh & Davis, 1996). Aktürk and Delen (2020) indicated that as technology acceptance level increases in teachers, self-efficacy also increases. In this study, self-efficacy was used to determine teachers' self-efficacy perceptions about the use of artificial intelligence technologies.

Artificial Intelligence Anxiety

Anxiety is the uneasiness or irrational fear that arises because people are afraid of any dangerous situation (Manav, 2011). The fact that artificial intelligence (AI) technologies cause anxious or emotional reactions while being used is referred to as AI anxiety (Heerink, et al., 2014). Artificial intelligence anxiety is classified as "job replacement anxiety, sociotechnical blindness, AI configuration anxiety and AI learning anxiety (Wang & Wang, 2022). Research has revealed that teachers' and university instructors' attitudes towards adopting technologies while teaching are affected by their anxiety (Şahin, & Şahin, 2021; Ursavaş, 2014; Wang et al., 2021). In this study, AI anxiety was used to determine teachers' anxiety about the use of Al technologies.

It is not certain that teachers will adopt new technologies if they are not predisposed to them (Chen et al., 2020). Knowing teachers' positions towards the acceptance of artificial intelligence technologies is significant for the development of technology-supported teaching. The fact that the Artificial Intelligence Applications Course Curriculum will be applied to 7th and 8th grade students in Turkey in the 2024-2025 makes teachers' acceptance of artificial intelligence technologies important. This study presents a model based on TAM to examine the factors affecting teachers' acceptance of AI technologies. Teachers' active use of educational technologies is thought to be related to technology acceptance (Aktürk & Delen, 2020). In this study, TAM was used to investigate the acceptance of AI technologies due to its solid theoretical foundation. The TAM has been integrated into different types of technologies and extended with other factors that are assumed to affect intention to use or usage (Heerink et al., 2014).

In their study, Çelik et al. (2024) aimed to determine the effects of perceived usefulness, perceived ease of use, hedonic motivation, value and attitude on behavioral intentions related to distance education applications. In the study, it was determined that usefulness, ease of use and value had a positive and significant effect on attitude, while hedonic motivation did not have a significant effect on attitude. In addition, it was determined that attitude had a positive and significant effect on behavioral intention. Ursavaş et al. (2019) aimed to investigate the effect of subjective norms on teachers' perceptions, attitudes and behavioral intentions towards using computer technology. The results revealed that attitude towards using computer was the most dominant predictor of behavioral intention in teachers. Gurer (2021) investigated the

intentions of prospective teachers to use technology in their future teaching by expanding TAM with different variables such as facilitating conditions, subjective norms and technology self-efficacy. The results showed that facilitating conditions, subjective norms and attitudes were important predictors of intention to use technology. In addition, technology self-efficacy significantly determined perceived ease of use. When looking at the studies conducted in Turkey, no TAM study was found in which self-efficacy and anxiety towards AI were integrated. In the current study, teachers' acceptance levels of AI technology were investigated by adding the factors of self-efficacy and anxiety towards AI technologies. Thus, it can be said that this gap in the literature will be filled by adding a TAM study on AI technologies to the literature.

In addition, when the limited number of studies on AI in Turkey is examined, it is seen that there are also few studies in which teachers or teacher candidates constitute the participant group. Ağmaz and Ergüleç (2024) aimed to reveal the views of teacher candidates on the use of AI in education through metaphors. According to the results, the metaphors of teacher candidates who have previously used AI tools are more positive and free from anxiety. The metaphors of those who have not used AI tools are more negative and anxious. Demir Dülger and Gümüşeli (2023) examined the views of school principals and teachers on the use of AI in education in their study. According to the results, the use of AI in education is considered an opportunity and it is seen that it will provide benefits in various areas. Seyrek et al. (2024) aimed to obtain the views of teachers on AI in their study. It was revealed that teachers perceive the role that AI will undertake in the field of education in the future as impressive, positive and exciting. Teachers stated that they prefer AI mostly in the areas of question preparation, content creation, activity preparation, data analysis and success tracking. In addition, it has been observed that the use of AI in education raises concerns such as reduces creativity, students becoming lazy, and data breaches. Balıkçı et al. (2024) aimed to examine teachers' perspectives on the concept of AI using the metaphor analysis method. The results showed that teachers conceptualized AI as a job facilitator by associating it with robots and machines representing cognitive intelligence. In addition, concerns were also identified about the potential risks of AI and its impact on creativity. No study has been found in the Turkish literature examining self-efficacy and artificial intelligence anxiety towards artificial intelligence together. For this reason, the current study is important both in terms of being a study that includes these together

and examining these components together with TAM. In this direction, a 5-structure model related to the acceptance of AI technologies was created by integrating AI into TAM. Relational hypotheses based on this model are presented below:

- H1: Self-efficacy towards AI has a significant negative effect on AI anxiety
- H2: AI anxiety has a significant positive effect on the PEU of AI technology.
- H3: PEU of AI technology has a significant positive effect on its PU.
- H4: Self-efficacy towards AI has a significant positive effect on intentions to use it.
- H5: PEU of AI technology has a significant positive effect on behavioral intentions to use it.
- H6: PU of AI technology has a significant positive effect on behavioral intentions to use it.
- H7: AI anxiety has a significant negative effect on behavioral intentions to use it.

2. Method

The descriptive scanning method, one of the quantitative research methods, was used in this research. Descriptive scanning method is a research method that aims to describe an event that has happened in the past or is actively ongoing (Karasar, 2016).

Working Group

Primary and middle school teachers working in two different provinces of Turkey in 2023-2024 academic year were selected as study group. The participants of the study were selected using purposive sampling method. This method requires a selection based on participants' compliance with the screening conditions and their knowledge or expertise on the topic (Palinkas et al., 2015). In the study, data were obtained from separate groups for Exploratory Factor Analysis (EFA) and SEM. Data were obtained from 132 participants (Group 1) for EFA and 174 participants (Group 2) for SEM. It is stated that the number of participants for EFA should be at least 5 per item (Hair et al., 2005). Therefore, the number of items in the study being 21 requires at least 105 participants. For the study, a participant group of 132 participants was reached and a sufficient number was obtained for EFA. 89 participants in Group 1 were female and 43 were male. Of this group, 66 were primary school teachers and 66 were middle school teachers. In SEM analysis, the reasonable sample size for normally distributed data is

approximately N = 150 (Muthén & Muthén, 2002). Kline (2023) stated that the acceptable sample size for educational measurements using Structural Equation Modeling (SEM) varies between 100 and 150. Therefore, a participant group of 174 participants was reached for the study and a sufficient number was obtained for SEM analysis. Of this group, 98 were female, 76 were male, 86 were primary school teachers and 88 were middle school teachers.

Data Collection

A scale consisting of 21 items and two parts was prepared for the purpose of the study. The first part of this scale, includes gender and school level information. In the second part, the scale items based on the theoretical model (TAM) were included. The five constructs in TAM are Self-Efficacy (SE), Artificial Intelligence Anxiety (AIA), Perceived Ease of Use (PEU), Perceived Utility (PU) and Behavioral Intention (BI). Each construct in the scale is represented by more than one item. SE contains 5 items (e.g., I can use AI technologies without any problems even though I have not used them before), AIA contains 4 items (Learning to use a new AI technology makes me anxious), PEU contains 4 items (The functioning of an AI-based system is clear and understandable), PU contains 4 items (I think that using AI technologies is beneficial for me), and BI contains 4 items (I plan to spend time exploring new features of AI applications in the future). Ethics committee permission was obtained before collecting data. This study was conducted by the Inonu University Scientific Research and Ethics Committee with the ethics committee decision dated 22/02/2024 and numbered E.414965. The data of the study were collected in the spring semester of the 2023-2024 academic year. Data collection was carried out through Google Forms.

Scale Development Process

In the scale development process, the items were adapted from reliable tools and 23 items related to artificial intelligence technologies were created (Ng, et al., 2023; Venkatesh & Bala, 2008; Wang, et al., 2019; Wang, et al., 2021; Zhang et al., 2023). These items were presented to experts from the fields of Computer and Communication Technologies, Measurement and Evaluation, and Guidance and Psychological Counseling. After the expert evaluation, some of the statements were modified, two repeated items were removed and the items were reshaped by making corrections. Thus, a 21-item trial form was obtained. This scale was read by twelve teachers and corrections were made in the parts that were not comprehensible. This scale was

formed in 5-point Likert type and was graded as Completely agree (5), Agree (4), Partially agree (3), Disagree (2), Strongly disagree (1).

First, EFA was conducted using the data of the first study group. SPSS 25.0 program was used to calculate descriptive statistics. Before starting the factor analysis, skewness and kurtosis values of the items were examined. These values ranged between -.774 and .737; -.833 and .451, respectively. It can be said that these values are within acceptable limits for the normality assumption (Büyüköztürk, 2014).

Kaiser-Meyer-Olkin (KMO) and Barlett's test of sphericity were calculated to test the adequacy of the data set for factor analysis. Barlett test (x2 =1754.983; sd= 210; p=0.000) and KMO test (0.886) showed that the data set was suitable for the analysis (Kaiser, 1974). Principal component analysis and Varimax rotation technique were used for EFA. As a result of EFA, 3 items (AIA4, PEU2, and SE5) that did not meet the criteria for factor formation process (Büyüköztürk, 2014; Çokluk, et al., 2021) were removed from the trial form. After the first rotation, since AIA4 was included as a single item under a separate factor, it was removed from the scale. The analysis was repeated and it was determined that the difference between the loading values of PEU2 and SE5 and the loading values in another factor was not higher than .10. Thus, three items were removed from the trial form and a 5-factor structure with 18 items was obtained. This 5-factor structure explains 76.23% of the total variance. After rotation, the first factor contributed 18.98%, the second 16.50%, the third 14.86%, the fourth 14.76% and the fifth 11.13% of the total variance. The factor loadings of the scale items and their contributions to the common variance are given in Table 1.

Table 1.

Factor Loadings

Item	F. Loadings Before Rotation	F1	F2	F3	F4	F5
PU1	.763	.811				
PU3	.754	.810				
PU2	.841	.798				
PU4	.774	.721				
SE4	.826		.882			
SE1	.761		.837			
SE2	.742		.777			
SE3	.657		.541			
BI4	.798			.745		
BI3	.767			.744		
BI2	.782			.658		
BI1	.667			.618		
AIA2	.787				.867	
AIA1	.794				.848	
AIA3	.828				.844	
PEU1	.766					.823
PEU4	.732					.698
PEU3	.682					.587

*F= Factor

In Table 1, the factor loadings ranged between .72 and .81 in the first dimension (PU), .54 and .88 in the second dimension (SE), .62 and .75 in the third dimension (BI), .84 and .87 in the fourth dimension (AIA) and .59 and .82 in the fifth dimension (PEU). These values show that the acceptance level of the items is .55 and above. Cronbach's α values examined to reveal the reliability of the data. The Cronbach's α coefficient for the overall 18-item scale was found to be .836. This coefficient was calculated as .897 for the PU, .762 for the PEU, .860 for the SE, .867 for the AIA and .868 for the BI factor. Cronbach's α value between .60 and .90 means that the scale is highly reliable (Büyüköztürk, et al., 2018).

Data Analysis

In this study, SEM was used to evaluate and validate the proposed theoretical model. SEM is a statistical approach that explains the cause-and-effect relationship between observed and latent variables within hypotheses and can determine direct and indirect effects and standard errors between variables (Raykov and Marcoulides, 2000). The following steps were followed in the structural equation modeling method (Dursun & Kocagöz, 2010):

(1) A structural model was created to explain the hypotheses of the research. (2) The parameters of the model were defined and the observed variables belonging to the latent variables were

determined and the measurement model was defined. (3) The goodness of fit statistics of the model were examined. (4) The regression weights (estimates) and significance values of the relationships were examined and the model was analyzed. In this context, the measurement model was evaluated first and the structural model was tested in the next step. In the first step, reliability and convergent validity were calculated by examining the adequacy of fit. Finally, the seven hypotheses of the study were tested with Amos. Maximum Likelihood method was used to analyze data.

3. Result

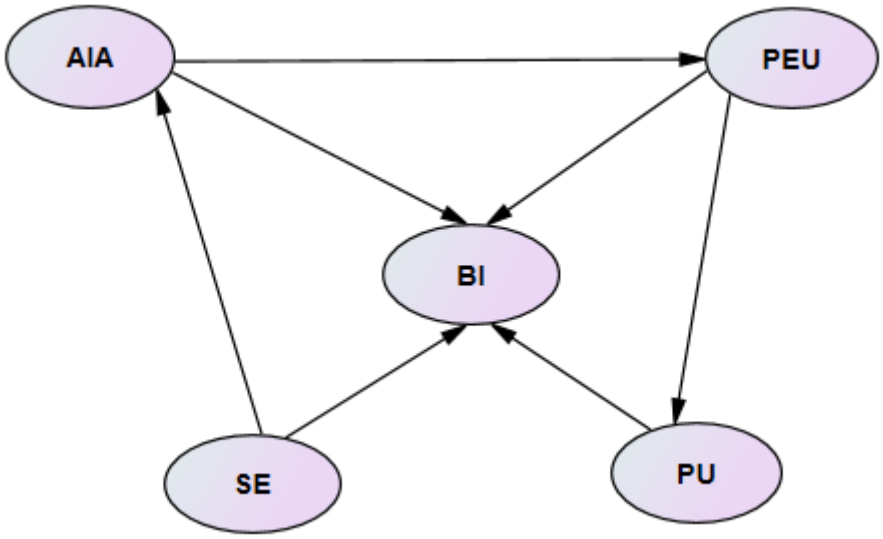
Text Testing the Measurement Model

Before testing the measurement model, the skewness and kurtosis values of the items were calculated to vary between -1.033 and .705 and -.931 and .951, respectively. These values were found to be within acceptable limits for the normality assumption (Büyüköztürk, 2014).

In this study, the CFA evaluation model (Structural model), which includes five constructs, namely PU, PEU, SE, AIA and BI, was applied (Figure 1).

Figure 1.

Structural Model



$\chi 2$/df and TLI, CFI, NFI, RMSEA, SRMR fit indices were used for the fit evaluation of the model created with seven hypotheses. The $\chi 2$/df value of the model is 2.067. This value is below the

threshold of ≤ 3.0 defined by Schermelleh-Engel et al. In addition, the NFI, CFI and TLI values obtained in the study are 0.900, 0.945 and 0.933, respectively. All of these values exceed the 0.9 threshold specified by Hair et al. (2005) and Kline (2023). The RMSEA value is 0.079, which is below the threshold of <0.08 suggested by Hair et al. The values showed a good fit with the data set.

After determining that the values were acceptable, the standardized factor loadings of the items and the Cronbach's α, AVE and CR values of the dimensions were calculated (Table 2).

Table 2.

Values of Measurement Model

Factor	Item	Standardized Factor Loading
Self-efficacy (SE)	SE1	.777***
(α = .889; AVE= .672; CR= .891)	SE2	.854***
	SE3	.808***
	SE4	.840***
Artificial Intelligence Anxiety (AIA)	AIA1	.779***
(α = .856; AVE= .664; CR= .855)	AIA2	.752***
	AIA3	.906***
Perceived Ease of Use (PEU)	PEU1	.680***
(α = .818; AVE= .596; CR= .815)	PEU3	.815***
	PEU4	.815***
Perceived Usefulness (PU)	PU1	.864***
(α = .928; AVE= .767; CR= .929)	PU2	.904***
	PU3	.850***
	PU4	.886***
Behavioral Intention (BI)	BI1	.781***
(α = .918; AVE=.745; CR= .921)	BI2	.912***
	BI3	.863***
	BI4	.893***

***$p < 0.001$

In Table 2, factor loading values range between 0.680 and 0.912. Factor loadings are recommended to be above 0.50 (Hair et al., 2005). It is seen that the values obtained in Table 2 meet this threshold. The Cronbach's α values of the dimensions ranged between .818 and .928. Cronbach's α for the overall model was calculated as .841. These results show that the factor valuation has sufficient internal consistency.

In addition, the convergent validity of the measurement model was assessed using two main indices. These are; Composite Reliability (CR) and Average Variance Explained (AVE). Fornell and Larcker (1981) suggested that AVE should exceed 0.5 and CR should exceed 0.7 for

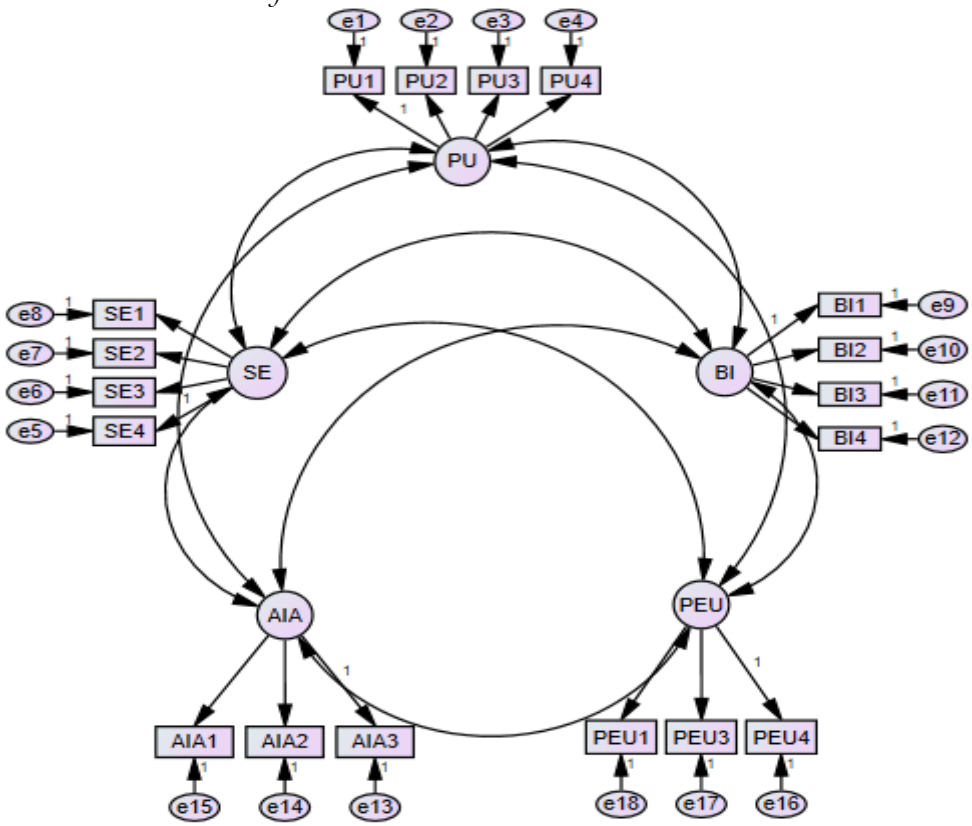
convergent validity. The values obtained in the measurement model are above these thresholds. This indicates that the current study has a good convergent validity for the variables used.

Structural Model

The structural model was evaluated after the measurement model. The hypothesized relationships of the model proposed in the study were established using SEM. Figure 2 shows a summary of the analysis of this model.

Figure 2.

Structural Model Analysis



The values and results calculated as a result of analyzing the model are given in Table 3.

Table 3.

Hypotheses and Results of the Model

Hypotheses	Path	β	S.e	*t*	*p*	Result
H1	SE - > AIA	-0.374	0.094	-4.426	***	Supported
H2	AIA - > PEU	-0.560	0.063	-6.569	***	Supported
H3	PEU - > PU	0.882	0.096	10.641	***	Supported
H4	SE - > BI	0.463	0.049	7.087	***	Supported
H5	PEU - > BI	0.126	0.143	-0.819	0.413	Not supported
H6	PU - > BI	0.575	0.117	3.952	***	Supported
H7	AIA - > BI	-0.270	0.047	-3.911	***	Supported

β = Standardized path coefficient ***: *P*< 0.001

Table 3 shows that six of the seven hypotheses are supported ($p< 0.001$) and only one (H5) is not supported. A significant negative effect of SE on AIA ($\beta= -0.374$); AIA on PEU ($\beta= -0.560$) and AIA on BI ($\beta= -0.270$) was found (H1, H2, H7). In addition, PEU had a significant positive effect on PU ($\beta= 0.882$); SE on BI ($\beta= 0.463$) and PU on BI ($\beta= 0.575$) (H3, H4, H6). the hypothesis that peu has a significant positive effect on bı (H5) was not supported ($\beta= 0.126$; $p=0.413$).

Standardized path coefficients less than |0.10| indicate a weak effect, close to |0.30| indicate a moderate effect, and greater than |0.50| indicate a strong effect (Cohen, 1992). In the structural model, the effect of PEU on PU was found to be the strongest positive effect ($\beta= 0.882$). This is followed by the effect of PU on BI ($\beta= 0.575$). The strongest negative effect is the effect of AIA on PEU ($\beta= -0.560$). The effects of SE on AIA ($\beta= -0.374$), SE on BI ($\beta= 0.463$) and AIA on BI ($\beta= -0.270$) are moderate. In addition, t values in path analyses are considered significant at 0.05 level if they are greater than |1.96| and at 0.01 level if they are greater than |2.56| (Hoyle, 1995). Therefore, the t values for the paths in hypotheses H1, H2, H3, H4, H6 and H7 can be accepted as significant at 0.01 level.

4. Discussion and Conclusion

This study examined the factors affecting the acceptability of AI technologies among teachers. Based on TAM, this study added "self-efficacy and anxiety" towards AI to investigate the factors affecting teachers' acceptance of AI technologies as well as their perspectives on AI-supported teaching. The findings of the study showed that teachers' PEU significantly positively influenced their AIA, SE significantly positively influenced their AIA, and AIA significantly positively influenced their AIA, supporting hypotheses H3, H4, and H6, respectively. In addition, teachers' SE significantly negatively affected their AIA, and AIA significantly negatively affected their PEU and BI, supporting hypotheses H1, H2 and H7, respectively. Hypothesis H5, which states that teachers' PEU positively affects their BI, was not supported. Thus, six of the seven proposed hypotheses were supported while only one was not supported.

The effect of teachers' PEU on their PU and then the effect of PU on BI were found to be the strongest positive effects in the model, respectively. These findings indicate that teachers believe that AI technologies that are easy to use in technology-assisted instruction are more likely to be useful. And it shows their belief that the usefulness of these technologies can make

them willing to use them. These results are in line with the principles of the TAM theory (Davis et al., 1989). The positive effects of PEU on PU and the positive effects of PU on BI are consistent with the existing findings in studies in which artificial intelligence technologies are integrated into TAM (Choi et al., 2023; Ma and Lei, 2024; Naidoo, 2023; Wang et al., 2021; Zhang et al., 2023)

Findings demonstrate a strong negative effect of teachers' AIA on their PEU. In other words, when teachers' AI anxiety is low, they think that it is easy to use AI technologies in teaching. Zhang et al. (2023) reported that anxiety of female teachers about artificial intelligence was effective on PEU, but it was not effective in the male group. Venkatesh (2000) stated that anxiety is a belief that prevents the formation of a positive perception of ease of use.

This study confirmed the negative effect of teachers' SE on their AIA. This finding indicates that teachers with high self-efficacy have low anxiety about using AI technologies in teaching. In parallel with the current finding, Wang et al. (2021) emphasized in their study that university teachers' self-efficacy towards AI-based applications negatively affected their anxiety. In addition, Chatzoglou et al. (2009) indicated a positive relation between self-efficacy and computer anxiety in the model they created based on TAM.

The positive relation between teachers' SE and BI in this study is in line with Aktürk and Delen's (2020) finding. The current finding indicates that when teachers' self-efficacy towards artificial intelligence is high, intention to use this technology in teaching and therefore acceptance may also be high. Similarly, Çelik (2019) stated that instructors' self-efficacy to use augmented reality technology in teaching has a positive relation with their acceptance of this technology. Alenezi et al. (2010), Teo (2009) and Wong (2015) concluded that computer self-efficacy is good at predicting intent. Gurer (2020), on the other hand, highlighted that there wasn’t direct effect between technology self-efficacy and behavioral intention. In addition, teachers' AIA significantly and negatively affected their BI. This result implies that teachers with high AI anxiety are less inclined to accept AI technology-supported instruction. Also it is similar to the findings of Alenezi et al. (2010) that computer anxiety significantly affects intentions to use technology. When we look at the other studies in which TAM was used, it was found that anxiety towards technology use negatively affected behavioral intention indirectly rather than directly (Akbıyık & Coşkun, 2013; Wang et al., 2021). Since AI technology in teaching is in its

infancy, most teachers are still concerned about whether their computer and communication technology skills can meet the needs of integrating AI into teaching practice (Wang et al., 2021).

Contrary to expectations, there wasn't significant relation between teachers' PEU and BI. This explain that even if teachers perceive the use of artificial intelligence technologies as easy, this does not mean that they accept to use these technologies in teaching. Similar to the findings, there are studies that concluded participants' ease of use in integrating technologies into teaching is correlated with intent to use them (Al-Adwan et al., 2023; Naidoo, 2023; Wang et al., 2021). The current finding is not in line with the principles of the TAM theory. In line with this theory, Ma and Lei (2024) concluded that teacher education students' perceptions of the ease of use of artificial intelligence technologies have a significant effect on their intention to use them. Venkatesh (2000) found differences in the effects of external constructs across populations when evaluating the effect of external constructs on TAM. It is possible that the effects of the external constructs (self-efficacy and AI anxiety) examined in current research are not generalizable and can change depending on different technologies (Teo & Zhou, 2014).

To summarize, this study shows that the extended version of the TAM is effective in explaining teachers' acceptance of AI technology in technology-enhanced instruction. In addition, this research provided a basis for investigators to uncover the underlying reasons for the lack of acceptance towards AI technologies. Davis (1989) emphasizes that systems should be evaluated not only to predict acceptability but also to diagnose the causes of lack of acceptance and develop interventions to improve user acceptance. The fact that this study is the first TAM study on artificial intelligence technologies in Turkey makes it important and fills the gap in the literature. In addition, the results are valuable in terms of helping future educational planning in the use of educational technologies.

This study reveals the important role of self-efficacy towards AI and AI anxiety in teachers' acceptance of AI technology and lays the foundation for future researches in technology acceptance model theory. Future research can extend the TAM by adding sociocultural or psychological factors that influence teachers' acceptance of AI. It was found that there were significant effects between PEU and PU and between PU and BI. Therefore, the ease of use of AI technologies positively affects its usefulness and usefulness positively affects the intention to use it. This emphasizes the importance of focusing on the practical utility of a particular AI

technology when evaluating whether it should be applied to teaching. That is, AI technology may improve the quality of instruction and allows teachers perform their tasks efficiently (Ma & Lei, 2024). Therefore, in-service trainings can be provided to teachers on the advantages of using AI technology in education. In addition, in this research, AIA has a significant effect on PEU. From the perspective of facilitating teachers' acceptance of AI technology, trainings can be designed and implemented that focuses the utility of AI technologies in education practices and reduce the anxiety they may cause (Wang, 2021).

The rapid progress and development of artificial intelligence technology may also change teachers' acceptance of using AI technology over time. In this context, the research can be repeated in the future and updates can be made. This research conducted with teachers can also be applied to prospective teachers. In this study, while determining the factors affecting teachers' acceptance of artificial intelligence technology, a model was created based on direct effects. The study can be expanded by considering indirect effects.

5. References

Abdullah, F., Ward, R., & Ahmed, E. (2016). Investigating the influence of the most commonly used external variables of TAM on students' Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) of e-portfolios. *Computers in Human Behavior*, *63*, 75–90. https://doi.org/10.1016/j.chb.2016.05.014

Ağmaz, R. F., & Ergulec, F. Perceptions of prospective teachers about artificial intelligence in education: A metaphor analysis. *Necmettin Erbakan University Ereğli Faculty of Education Journal*, *6*(2), 589-605.

Akbıyık, A., & Coşkun, E. (2013). A model for the acceptance and use of educational social software. *AJIT-e: Academic Journal of Information Technology*, *4*(13), 39-62.

Aktürk, A. O. & Delen, A. (2020). The relationship between teachers' technology acceptance levels and self-efficacy beliefs. *Journal of Science, Education, Art and Technology (BEST Journal)*, *4*(2), 67-80.

Alenezi, A. R., Abdul Karim, A. M., & Veloo, A. (2010). An empirical investigation into the role of enjoyment, computer anxiety, computer self-efficacy and internet experience in influencing the students' intention to use e-learning: A case study from Saudi Arabian governmental universities. *Turkish Online Journal of Educational Technology-TOJET*, 9(4), 22-34.

Antonenko, P., & Abramowitz, B. (2023). In-service teachers'(mis) conceptions of artificial intelligence in K-12 science education. *Journal of Research on Technology in Education*, *55*(1), 64-78.

Balıkçı, H. C., Alpsülün, M., & Hayoğlu, G. (2024). Determination of *Teachers' Perceptions of Artificial Intelligence Concept: A Metaphor Analysis*. *Sakarya University Journal of Education*, *14*(2 (Special Issue-Artificial Intelligence Tools and Education)), 179-193.

Bandura A. (1997). *Self-Efficacy: The exercise of control*. New York: Freeman

Büyüköztürk, Ş. (2014). *Data analysis handbook for social sciences*. Pegem Academy.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2018). *Scientific research methods.* Pegem Academy.

Çelik, İ. (2019). *Investigation of instructors' acceptance of augmented reality technology as a course material*. Van Yüzüncü Yıl University Institute of Educational Sciences. Master's thesis, Van.

Çelik, S., Türkoğlu, T., Baydeniz, E., & Sandıkçı, M. (2023). Determination of factors affecting students' behavioral intentions in the context of the Technology Acceptance Model, *AHBVÜ Tourism Faculty Journal, 26* (1), 1-28.

Çetin, M., & Aktaş, A. (2021). Artificial intelligence and future scenarios in education. *OPUS International Journal of Social Research*, Special Issue of Educational Sciences.1-1. doi:10.26466/ opus.911444

Chahal, J., & Rani, N. (2022). Exploring the acceptance for e-learning among higher education students in India: Combining technology acceptance model with external variables. *Journal of Computing in Higher Education*, *34*, 844–867. https://doi.org/10.1007/s12528-022-09327-0

Chatzoglou, P. D., Sarigiannidis, L., Vraimaki, E., & Diamantidis, A. (2009). Investigating greek employees' intention to use web-based training. *Computers & Education, 53*(3), 877e889. http://dx.doi.org/10.1016/j.compedu.2009.05.007

Chen, H.-R., & Tseng, H.-F. (2012). Factors that influence acceptance of web-based e-learning systems for the in-service education of junior high school teachers in Taiwan. *Evaluation and Program Planning, 35*(3), 398–406. https://doi.org/ 10.1016/j.evalprogplan.2011.11.007

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *Institute of Electrical and Electronics Engineers Access*, *8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Chen, S., Qiu, S., Li, H., Zhang, J., Wu, X., Zeng, W., & Huang, F. (2023). An integrated model for predicting pupils' acceptance of artificially intelligent robots as teachers. *Education and Information Technologies*, 1-24.

Choi, S., Jang, Y., & Kim, H. (2023). Influence of pedagogical beliefs and perceived trust on teachers' acceptance of educational artificial intelligence tools. *International Journal of Human–Computer Interaction*, *39*(4), 910-922.

Cohen, J. (1992). Quantitative methods in psychology: A power primer. *Psychological Bulletin, 112*(1), 155-159.

Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, Ş. (2021). *Multivariate statistics for social sciences: SPSS and LISREL*, Pegem Academy.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340

Dülger, E. D., & Gümüşeli, A. İ. (2023). Views of school principals and teachers on using artificial intelligence in education. *ISPEC International Journal of Social Sciences & Humanities, 7*(1), 133-153.

Durak, H. Y. (2018). Flipped learning readiness in teaching programming in middle schools: Modeling its relation to various variables. *Journal of Computer Assisted Learning*, *34*(6), 939-959. https://doi. org/10.1111/jcal.12302

Dursun, Y., & Kocagöz, E. (2010). Structural Equation Modeling and Regression: A Comparative Analysis. *Erciyes University Journal of Faculty of Economics and Administrative Sciences*, (35), 1-17.

Fornell, C. ve Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.

Gurer, M. D. (2021). Examining technology acceptance of pre-service mathematics teachers in Turkey: A structural equation modeling approach. *Education and Information Technologies*, *26*(4), 4709-4729.

Güzey, C., Çakır, O., Athar, M. H., & Yurdaöz, E. (2023). Investigation of Trends in Research on Artificial Intelligence in Education. *Journal of Information and Communication Technologies*, *5*(1), 67-78.

Hair, J. F., Jr., Black, W. C., Babin, B. J. & Anderson, R. E. (2005). *Multivariate data analysis* (6th ed.). NY: Prentice Hall.

Hamet, P. ve Tremblay, J. (2017). Artificial intelligence in medicine. *Metabolism, 69*(S), 36-40. https://doi.org/10.1016/j.metabol.2017.01.011

Heerink, M., Krose, B., Evers, V., & Wielinga, B. (2009). Measuring acceptance of an assistive social robot: A suggested toolkit. In *RO-MAN 2009-The 18th IEEE International Symposium on Robot and Human Interactive Communication* (pp. 528–533). Toyama: IEEE. https://doi.org/10.1109/roman. 2009.5326320

Hoyle, R. H. (1995). *Structural Equation Modeling: Concepts, Issues, and Applications*. (First Edition). California: SAGE Publications, Inc.

Işıksal, M., & Aşkar, P. (2003). Mathematics and computer self-efficacy perception scales for elementary school students. *Hacettepe University Journal of Faculty of Education*, *25*(25).

Kaiser, H.F. (1974) An index of factorial simplicity. *Psychometrika*, *39*, 31-36.

Karasar, N. (2016). *Scientific research method: Concepts, principles, techniques.* Nobel Academy Publishing.

Kim, Y., & Glassman, M. (2013). Beyond search and communication: Development and validation of the Internet Self-efficacy Scale (ISS). *Computers in Human Behavior*, *29*, 1421-1429.

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford publications.

Lee, J., Kim, J., & Choi, J. Y. (2019). The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. *Telematics and Informatics, 39*, 37–48. https://doi.org/10.1016/j.tele.2018.12.006.

Ma, S., & Lei, L. (2024). The factors influencing teacher education students' willingness to adopt artificial intelligence technology for information-based teaching. *Asia Pacific Journal of Education*, 1-18. https://doi.org/10.1080/02188791.2024.2305155

Mac Callum, K., Jeffrey, L., & NA, K. (2014). Factors impacting Teachers' adoption of mobile learning. *Journal of Information Technology Education: Research, 13*, 141–162

Manav, F. (2011). The concept of anxiety. *Journal of Social Sciences*, *5*(9), 201-211.

Muthén, L. K., & Muthén, B. O. (2002). How to use a Monte Carlo study to decide on sample size and determine power. *Structural Equation Modeling, A Multidisciplinary Journal, 4*, 599–620.

Nabiyev, V. & Erümit, A. K. (2020). Yapay zekânın temelleri. İçinde V. Nabiyev ve A. K. Erümit (Edl.), *Eğitimde yapay zekâ kuramdan uygulamaya* (ss. 2-37), Pegem Akademi Yayınları.

Ng, D. T. K., Luo, W. Y., Chan, H. M. Y., & Chu, S. K. W. (2022). An examination on primary students' development in AI literacy through digital story writing. *Computers & Education: Artificial Intelligence, 100054*.

Ng, D. T. K., Wu, W., Leung, J. K. L., Chiu, T. K. F., & Chu, S. K. W. (2023). Design and validation of the AI literacy questionnaire: The affective, behavioural, cognitive and ethical approach. *British Journal of Educational Technology.*

Nuangchalerm, P. & Prachagool, V. (2023). AI-driven learning analytics in STEM education. *International Journal of Research in STEM Education*, *5*(2), 77-84.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research, 42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Raykov, T., & Marcoulides, G.A., (2000). *A first course in structural equation modeling*, Mahwah, NJ: Lawrence Erlbaum Associates, 238 p.

Şahin, F., & Şahin, Y. L. (2021). Examining the acceptance of e-learning systems during the pandemic: The role of compatibility, enjoyment and anxiety. *International Technology and Education Journal*, 5(1), 01-10

Scherbelleh-Engel, K. ve Moosbrugger, H, Muller, H., (2003), "Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-it measures", *Methods of Psychological Research Online,* S.8, No.2, ss. 23-74

Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of educational psychology*, *73*(1), 93. https://psycnet.apa.org/doi/10.1037/0022-0663.73.1.93

Seyrek, M., Yıldız, S., Emeksiz, H., Şahin, A., & Türkmen, M. T. (2024). Teachers' perceptions of artificial intelligence in education. *International Journal of Social and Humanities Sciences Research (JSHSR), 11*(106), 845-856.

Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education, 52*(2), 302–312. https://doi.org/10.1016/j.compedu.2008.08.006

Teo, T., & Zhou, M. (2014). Explaining the intention to use technology among university students: A Structural equation modeling approach. *Journal of Computing in Higher education*, *26*(2), 124–142.

Ursavaş, Ö. F. (2014). *Modeling teachers' behaviors towards using information technologies.* Unpublished Doctoral Dissertation. Gazi University, Ankara.

Ursavaş, Ö. F., Yalçın, Y., & Bakır, E. (2019). The effect of subjective norms on preservice and in-service teachers' behavioral intentions to use technology: A multigroup multimodel study. *British Journal of Educational Technology, 50*(5), 2501-2519.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation and emotion into the Technology Acceptance Model. *Information Systems Research, 11*(4), 342–365.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, *39*(2), 273-315.

Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences*, *27*(3), 451–481. https://doi.org/10.1111/j.1540-5915.1996.tb00860.x

Wang, B., Rau, P., & Yuan, T. (2022). Measuring User Competence in Using Artificial Intelligence: Validity and Reliability of Artificial Intelligence Literacy Scale. *Behaviour \& Information Technology*, *42*(9), 1324–1337. Https://Doi.Org/10.1080/0144929x.2022.2072768

Wang, Y. Y. & Wang, Y. S. (2019). Development and validation of an artificial intelligence anxiety scale: an initial application in predicting motivated learning behavior. Interactive Learning Environments, 1–16. https://doi.org/10.1080/10494820.2019.1674887

Wang, Y. Y., & Wang, Y. S. (2022). Development and validation of an artificial intelligence anxiety scale: An initial application in predicting motivated learning behavior. *Interactive Learning Environments*, *30*(4), 619–634. https://doi.org/10.1080/10494820.2019.1674887

Wang, Y., Liu, C., & Tu, Y. F. (2021). Factors Affecting the Adoption of AI-Based Applications in Higher Education: An Analysis of Teachers' Perspectives Using Structural Equation Modeling. *Educational Technology & Society*, *24* (3), 116– 129.

Wong, G. K. W. (2015). Understanding technology acceptance in pre-service teachers of primary mathematics in Hong Kong. Australasian *Journal of Educational Technology*, *31*(6), 713–735.

Yeşilyurt, E., Ulaş, A. H., & Akan, D. (2016). Teacher self-efficacy, academic self-efficacy, and computer self-efficacy as predictors of attitude toward applying computer-supported education. *Computers in Human Behavior*, *64*, 591-601.

Zhang, C., Schießl, J., Plößl, L., Hofmann, F., & Gläser-Zikuda, M. (2023). Acceptance of artificial intelligence among pre-service teachers: a multigroup analysis. *International Journal of Educational Technology in Higher Education*, *20*(1), 49.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary educational psychology*, *25*(1), 82-91. https://doi.org/10.1006/ceps.1999.1016