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Bir sonraki sayımıza kadar sevgi ve sağlıkla kalmanızı dilerim.

Prof. Dr. Şefika Şule Erçetin

Dear readers,

We are excitedly sharing the 41st volume (2026), 2nd issue of the Hacettepe University Journal of Education. I would like to thank our Editor-in-Chief, field editors, reviewers and authors for their valuable contributions to the literature in this issue. I hope that our new issue will contribute to the scientific knowledge in the educational literature both in national and international contexts.

I wish you to stay with love and health until our next issue.

Prof. Dr. Şefika Şule Erçetin

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Technology Integration in Middle School Mathematics: Teachers' Perspectives, Challenges, and Opportunities through the SAMR Model*

Anıl Ayseli DURAN DÜNDAR, Erdinç ÇAKIROĞLU*****

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ABSTRACT

This study explores the views and experiences of middle school mathematics teachers regarding technology integration. The research examines the teachers' use of technology, the benefits of using technology, the challenges encountered, solutions to these challenges, and their suggestions for broader teacher support. In-depth interviews were conducted with nine teachers selected through snowball sampling using a qualitative research method. According to the findings, teachers use technology to make content more visible, enrich lessons, and involve students more. However, the analysis based on the SAMR model shows that teachers mostly use technology at the substitution and augmentation levels. The benefits of technology include improving students' academic and affective development, making lessons more practical, and supporting teacher development. The challenges encountered were student-centered problems, teacher-based obstacles, time management problems, and technical/infrastructure problems. The solution suggestions include guidance, a preparation process, immediate problem-solving, and technical support. Teachers emphasized that technology use in schools was inadequate and suggested wider technology integration, such as seminars, motivational initiatives, project funding, administrative support, collaboration opportunities, better tool access, and increasing student technology use.

Keywords: Technology Integration, Technology Use, Teachers' Views, Benefits, Barriers, SAMR Model

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1. INTRODUCTION

With the rapid development of technology, innovations and changes have occurred in many areas of life. There have been many new developments, such as industry, health, banking, and trade. Therefore, technology has become an indispensable part of human life because the purpose of technology is to make human life easier. It is crucial to adapt to the changes in our world, where technology is developing rapidly, and to look at the world from a wider window. These developments in technology bring along some innovations in education, as in many other fields. Education is a process that prepares individuals for life through gaining skills and knowledge (Ekici et al., 2012). Today, this process can be supported by technology because new technologies can improve the effectiveness of teaching (Taşçı et al., 2010). Teachers can benefit from technology in many ways during their teaching to attract students' attention and appeal to many senses. As Bozkurt and Cilavdaroğlu (2011) and Taş et al. (2020) noted, teachers use technology to project lesson content, ensuring visibility and uniform access to information for all students, which is especially vital in subjects like mathematics. Similarly, large-scale reports highlight that digital technologies play a significant role in improving reasoning, problem-solving, and equal access to learning opportunities (OECD, 2015).

Educational environments equipped with technological tools are necessary but insufficient to cause a significant change in schools. It is an undeniable fact that teachers are an indispensable factor in the use of technology in educational environments because teachers are the vital elements that give meaning and spirit to education and make it functional, effective, and efficient (Çelik & Bindak, 2005). Without the guidance of teachers, students cannot benefit from the existing technology at the desired level. Therefore, teachers need to have the necessary competence in the use of technology. In-service training should be an

* Ethical approval for the study was obtained from the Research Center for Applied Ethics at Middle East Technical University (Protocol No: 0001-ODTUİAEK-2024) with its decision dated 14.01.2022 and numbered 28620816. This research was derived from the master's thesis conducted by the first author under the supervision of the second author.

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integral part of a teacher's career (Gaborek, 2024). This training should not only ensure that teachers learn to use technology, but also that they integrate these tools effectively into educational processes. To raise individuals who can adapt to contemporary society and use technology effectively, teachers must first have competence in the use of technology. As emphasized by Birişçi and Uzun (2014) and Koştur and Türkoğlu (2017), tools such as GeoGebra and videos are necessary to improve teachers' lesson visualization and improve student participation. However, for the effective use of these tools, teachers must be supported through in-service training. Such training will ensure that teachers see technology not only as a tool but also as an element that enriches their pedagogical processes. Research also shows that teachers' beliefs, knowledge, and professional development opportunities are key determinants of whether technology is integrated effectively into classrooms (Ertmer, 1999; Mishra & Koehler, 2006; Voogt & Roblin, 2012).

Mathematics education is perhaps one of the essential building blocks of education. Mathematics education assumes a function beyond learning numbers and operations and gaining calculation skills, which are indispensable in daily life. It provides essential support, such as problem-solving (Umay, 2003). With the importance of mathematics education, studies on this subject are constantly increasing. Previous studies in mathematics education have examined technology integration from different perspectives. Some focused on how technology is used in classrooms, such as the types of tools and activities preferred by teachers (Koştur & Türkoğlu, 2017; Ruggiero & Mong, 2015; Tican & Toksoy Gökoğlu, 2021). Others emphasized the benefits of technology, including enhancing conceptual understanding, increasing motivation, and supporting lasting learning (Akkaya, 2016; Birişçi & Uzun, 2014; Goos & Bennison, 2004; Rosas & Campbell, 2010; Ural, 2015; Yılmaz & Naci, 2017; Yazlık, 2019). In addition, a significant body of research has highlighted the challenges teachers face, such as limited infrastructure, lack of training, and classroom management difficulties (Agyei & Voogt, 2011; Cuban, 2001; Francom, 2016; Snoeyink & Ertmer, 2001; Taş et al., 2020; Wachira & Keengwe, 2011). Other studies have shown that time constraints, curriculum pressures, and insufficient institutional support are among the main barriers preventing teachers from moving beyond basic technology use (Howard et al., 2022; Tondeur et al., 2017). Taken together, these studies show that technology offers important opportunities for mathematics teaching but also presents notable barriers that complicate its effective integration.

Considering the impact of technology on education and the great place of mathematics in education, teachers' experience of technology integration in mathematics education, the benefits they get from it, the challenges they face, and the ways they overcome these challenges are worth investigating. In addition, knowing teachers' level of technology use in their lessons and how they use it can provide useful information about the course and content of the lesson. The SAMR model is an effective framework for classifying teachers' technology use levels.

In this study, the SAMR model was chosen to examine teachers' technology integration levels. This allows for the exploration of how technology transforms the teaching-learning process, rather than simply being used as a tool in educational settings. The model's four-stage structure (substitution, augmentation, modification, and redefinition) provides a clear and practical framework for classifying the extent to which teachers use technology. Furthermore, while other models frequently used in the literature, such as TPACK, emphasize the intersection of technology, pedagogical knowledge, and content knowledge, the SAMR model was deemed more suitable for this study because it reveals the levels of application in the teaching process. Therefore, the SAMR model was adopted to analyze teachers' technology use experiences.

In summary, although numerous studies on teachers' technology use exist in the literature, these studies are generally descriptive and do not provide a detailed explanation of the extent to which teachers integrate technology. Furthermore, while the benefits of technology are frequently emphasized, its limitations and the challenges teachers face have not been sufficiently discussed. In this context, studies examining the classroom experiences of middle school mathematics teachers, in particular, are limited. This research aims to reveal both teachers' experiences, the challenges they face, and their proposed solutions by analyzing teachers' technology integration levels within the framework of the SAMR model.

In this context, the research questions examined in the study are as follows:

1. How do middle school mathematics teachers integrate technology into their lessons?
    a. What are the perceived benefits of technology use in mathematics classrooms?
    b. What difficulties do middle school mathematics teachers face in using technology in their lessons?
    c. What are the ways of overcoming the difficulties middle school mathematics teachers face in using technology in their lessons?
2. What are the suggestions of middle school mathematics teachers for teachers who want to use technology in their lessons, and their suggestions to increase the use of technology in mathematics classrooms?

1.1. The SAMR Model

SAMR (Substitution, Augmentation, Modification, and Redefinition) model proposed by Puentedura (2006) can be used to provide technology integration for students to be successful (Mejías, 2019). Puentedura's (2006) model can be considered a method for evaluating the effectiveness of technology integration. It encourages teachers to move away from using technology for traditional and straightforward purposes and integrate technology to provide innovative learning (Savignano, 2017). The SAMR model can assess how much technology impacts students' learning. This model also aims to increase the quality of education provided using technology. Moreover, it is a framework developed to increase the use of technology in schools (Medel et al., 2008). The visual representation of the SAMR model can be seen in Figure 1.

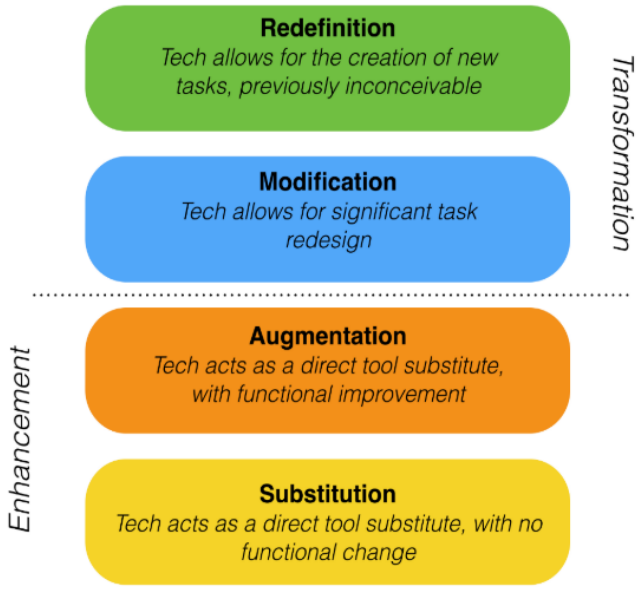


Figure 1. Substitution, Augmentation, Modification, and Redefinition (SAMR) model (Puentedura, 2010).

Figure 1 illustrates the hierarchical structure of the SAMR model, dividing technology integration into enhancement (substitution and augmentation) and transformation (modification and redefinition). The figure serves as a visual guide to understanding the four levels and provides the conceptual framework for interpreting the findings of this study.
Gorman (n.d.) stated that the SAMR model is divided into two main teaching styles: enhancement and transformation. This distinction relates to whether a task can merely enhance student learning or transform the way learning occurs (Mejías, 2019). The model consists of four levels of technology integration: substitution, augmentation, modification, and redefinition (Rowe, 2014). The enhancement phase encompasses substitution and augmentation, while the transformation phase encompasses modification and redefinition (Jude et al., 2014).

At the substitution level, technology merely replaces traditional tools and does not create a functional change in the teaching process (Hamilton et al., 2016). In this case, traditional materials are replaced with digital tools, but teaching methods remain the same; therefore, no significant improvement in learning outcomes is observed (Savignano, 2017). For example, presenting a math test to students digitally instead of on paper is a typical example of substitution (Hamilton et al., 2016). While this level offers advantages in terms of accessibility and practicality, its pedagogical contribution is limited, and it has been criticized for not increasing student engagement (Hamilton et al., 2016).

The next level, augmentation, involves using digital tools instead of traditional ones, but this time, functional improvements that support learning (Wijaya et al., 2021). For example, preparing course materials in digital format or creating videos for review are examples of augmentation (Binangbang, 2020). While augmentation adds value to teaching in terms of interaction and efficiency, some researchers emphasize that this level actually carries the risk of reinforcing traditional practices because it does not fundamentally change core teaching practices.

Beyond augmentation, the modification level is the stage where pedagogical transformation begins. At this level, technology enables the significant redesign of learning activities, transforming both teaching and learning styles (Hamilton et al., 2016). At this stage, students can access content outside of school through digital tools (Savignano, 2017). For example, designing and presenting an interactive simulation to students instead of simply showing them a diagram is an example of this level (Hamilton et al., 2016). However, this stage requires teachers to possess strong technological competencies and the availability of appropriate resources; the inability to always meet these requirements reveals practical limitations.

The final stage, the redefinition level, enables tasks that cannot be accomplished without technology (Binangbang, 2020). At this stage, technology enables students and teachers to collaborate on digital platforms by sharing documents, commenting, and making collaborative edits (Savignano, 2017). Thus, technology creates opportunities for student-centered learning and authentic interaction. However, researchers note that reaching this level is quite rare in practice, and the model does not provide sufficient guidance on how teachers can progress to this stage (Hamilton et al., 2016).

While the SAMR model provides a practical and understandable framework for classifying technology integration, some researchers have criticized it for being oversimplified, failing to consider teachers' pedagogical and content knowledge, and failing to clearly distinguish transitions between levels in practice (Hamilton et al., 2016). In this context, the TPACK model, one of the most frequently used models, reveals teachers' competencies in integrating technology, pedagogical, and content knowledge, while the SAMR model classifies the levels of technology application in the teaching process. Therefore, while SAMR allows for concrete and observable analysis of teachers' classroom technology use, TPACK focuses more on teacher

competencies. This difference suggests that the models can be used complementarily to understand teachers' multidimensional technology integration. However, while Figure 1 presents the stages of technology integration clearly and linearly, researchers have noted that in practice these transitions are often blurred and not as straightforward as the model suggests (Hamilton et al., 2016). This highlights one of the main limitations of SAMR, namely that it simplifies the complexity of classroom realities.

2. METHODOLOGY

2.1. Design of the Study

A phenomenological design was chosen for this study because the purpose was to explore middle school mathematics teachers' subjective experiences of technology integration in mathematics education and the meanings they attribute to these experiences. The phenomenon under investigation is teachers' experiences of using technology in their mathematics lessons, including how they integrate digital tools, the benefits they perceive, the challenges they encounter, and the strategies they employ to address these challenges. A phenomenological approach allows for an in-depth examination of participants' perceptions, experiences, and feelings about this phenomenon (Creswell, 2018). In this context, understanding teachers' experiences of technology integration directly through their own statements aligns with the study's core research questions. Therefore, a phenomenological design was selected as the methodological framework most appropriate for the nature of the study.

2.2. Participants of the Study

The study group for this study consists of middle school mathematics teachers working in Türkiye. Middle school mathematics teachers were selected because technology plays a critical role in mathematics lessons, particularly in visualizing abstract concepts, capturing students' attention, and supporting learning processes. Furthermore, middle school is a period when the foundations of students' mathematical thinking skills are laid, and the decisive effects of technology integration on learning can be observed. Therefore, the study focused on the technology integration experiences of teachers at this level.

A snowball sampling method, a purposive sampling method, was used in participant selection. This method was preferred because reaching teachers with relevant experience in technology integration can be challenging, and snowball sampling allows the researcher to access participants through referrals from others with similar characteristics. Thus, teachers who not only volunteered but were also identified by their colleagues as having relevant experiences could be included in the study. The criterion for teachers was that they had at least three years of professional experience. This criterion assumes that beginning teachers may not have sufficient classroom experience with technology use, while teachers with three or more years of experience may offer more mature and reliable perspectives on technology integration.

A total of nine middle school mathematics teachers participated in the study. Five of the participants were female and four were male. All participants had a bachelor's degree in mathematics teaching. Additionally, two are pursuing a master's degree. All teachers work in various public schools and have experience teaching at all grade levels of secondary school. Participants were coded P1 through P9 to ensure confidentiality in the study. Basic demographic and professional information about the participants is presented in Table 1.

Table 1.
Demographic Information about Participants

Code for Participant	Years of Experience	Undergraduate Education	Graduate Education
P1	3	Mathematics Education	M.S. in Mathematics Education
P2	17	Mathematics Education	-
P3	19	Mathematics Education	-
P4	16	Mathematics Education	-
P5	10	Mathematics Education	-
P6	16	Mathematics Education	-
P7	13	Mathematics Education	-
P8	10	Mathematics Education	-
P9	7	Mathematics Education	M.S. in Mathematics Education (ongoing)

2.3. Data Collection Tool

A semi-structured interview form (Appendix A) developed by the researcher was used to collect data. During the development of the interview form, literature was reviewed to understand teachers' experiences of technology integration (e.g., the SAMR model, the TPACK framework, and previous studies on teachers' use of technology), and the questions were based on this theoretical background.

The interview form was structured around three main themes:
The teaching process and teaching practices (e.g., how the course is taught, teaching methods, and the definition of an effective course).
Technology use and integration (e.g., digital tools used, applications, teacher and student roles, contributions, rationales, and importance of technology use).
Challenges encountered and contextual factors (e.g., problems encountered in digital tool use, solutions, the role of stakeholders, factors supporting or inhibiting technology use, and suggestions for improvement).

The form consists of two sections. The first section includes demographic questions aimed at identifying the participants' personal and professional characteristics (graduate faculty and field of study, degree, professional experience, grade levels taught, etc.). The second section detailed teachers' instructional processes, their experiences with technology integration, their use of digital tools and applications, the challenges they encountered and their solutions, and their general perceptions of technology. The interview form was evaluated for content validity by consulting experts and then pilot-tested. Following the pilot, only minor linguistic adjustments were made to improve clarity, and the number of questions remained unchanged. Therefore, all 27 questions on the interview form were used in the data collection process.

2.4. Data Collection Process

Data for this study were collected through semi-structured interviews. The interviews were conducted during the fall semester of the 2021–2022 academic year. The interviews were conducted outside of class hours, considering the teachers' schedules, to ensure the process did not disrupt the flow of the lesson and to ensure participants felt comfortable. All interviews were conducted in quiet and convenient environments at the schools where the teachers worked; some were conducted in an unoccupied corner of the teachers' lounge, and others in a private room allocated by the school administration.

Each interview lasted approximately 25–40 minutes. The first part of the 27 questions in the interview form consisted of short demographic questions that revealed participants' personal and professional information, thus requiring less time. The majority of the interview time was devoted to the second part, which explored teachers' experiences with technology integration. Participants provided detailed responses to these questions, and when necessary, probing questions were asked to gain more in-depth information. This method yielded rich and comprehensive qualitative data about the teachers' experiences, despite the relatively limited interview time. All interviews were audio-recorded with the participants' consent and later transcribed in detail by the researcher. Participants were informed about the process in advance, volunteering was considered, and the principle of confidentiality was observed.

2.5. Data Analysis

The data obtained in this study were analyzed using content analysis. First, the interview recordings were transcribed in detail by the researcher. The data were then carefully read and broken down into meaningful units, and similar expressions were grouped under codes. These codes were categorized, and themes were created based on the research questions and theoretical framework (e.g., the SAMR model, technology integration literature). The coding process was conducted using Microsoft Word. No computer-assisted qualitative data analysis programs were used.

The coding process was initially conducted by the first author and then independently reviewed by the second author. This increased the reliability of the analysis process. Furthermore, to increase the transparency of the analysis process, sample participant statements were included directly in the findings section. Table 2 also displays the relationship between the interview statements, the generated codes, and the relevant themes to illustrate the coding process.

Table 2.
Sample Coding Table

Participant statement (direct quote)	**Code**	**Category**	**Theme**
I finished a topic that could have taken me an hour to explain in 10 minutes. So, it was incredibly helpful for me.	Time management	Providing convenience for lesson process	Perceived Benefits of Technology
There may be problems, such as the smart board freezing or power outages.	Problems with the smartboard Power & internet outages	Technical and infrastructural problems	Barriers to Technology Use
When the children have difficulty, I help them and show them how to do it. That's how we solve it.	Guiding students	Student-related challenges	Teachers' Ways of Overcoming Barriers
… our content has been enriched, but I believe programs can be developed that utilize more sophisticated techniques,	Making effective technological tools available	Suggestions for an increase technology use in the	Teachers' Suggestions

especially for three-dimensional objects. I believe that if these programs are improved, their use will increase.	classrooms

3. FINDINGS

The findings are presented under five main themes, directly related to the research questions and the problem statement. The primary objective of the study was to reveal middle school mathematics teachers' experiences with technology integration and to understand the facilitators and barriers they encountered during this process. The findings were structured around themes emerging from the content analysis of the interview data. The five themes were developed by considering both prominent conceptual frameworks on technology integration in the literature and codes inductively derived from participants' statements. Thus, the findings were grounded in both theoretical and empirical underpinnings.

3.1. How Teachers Use Technology

Teachers use technology in their lessons in three main ways, as seen in Table 3.

Table 3.
Overall Information about the Teachers' Technology Use

Main Use Category	Subcategories	Frequency	Participants	SAMR Levels
Enhancing the visibility of content	Showing problems on the smartboard	7	P2, P3, P4, P5, P6, P8, P9	Substitution
	Showing textbooks on the smartboard	3	P1, P3, P5	Substitution
	Showing graphs on the smartboard	1	P7	Substitution
Enriching lesson processes	Using z-books	5	P1, P2, P5, P6, P9	Substitution
	Using interactive virtual manipulatives	4	P2, P7, P8, P9	Augmentation
	Showing videos	2	P2, P7	Augmentation
Engaging students	Playing games	6	P1, P5, P6, P7, P8, P9	Augmentation
	Doing classroom activities	6	P1, P2, P5, P7, P8, P9	Augmentation

According to Table 3, one purpose of the participants' technology use in their classrooms was to enhance content visibility. To enhance content visibility, teachers use smartboards to enable all students to see the lesson's content easily. This includes showing problems, pieces from the textbook's digital versions, and graphs on the smartboard. A great majority of the participants show problems with the smartboard for enhancing content visibility. P6 mentioned its effectiveness:

> *"I prepare problems for the students and show them on the smartboard. It is helpful in terms of saving paper as well, and all students can see the problems easily."*

The enriching lesson processes category includes mainly teacher-centered use of technology. They use technology to enrich the lesson process by using z-books, which are written and visual documents as enriched content on digital platforms containing the Ministry of National Education curriculum, using interactive virtual manipulatives, and showing videos. For enriching lesson processes, most of the participating teachers use z-books. P1 explained her experiences with the z-books as follows:

> *"Z-books are excellent facilitators. If I were to write and draw by myself, half of the lesson would be over, but thanks to the z-books, all the explanations are ready in front of the students."*

More than half of the participants had students play digital games and do classroom activities with digital content that they can usually access free of charge over the internet, using the smartboard to engage students. Six teachers stated that they use technology to make students play games after the end of the topic. In this manner, students practice what they have just learned. They also said that playing games increases students' motivation. P5 exemplified that, based on her experiences:

> *"I provide students with the opportunity to play games, especially on the topic of multiplication. Playing games is very helpful for their learning because these games make students more willing to work and learn."*

According to the SAMR Model, the levels of teachers' technology use were classified, and it was found that they use technology in the lower levels, which are substitution and augmentation.

3.2. Perceived Benefits of Technology

Participating teachers were asked about their experiences using technology and how technology affects their lessons throughout the interviews. They often referred to the benefits of technology. These benefits are seen in the table below (Table 4).

Table 4.
Perceived Benefits of Technology

Main Category	Subcategories	Frequency
Students' academic development	Making students active	9
	Increasing memorability	4
	Students' conceptual understanding	4
	Student-centered learning	3
	Competitive environment	2
	Making students think deeply	1
Students' affective development	Attracting students' attention	7
	Increasing students' motivation	6
	Loving mathematics and the teacher	1
Providing convenience for lesson process	Facilitator	8
	Time management	6
	Easily accessible	3
	Rich content	1
Teachers' development	Teachers' conceptual understanding	1

The participants asserted that technology use develops students' academic success. All participating teachers argued that technology use in mathematics classrooms makes students active. They pointed out that it makes them more willing to participate. For example, P3 expressed his opinion about this issue:

> *"When technology is used in the lesson, students are more willing to come to the board. Smartboards are a technological tool, and some students raise their hands even if they do not know because they want to use them."*

Some of the participants stated that technology use in mathematics classrooms increases memorability. In other words, thanks to technology, students can remember easily what they learned before. Many participating teachers think that the use of technology in mathematics classrooms enhances students' conceptual understanding. While a minority of teachers talked about the benefits of technology, they stated that it provides student-centered learning. A few teachers stated that technology is beneficial for students' academic development to create a competitive environment. According to their opinions, playing games with technology allows students to compete and makes them ambitious in mathematics. One of them (P6) mentioned that it makes students think deeply. According to his answers to interview questions, he uses digital tools on the smartboard to make students play mind games such as Sudoku and Mancala. He argued that these games make students think deeply.

In light of the answers received from the interviews with the middle school mathematics teachers, technology use provides students' affective development. They emphasized that students' attitudes, beliefs, and emotions toward learning mathematics have improved thanks to technology. Almost all teachers referred to the students' affective development to attract their attention. From their point of view, technology use in the classroom enables students to increase their interest in the lesson. P4 explained his opinion based on his experience:

> *"Since we are in the age of technology, and children are very good with technology, using technology in the classroom attracts their attention."*

He explained his thoughts on this point by associating it with students' enjoyment of using technology. On the other hand, P5, P8, and P9 express their thoughts about this issue by making a relationship between visuality and increasing students' interest. For example, P9 said visuality is very attractive, especially for middle school students. In addition to P9, P5 shared her observations based on her experience:

> *"While giving a lecture, I used unit cubes as concrete material. I also used technology to show the students the cubes. I realized that seeing the smartboard is more attractive for them than the concrete materials they have."*

Most of the participating teachers pointed out that technology use increases students' motivation. P1 mentioned the competitive environment created by technology. Correspondingly, she said that this competitive environment increases the motivation of students. One of the participating teachers (P1) stated that using technology in mathematics lessons allows students to like mathematics and the teacher.

According to the information obtained by the teachers interviewed, the use of technology provides convenience for the lesson process in many ways. Most of them stated that technology use is a significant facilitator when writing, drawing geometric shapes, using ready-to-use exercises, and doing practice sessions. P1, P2, P3, P4, P5, P6, and P9 pointed out that technology is a good facilitator in writing and drawing shapes. They generally said that it is much easier to write and draw shapes on the smartboard than to do these on the board. As an example of this, P1 said:

"We have z-books. A pencil tool, eraser tool, and geometric shapes tool are included. We can easily use them, and it is so helpful for us. We do not need to worry about writing and drawing on the board."

P1, P8, and P9 emphasized the facilitating effect of technology in terms of students' practices. P1 explained this by talking about z-books again. She said:

"Z-books give feedback. For instance, there is a question mark button. After students solve the problems on the smartboard, they can see whether their answers are correct or wrong when they press that button."

Only P9 mentioned the benefit of technology in terms of providing ready-to-use exercises. She said that it is a good facilitator because there are ready-to-use exercises or activities, and therefore, she does not have to make any preparations for them. Moreover, most teachers think that technology use provides convenience in terms of time management. According to them, it speeds up the process and allows them to solve more problems.

According to the answers obtained from the interviews with the teachers, one of the other reasons technology provides convenience is that it is easily accessible. One of the participating teachers (P7) stated that technology provides convenience due to its rich content. She emphasized that she could access all kinds of activities or course content related to any topic, making her work much easier. One of the participating teachers (P1) mentioned that technology provides development to teachers while talking about the benefits of technology. She stated that technology use increases teachers' conceptual understanding.

3.3. Barriers to Technology Use

The participants of this study, who are middle school mathematics teachers, were asked to describe the challenges they encountered in using technology in their classrooms, if they had. In light of the information obtained, barriers to technology use were grouped into four categories: (i) student-related challenges, (ii) teacher-related challenges, (iii) time management issues, and (iv) technical and infrastructural problems. Table 5 presents these categories and their subcategories with the frequencies for each subcategory.

Table 5.
Barriers to Technology Use

Main Category	Subcategories	Frequency
Student-related challenges	Students' lack of prior knowledge of mathematics	2
	Students' difficulty in using technology	2
	Students' negative attitudes towards mathematics	2
	Students' difficulty in mathematics	1
Teacher-related challenges	Teachers' difficulty in using technology	3
	Classroom management problems	3
Time management issues	Increased preparation time	2
	Increased time for low-achieving students	2
	Having limited time to cover the curriculum	1
Technical and infrastructural problems	Power & internet outages	5
	Problems with the smartboard	3

A few of the teachers had difficulty because of the students' lack of prior knowledge of mathematics. P1 explained the problem she faced in this regard:

"Technology use increases students' participation in the lesson. However, some students lack prior knowledge. It is tough to enable them to participate in the lesson in such cases. Technology attracts their attention, but it would not be enough."

When asked, teachers shared their difficulties in using technology; two of them mentioned students' difficulty using technology. Students' negative attitudes towards mathematics were another barrier that some teachers mentioned. They mentioned that students fear mathematics, which causes them to fall behind at every lesson stage.

One of the participating teachers (P1) mentioned students' difficulty in mathematics as a barrier. She shared her ideas based on her experiences:

"Students may fail when using technology due to their knowledge of mathematics. This may lead to a decrease in students' motivation."

Some of the teachers remarked on their deficiency in using technology and stated that this was among their difficulties. To explain this barrier that he encountered, P2 said:

"It is a fact that, at first, I had difficulty using smart boards. I had problems writing on it, using applications, etc. In the distance education process, it was hard to instruct the lesson due to my deficiencies in using technology."

Classroom management problems are another teacher-related problem mentioned by participating teachers. P9 touched on this when talking about knowing how to use technology by saying, "Experiencing such difficulties caused the reaction from the students." Also, she added, "These reactions can create an atmosphere of chaos in the classroom and cause us to have problems with classroom management."

Two of the participating teachers (P1 and P4) think the use of technology is time-consuming because it increases the preparation time for the lesson. P1 and P5, who thought that the use of technology is time-consuming, pointed out that students' level of success affects this. They believe that if students' achievement level in mathematics is low, there is limited time to use technology. One of the teachers (P5) had difficulty having a limited time to cover the curriculum. She said there is a curriculum, and she needs to follow it week by week. She added that she wants to do more technology activities, but has limited time.

The most mentioned barrier was technical and infrastructural problems. Seven of the nine teachers talked about technical and infrastructural issues. Most of them noted that power and internet outages could be a barrier to the lesson. As an example, P6 said that he makes students play math-related games with digital content on the smartboard. He emphasized that the electricity or the internet could be cut off at that moment, which caused him difficulties.

Some of the teachers stated that the problems with the smartboard are a barrier. P4 associated this situation with time management issues from his experiences and exemplified:

"Sometimes the smartboard takes too long to boot up. We waste time waiting for it to boot up in the classroom."

3.4. Teachers' Ways of Overcoming Barriers

The teachers were asked how they overcame these barriers. Table 6 shows their methods of overcoming the obstacles that were mentioned before.

Table 6.
Teachers' Ways of Overcoming Barriers

Barriers	Overcoming Ways	Frequency
Student-related challenges	Guiding students	2
	Being prepared	1
Teacher-related challenges	Being prepared	2
	Instant solutions	2
	Rewarding	1
Time management issues	Instant solutions	2
	Being prepared	1
Technical and infrastructural problems	Instant solutions	4
	Technical assistance	2
	Using textbooks and materials	2

The teachers mentioned four student-related challenges. These were students' lack of prior knowledge of mathematics, students' difficulty in mathematics, students' difficulty in using technology, and negative attitudes towards mathematics. Some teachers pointed out that they guide students to overcome these barriers. For example, P9 stated that if the students have difficulties using technology, she guides them. She said that she helps students with the points when they have problems. One of the participating teachers (P1) emphasized that it is essential to be prepared for student-related challenges, such as students' difficulty in mathematics and using technology.

The teachers mentioned that, as teacher-related challenges, teachers' difficulty using technology and classroom management problems are barriers to technology use. Some of the teachers pointed out that being prepared is a method for overcoming the obstacles of teacher-related difficulties in using technology. P1 mentioned that sometimes she has difficulties using technology. She pointed out that being prepared is an effective method for student-related challenges. She also used this method while having difficulty using technology. She said that she prepared before the lesson and minimized this difficulty. Some of the participants referred to using instant solutions when they have problems with classroom management. For instance, P5 explained how she managed to overcome the classroom management problem, which was mentioned in the teacher-related challenges part:

"I allow students to play the game they want to play if we have enough time. However, if there is no time, I say let's finish the topic; if any time remains, we will play."

One of the participating teachers (P8) used rewards as an overcoming method to overcome the classroom management problem. She pointed out that while using technology in the classroom, especially when students are playing games, there is a chaotic environment in the school. She explained her overcoming method in such a case:

> *"I use the reward method when there is chaos in the classroom. I say that I will give a prize or give a high score to the winning group. In this way, I enable students to focus better."*

For the increased preparation time problem, one of the teachers (P4) used instant solutions. He mentioned the challenge of increasing preparation time by associating it with technical and infrastructural problems. He pointed out that the smartboard takes too long to boot up, which causes time problems. He shared his overcoming method:

> *"I usually assign students. Before I enter the class, they make the smartboard open and usable during the break. I do not have to deal with it again in the lesson."*

P1 noted the difficulty of students' level of success as a time-consuming problem. She stated that if she chose a student with a low level of success in technology use, she lost time. To overcome this, she mentioned using instant solutions:

> *"I choose students with a high level of success because some students have deficient achievement levels. If I choose them, besides wasting time, I cannot get efficiency from the lesson. Rather than misdirecting the process, I select successful students."*

For the barrier that technology is time-consuming in terms of increasing preparation time, one of the teachers (P1) mentioned the importance of being prepared as an overcoming method. She pointed out that the preparation time is getting longer because of her lack of use of technology. As an overcoming method, she stated that she tried to prepare more and learn the use technology better.

The teachers referred to power and internet outages and problems with smartboards in terms of student level as technical and infrastructural problems. Many of the teachers overcome technical problems by using instant solutions. P9 explained her method, other than technical assistance, for the problem with the smartboard and power outage:

> *"Since students' notebooks are open, I draw whatever the question or shape is on the board, or we just move on to another example."*

3.5. Teachers' Suggestions

The participants who are middle school mathematics teachers were asked to make suggestions (i) to teachers and (ii) to increase technology use. A summary of their recommendations is shown in Table 7.

Table 7.
Teachers' Suggestions

Main Category	Subcategories	Frequency
Suggestions for teachers	Practicing technology use	4
	Researching	4
	Knowing when to use technology	2
	Collaborating with other teachers	1
	Preparing technology-integrated lesson plans	1
	Guiding and making all students active	1
Suggestions for an increase technology use in the classrooms	Organizing seminars	4
	Motivating teachers' technology use	3
	Writing projects	2
	Support from the school administration	2
	Collaborating with other teachers	2
	Making effective technological tools available	2
	Improving students' technology use	1

The participants were asked for their suggestions for teachers who want to use technology in their lessons. One of the most mentioned suggestions is practicing technology use. To use technology in mathematics classrooms, they pointed out that it is essential to practice using technology to do it successfully. For example, P7 said:

> *"Since visuality is essential, I think it should be used abundantly. It is necessary to have full knowledge of the use of technology. They need to know very well how to use the smartboard so as not to have any problems."*

Another suggestion most frequently mentioned by teachers is research. They emphasized that teachers need to research and learn about technology. Some of the teachers stressed the importance of knowing when to use technology. They mentioned that knowing this allows teachers to use technology more effectively. One of the participants (P1) suggested that teachers who want to use technology in their lessons collaborate with other teachers. Preparing technology-integrated lesson plans is a suggestion of one of the participating teachers (P9). She emphasized that teachers should make their lesson plans, including technology use. One of the participants (P8) drew attention to the fact that all students should be active in the lesson. According to her, teachers need to guide students well to make all students active.

The participants generally stated that technology should be used in mathematics classrooms, but it is not used sufficiently. They were asked what their suggestions were for increasing technology use. The teachers' most common suggestion to increase technology use in mathematics classrooms was to organize seminars about it. P3 mentioned this while talking about his suggestion:

> *"It would be good to have seminars for teachers about programs like GeoGebra, which I just mentioned. … We spend our free time doing nothing in seminars. For example, I think it would be more beneficial for teachers from the same branch to gather in a single school and organize seminars."*

Three of the teachers suggested that teachers should be motivated to use technology. It was mentioned that this could be achieved by recommending and supporting teachers who do not use technology in their classrooms. It was also said that the use of technology could be increased with motivation. Some of the teachers pointed out that the school administration should support the teachers' use in schools. It was also mentioned that the school administration could control the use of technology by teachers. Collaborating with other teachers was another suggestion by the participating teachers. They mentioned the importance of teachers sharing whatever content they use with each other. Another suggestion of teachers (P7 and P8) to increase technology use in classrooms was to make effective technological tools available. They stated that technological tools and the techniques used in these technological tools should be developed. They think that the availability of effective technological tools that enable students to participate more actively in the lesson will increase the use of technology. One of the teachers (P5) remarked that students' use of technology should be improved to increase the use of technology in mathematics classrooms.

4. DISCUSSION

The study revealed that teachers use technology to enhance content visibility, enrich lesson processes, and engage students. Teachers stated that projecting problems, textbooks, and graphs on the smartboard ensures that all students can see them quickly, which they find essential for teaching mathematics. Similarly, Bozkurt and Cilavdaroğlu (2011) found that teachers use technology to project lesson content, while Taş et al. (2020) observed that it helps students view questions uniformly.

Beyond enhancing visibility, teachers also reported using technology to enrich their lessons with diverse digital tools. Teachers also use technology to enrich lessons through z-books, interactive virtual manipulatives, and videos. Z-books, containing ready-made content, are particularly useful in facilitating lessons, while interactive tools like GeoGebra help visualize geometric shapes in three dimensions. Videos shown at the start of new topics provide general knowledge and engaging introductions. Consistent with these findings, Koştur and Türkoğlu (2017) highlighted teachers' use of GeoGebra and videos for lesson visualization. However, this study contributes to the literature by showing that z-books are not only beneficial in distance education but also effective in face-to-face classrooms. This indicates that digital tools originally developed for online learning can also enhance traditional classroom environments, which constitutes an original contribution of the study.

In addition to improving lesson content, teachers emphasized that technology served as a tool for increasing student engagement and motivation. To engage students, teachers frequently use games and classroom activities, believing these practices boost motivation, conceptual understanding, and learning. Games often played for practice at the end of topics were identified as one of the most common uses of technology. This aligns with Ruggiero and Mong's (2015) findings, emphasizing technology's role in post-lecture activities.

Despite these benefits, the findings suggest that technology integration mostly remained at basic levels of the SAMR framework. From the results of the study, it can be concluded that teachers integrate technology into their lessons at a basic level. Their technology uses are concentrated on the substitution and augmentation levels, called enhancement, which are the first two steps of the SAMR model. For example, using z-books is at the substitution level of the SAMR model because there is no functional change. Using textbooks, teachers can reach the goals they have achieved in the lesson using z-books. In other words, z-books are used instead of textbooks. On the other hand, making students play games and do classroom activities is at the augmentation level of the SAMR model because, according to the participating teachers, they increase students' motivation and understanding. It was concluded that technology integration was not achieved in the modification and redefinition levels, called transformation, which are the more advanced steps of technology integration. This may be because teachers do not know how to properly integrate technology at these two levels. However, claiming this is solely due to a lack of knowledge provides a narrow perspective. Institutional barriers (e.g., exam-oriented curricula, lack of administrative support), cultural elements (e.g., entrenched teaching practices, resistance to change), and pedagogical challenges (e.g., insufficient instructional design

knowledge) also may contribute to why teachers remain at the lower levels of integration. Thus, while teachers are aware of the transformative potential of technology, they are often constrained by both individual and systemic barriers. This echoes findings from Tondeur et al. (2017) and Howard et al. (2022), who emphasized that structural and policy-related barriers often prevent teachers from progressing beyond substitution and augmentation.

Although participants stated that they had a high awareness of the pedagogical benefits of technology, this awareness was not reflected to the same extent in classroom practice. This situation reveals a phenomenon referred to in the literature as the attitude-practice gap. Indeed, a study by Bartilol et al. (2025) emphasized that despite teachers' positive attitudes toward technology, integration levels in classroom practices remained quite limited, stemming from inadequate infrastructure and capacity. Similarly, a study by Clipa et al. (2023) found that while teachers' attitudes toward technology were high, time constraints and lack of technical skills hindered implementation. As Ertmer et al. (2012) also noted, teacher beliefs and attitudes are critical in shaping technology integration, but this impact is often limited by structural barriers. In other words, a positive attitude alone does not guarantee advanced integration. Consistent with these studies, the present research also shows that heavy curriculum loads, exam-focused educational policies, inadequate institutional support, and limited technical infrastructure reduce the ability of teachers to put their awareness into sustained practice. Addressing this gap requires not only developing teachers' technical and pedagogical skills but also creating institutional conditions that support innovative practices.

Participant demographic data further helps explain why integration remains at the lower levels. For example, the only participants using interactive virtual materials (P2, P7, P8, P9) and videos (P2, P7) were mid-level teachers with 7–17 years of experience. This suggests that teachers with several years of experience, but not at the very beginning or end of their careers, may be more open to experimenting with relatively more advanced tools. In contrast, participants with the longest experience (P3 – 19 years, P4 – 16 years) remained more at the substitution level, using the smartboard only for problem-solving or textbook presentations. This finding suggests that ingrained teaching habits may limit progression to the transformation level. Graduate education also appears to have an impact on this. P1, who completed her master's degree, and P9, who is currently pursuing her master's degree, were among the few teachers who employed a wider variety of technologies, such as e-books, interactive materials, and classroom activities. This suggests that research experience and training gained during graduate education encouraged teachers to use a wider range of digital applications. On the other hand, teachers without graduate education generally remained at the substitution level, focusing more on basic applications such as problem-solving or textbook reflection.

Notably, increasing professional seniority did not always parallel advanced technology use. The youngest teacher (P1), with only three years of experience, demonstrated multi-tool integration by using both e-books and classroom activities. This suggests that early-career teachers, supported by current academic training, may be willing to use digital tools more diversely. In contrast, teachers with many years of experience (P3, P4, P6) remained more at the substitution level. These patterns indicate that while demographic factors such as career stage and graduate education shape technology use, they do not automatically lead to transformative practices.

While teacher demographics help explain usage patterns, it is equally important to highlight how these practices influence student outcomes. The study found that technology integration positively impacts students' academic success by making them active, improving memorability, supporting conceptual understanding, fostering student-centered learning, creating a competitive environment, and encouraging deep thinking. Games, such as Sudoku and Mancala, increase competition and motivation, leading to better topic comprehension and exam success. Teachers emphasized that the visual effects of digital tools enhance conceptual understanding and help students relate to and make sense of topics, highlighting the importance of quality digital content. Technology also promotes student-centered learning through active participation in games and activities, which boosts retention of basic skills and increases interest in lessons. These findings align with prior studies emphasizing the role of technology in enhancing conceptual understanding (Birişçi & Uzun, 2014; Koştur & Türkoğlu, 2017), supporting student-centered learning (Akkaya, 2016; Yılmaz & Naci, 2017), and promoting lasting learning (Ural, 2015). Moreover, technology increases motivation by offering visual elements and creating competitive environments (Akkaya, 2016; Rosas & Campbell, 2010). The study also adds new insights, such as how technology makes lessons and teachers more likable, which is linked to increased student motivation and positive attitudes.

In addition to its impact on students, technology was also found to facilitate teaching processes. Technology facilitates teaching by enabling easy writing, drawing, accessing ready-made activities, and saving time, allowing teachers to solve more diverse problems. It provides rapid feedback and supports effective lesson delivery (Goos & Bennison, 2004; Yılmaz & Naci, 2017). Additionally, technology offers various representations, real-life examples, and visualization, enhancing reasoning and learning in mathematics (Akkaya, 2016; Yazlık, 2019). These benefits stem from the rich content of digital tools, which are critical for effective learning. The study highlighted that technology also aids teachers' professional development by enhancing their mathematical knowledge and reasoning abilities. While rarely mentioned in the literature, this finding suggests that technology fosters both student and teacher development, with teachers primarily focusing on its benefits for students.

Despite these opportunities, both students and teachers face significant barriers that restrict effective technology integration. The study identified student-related challenges as a lack of prior mathematics knowledge, difficulty using technology, negative

attitudes, and general difficulty in mathematics. Insufficient prior knowledge and struggles with mathematics lead to a loss of interest and focus, potentially disrupting lessons despite technology's appeal. Students' technological difficulties hinder integration and necessitate additional instruction time. Negative attitudes further impede lesson participation. The literature mostly addresses teacher-related challenges, mentioning student misuse of technology, such as using smartboards or the internet for unrelated purposes (Koştur & Türkoğlu, 2017; Yazlık, 2019).

Teacher-related challenges include technological difficulties and classroom management issues. Teachers struggling with technology face integration problems, and the attraction of technology, such as games, complicates classroom management. These findings align with studies highlighting technology-related challenges (Goos & Bennison, 2004; Snoeyink & Ertmer, 2001; Wachira & Keengwe, 2011) and classroom management problems (Kutluca & Tum, 2018; Taş et al., 2020). Other teacher-related barriers include a lack of confidence (Duhaney, 2001; Pierce & Ball, 2009) and negative attitudes (Hadley & Sheingold, 1993; Pamuk, 2022).

Time-related issues were identified as another challenge, including increased preparation time, accommodating low-performing students, and limited time for curricula (Francom, 2016; Agyei & Voogt, 2011). While technology can save time, its improper use can lead to inefficiency. Optimal use enhances convenience and minimizes difficulties. This aligns with Francom's (2020) observation that while technology has the potential to save instructional time, poor design and lack of preparation may instead increase teachers' workload.

Technical and infrastructural problems, such as power and internet outages and smartboard malfunctions, were the most significant barriers. These issues disrupt lessons and waste time, creating cascading challenges. This finding aligns with previous studies (Agyei & Voogt, 2011; Yazlık, 2019). Thus, problems during technology integration often interconnect, amplifying their impact. This demonstrates that effective integration cannot be achieved solely through individual teacher effort; systemic improvements in infrastructure and administrative support are equally crucial.

To cope with these barriers, teachers reported adopting various practical strategies. For obstacles like students' difficulty in mathematics and technology use, teachers guide students to improve their skills. To overcome the challenges that students experience due to their lack of mathematical knowledge, teachers aim to be better prepared and be helpful to students to make up for their deficiencies. When teachers have difficulties using technology, they overcome it by working harder and giving more importance to the preparation process before the lesson. Teachers stated that they try to overcome classroom management problems by making agreements with students. Talking to them and getting their focus on the class, or attracting their attention by rewarding them, are used to overcome this difficulty in case of chaos in the classroom. Being competent in using technology is a solution to the time-consuming problem because a teacher who knows how to use technology well does not need to spend much time preparing beforehand. For this, it is necessary to prepare better; that is, it is essential to try to learn and be competent. The problem can be overcome by producing instant solutions, such as assigning students to do this before the lesson, for the problem that it takes time to turn on the smartboard. When technical problems are encountered, they can be overcome by requesting technical support. When there is a problem, it can be ensured that the flow of the lesson is not disrupted by continuing from the book or transferring to the blackboard.

Finally, teachers emphasized the need for institutional support and professional development opportunities. The most frequent suggestion of the participants was to organize seminars by the school administration or the national education department to improve the teachers' use of technology and their knowledge on this subject. It can be deduced that teachers need training in technology use. Lack of training for teachers is a frequently mentioned problem in technology integration in the literature studies (Agyei & Voogt, 2011; Beggs, 2000; Bekdemir, 2024; Cuban, 2001; Duque et al., 2024; Dvorak & Buchanan, 2002; Harris & Sullivan, 2000; Hsu, 2016; Jones, 2004; Keong et al., 2005; Koştur & Türkoğlu, 2017; Schoepp, 2005; Snoeyink & Ertmer, 2001; Taş et al., 2020; Wachira & Keengwe, 2011). From this point of view, it can be concluded that studies in the literature support this suggestion of teachers. For example, Yazlık (2019) pointed out that teachers and students should be informed about the use of technology, especially training on smartboards, which should be given to both groups. Also, Gaborek (2024) emphasized the need to customize educational programs according to teachers' perspectives and preferences to ensure their suitability and effectiveness. Therefore, one of the practical implications of this study is the urgent need for sustained, context-sensitive professional development programs that move beyond technical skills to include pedagogical and curricular integration strategies.

4.1. Limitations and Recommendations for Future Research

This research has several limitations. First, the study was conducted only with middle school mathematics teachers in a specific geographic region. Therefore, the generalizability of the findings to teachers in other regions may be limited. Second, the data were based solely on semi-structured interviews with teachers. This does not reflect the perspectives of students, parents, or school administrators, limiting the ability to provide a comprehensive picture of technology integration. Finally, the limited dataset, which included a lack of diverse methods such as observation or document analysis, limited the ability to examine the findings in depth.

Some suggestions can be made for future studies to overcome these limitations. First, similar studies with larger samples from different geographic regions can increase the generalizability of the findings. Furthermore, multi-stakeholder studies that include students, parents, and school administrators, rather than focusing solely on teachers' opinions, would provide a more comprehensive perspective on technology integration. Using methods such as observation, direct examination of classroom practices, and analysis of various documents during the data collection process can yield more robust and diverse data beyond teachers' statements. Finally, mixed-methods studies that combine quantitative and qualitative methods can further explore the attitude-practice gap in teachers' technology integration.

Research and Publication Ethics Statement

Ethical approval for the study was obtained from the Research Center for Applied Ethics at Middle East Technical University (Protocol No: 0001-ODTUİAEK-2024) with its decision dated 14.01.2022 and numbered 28620816.

Contribution Rates of Authors to the Article

The first author performed this study and worked at each step, including data gathering and analysis. The second author is responsible for the supervision of the study from the beginning to the end.

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Statement of Interest

The authors declare that there is no conflict of interest.

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Appendix A.

Interview Questions

Personal Information

1. What is the faculty type and field of study you graduated from?
2. What is your degree
3. How many years have you been teaching?
4. How many years have you been working at this school?
5. What grade levels are you teaching this semester?
6. What grade levels have you taught in previous semesters?

Detailed Information

7. How does your math lesson work? What steps do you follow when teaching a topic?
8. What do you think an effective math lesson should be like?
9. Do you use digital tools in your lessons? Which ones? How?
10. What applications do you use? How?
11. Do your assignments require the use of technology? In what way?
12. Can you describe your process for using this application in your lesson?
13. What is your students' role in this application?
14. What is your role in this application?
15. How do you think this application contributes to your students?
16. What is your reason for using this application?
17. What is the importance of this application to you?
18. What factors motivate you to use this application?
19. What difficulties (if any) do you encounter when using digital applications?
20. What do you do to overcome the difficulties you encounter?
21. How do you feel as a teacher when using this application?
22. Were other educational stakeholders (colleagues, parents, administrators) involved in the process of using digital tools in your classroom? How?
23. What advice would you give to teachers who want to use digital tools in their classrooms?
24. What can be done to increase technology use in classrooms?
25. How do you evaluate the quality of your classrooms where you use digital tools?
26. What factors support teachers who want to use digital tools in their classrooms?
27. What factors hinder teachers who want to use digital tools in their classrooms?

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Distance Education and Teachers' Job Satisfaction during the COVID-19 Pandemic: The Mediating Role of Work-Family Conflict*

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ABSTRACT

Conventional school education mandatorily switched to distance education to sustain education and protect the health of students and teachers during the COVID-19 lockdown around the world. However, mandatory distance education, a sort of home-based telework, is highly likely to get more blurred the borders devoted to working and family domains and trigger the work-family conflicts experienced by teachers and reduce their job satisfaction. Although previous studies addressed the relationships between distance education and job satisfaction, there is a limited study on the effect of the COVID-19 lockdown on the relationship between these three variables. The current study aims to explore the mediating role of work-family conflict in the association between distance education and teachers' job satisfaction by using data collected from Turkish teachers working from home during the COVID-19 pandemic. The results found that although mandatory distance education increased their job satisfaction since it allows them to maintain teaching activities under the COVID-19 circumstances, work-family conflict negatively mediated the link between mandatory distance education and teachers' job satisfaction.

Keywords: Distance education, teachers, job satisfaction, work-family conflict, the COVID-19 pandemic.

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1. INTRODUCTION

Coronavirus (COVID-19), which was first detected in China's Wuhan city, spread worldwide like a nightmare at the beginning of 2020. To slow the spread of the pandemic, "*lockdown*" and "*social distancing*" rules ordered by governments radically changed people's living and working manners since they were forced to stay at home and work from home. After the COVID-19 outbreak was officially announced as a pandemic by the World Health Organisation in March 2020, many governments immediately took a range of measures to prevent the mode of transmission. In this sense, almost all economic sectors, especially health, tourism, transportation, cafe and restaurant, have been influenced by the COVID-19 pandemic. In addition to these, education is one of the most affected sectors. In this sense, many economic sectors switched from a full-time standard working schedule to mandatory working from home, which was normally practised for the limited working days (ILO, 2020). Similarly, many governments decided to switch from conventional education to mandatory distance education to maintain education within the framework of the new pandemic rules (Hebebci et al., 2020).

A similar process was also conducted in Turkey by the government. After the Turkish Ministry of Health officially reported the first COVID-19 case in March 2020, schools at all levels were shut down and restructured their weekly course schedules to adhere to distance education. Thus, all schools were kept closed, except for nursery schools, and classes that would take high school and university exams during the 2020–2021 academic year. In this period, some platforms such as Zoom, Google Meet, etc. and the Education Informatics Network (EBA-TV), an internet- and television-based public distance education system, were substituted for face-to-face formal education. Although the EBA TV, a public distance education system, was established to reduce educational disparities and increase educational inclusion rates, students who lacked access to television, computers and tablets, etc., as well as the internet, were unable to participate adequately in education (Sari and Nayir, 2020). In this sense, the education processes in Turkey, such as lessons, assignments and exams, were significantly affected by the COVID-19 crisis when delivered via EBA, ZOOM, Skype, WhatsApp, etc. Parents' satisfaction with distance learning was also moderate (Görgülü

* The data utilised in this research is based on the non-thesis master's project of the 2nd Author. The study was ethically approved by the Tekirdağ Namık Kemal University Ethics Committee on 12.12.2021 (No: 2021-779).

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et al., 2022). Eventually, with the rise of COVID-19 vaccination rates in Turkey, schools resumed face-to-face education as of the beginning of the 2021 academic year, provided that some hygiene and social distancing measures were taken.

Fundamentally, distance education is a form of home-based telework for teachers to maintain educational activities. The new compulsory working manner became a new standard for working under the COVID-19 circumstances and broke teachers' old working habits. In this line, teachers had to adapt to the new working environment. Further, with the transport of work to home, teachers' time devoted to work and family is more likely to become more blurred and increase work-family conflicts (WFC) among teachers. There is no doubt that the WFC has some adverse outcomes for organisations and individuals. It may create some adverse effects on individuals, such as increased fatigue, stress and burnout, and poorer physical and mental health, while organisations are encountering some labour troubles, such as increased absenteeism and turnover, lower job satisfaction and poor performance (Anandasayanan et al., 2011; Erdamar & Demirel, 2014).

Teachers had to consider family responsibilities while teaching from home in distance education during the COVID-19 pandemic. This new mandatory teaching method may have increased the WFC among teachers. The increased WFC among teachers may have also had an adverse effect on their job satisfaction. Admittedly, teachers' job satisfaction is a key factor in the education system's success in building up the future of a society. At this point, the following questions come to mind. How did mandatory distance education affect teachers' job satisfaction and WFC under the COVID-19 circumstances? What is the role of the WFC in the relationship between distance education and job satisfaction among teachers under the COVID-19 circumstances? As a negative psychological factor, the WFC might have a mediating role that affects the relationship between distance education and teachers' job satisfaction. Therefore, the distance education under the COVID-19 circumstances is distinct from traditional work from home, and there is a need for new research to understand the impact of distance education on teachers' job satisfaction through the WFC. To address these relationships, drawing on research about the relationship between working from home and job satisfaction, the present study aims to explore the relationship between distance education and the job satisfaction reported by teachers under the COVID-19 lockdown and to examine the mediating role of the WFC in this relationship. To test the model, we identify distance education as an exogenous latent variable, job satisfaction as an endogenous latent variable and the WFC as a mediator latent variable.

2. LITERATURE REVIEW

2.1 The Relationship between Distance Education and Job Satisfaction

Distance education is a type of teaching and planned learning where the teaching is performed in a separate location from the learning, and which requires information and communications technology (ICT) and specific institutional organisations (Moore & Kearsley, 2012). A new generation of distance education with the development of internet technologies offers the possibilities for online education as synchronous in virtual classes and schools or courses which were previously recorded via text, audio, or video can be followed on online platforms as asynchronous (Moore & Kearsley, 2012). Unarguably, ICT enables numerous benefits for teachers and students. In this sense, teachers can work from anywhere and at any time using ICTs such as mobile computers, collaborative software, and the learning management system, and learners can also access courses in the same way (Casacchia et al., 2021).

Essentially, distance education for teachers is a sort of telework applied in education. The concept of telework (telecommuting) was first introduced by Nilles (1975) to define that employees in large companies performed their jobs in offices close to their homes by using a network with computer and communication components rather than travelling long distances to the workplace. And then, ICT-based telework began to be widespread when smaller and lighter wireless devices such as mobile computers and phones allowed employees to work from anywhere at any time, including from home (Eurofound & ILO, 2017; Chung & Van der Lippe, 2018). In particular, the "*internet boom*" has highly contributed to the development of telework (Dambrin, 2004).

Recently, the debates on telework have mainly been ongoing about its benefits for employers and employees. In this regard, telework offers a "*win-win*" situation for both parties. Employers win because they get rid of building and office costs. Employees win because they get a better work-life balance, resulting in higher job satisfaction and organisational commitment (Felstead & Henseke, 2017). In addition, telework allows workers to flex place, which improves workers' control over the time boundaries between work and family domains. Teleworkers also have more time to integrate work and family responsibilities by saving travel time. However, some studies argue that flexible working, including working from home, has no consistent empirical association with the WFC (Chung & Van der Lippe, 2018). In this sense, border theory suggests that moving work to home has some challenges. On the one hand, the borders between work and non-work domains are physically eradicated and boost boundary-blurring, depending on an increased permeability between the two environments. On the other hand, the effects of work pressure extend to non-work life, as reflected by the inability to *"switch off*" and difficulty winding down at the end of the day (Felstead & Henseke, 2017; Chung & Van der Lippe, 2018).

After the pandemic, telework became one of the main components of the struggle with COVID-19. Also, the International Labour Organisation (ILO) recommended that workers eligible for telework, including temporary workers and interns, switch to full-time home-based telework to reduce the risk of transmission of the COVID-19 pandemic (Messenger, 2020). During the COVID-

19 pandemic, telework, typically used for limited periods, was practised full-time rather than part-time or occasionally, not voluntary but compulsory, compared to telework under normal circumstances (ILO, 2020). In this respect, telework used during the COVID-19 pandemic was the standard form of home-based telework (Belzunegui-Eraso & Erro-Garcés, 2020). In this line, distance education for teachers can be regarded as a type of regular home-based telework.

Despite flexible working prospects, the transition to distance education brought along significant challenges for teachers under the COVID-19 circumstances. First, teachers had to switch to mandatory distance education, differing from their standard working orders, immediately learn the technologies required for distance education and re-adjust their work and family roles to the pandemic context (Lizana & Vega-Fernadez, 2021). Distance education boosted teachers' workloads with the transformation of educational approaches and the requirement to learn new teaching methods (Silva et al., 2021). Increased workload depending on distance education led to adverse effects on teachers' mental health, such as depression, anxiety, stress, and burnout syndrome. In this sense, a study in Chile reported that distance education led to increased anxiety and stress, workloads, exhaustion, and burnout among Chilean teachers during the COVID-19 pandemic (Lizana & Vega-Fernadez, 2021). Although teachers tried to overcome challenges resulting from mandatory distance education and provide educational continuity, teachers suffered from higher stress, workload, and burnout than before during the COVID-19 outbreak (Suganya & Sankareshwari, 2020). Also, using ICTs negatively affected teachers' physical and psychological life satisfaction (Casacchia et al., 2021; Suganya & Sankareshwari, 2020).

Job satisfaction is one of the essential dimensions of life satisfaction. Job satisfaction is inherently based on employees' subjective judgments about their jobs (Kalleberg & Vaisey, 2005). In this regard, Locke (1976) and Smith et al. (1969) defined job satisfaction as "*an emotional affective response to a job or specific aspects of a job*". Therefore, job satisfaction can be identified as an overall employee's positive or negative judgments and evaluations about their jobs. It contains three components: cognitive, affective, and behavioural; however, it is not very easy to separate the cognitive and affective components from each other (Judge, Zhang & Glerum, 2021). In fact, job satisfaction reflects workers' individual expectations of their jobs. Therefore, workers might have different job expectations for different jobs (Green, 2006). In this respect, some employees may be satisfied with their current jobs, while others may have lower job satisfaction as their current jobs do not meet their expectations. In this context, dissatisfied employees with their jobs are more likely to be either dismissed or quit (Clark, 2001). In a nutshell, job satisfaction depends not only on the job gains, such as wage, career, working time, job autonomy and flexibility, but also on individual expectations from the job. In this sense, it is more likely that someone with limited job expectations may express a higher satisfaction, while others with greater expectations for the same job may report a lower satisfaction because of their higher education (Green, 2006). From this aspect, people naturally tend to stay in a satisfying job and quit a dissatisfying job. Thus, worker behaviours such as absenteeism and quit intention are associated with job satisfaction (Spector, 1985). When the relationship between working from home and job satisfaction is reviewed, previous studies indicate that home-based teleworkers have higher levels of job satisfaction than office workers (Ellis & Robert, 1998; Virick et al., 2010; Kelliher & Anderson, 2010; Bloom et al., 2015; Felstead & Henseke, 2017; Roz, 2019; Jaeseung et al., 2020).

2.2 The Mediating Role of the WFC

The WFC is based on the role conflict theory, which assumes that people have limited time and energy to devote to their various roles (Kahn, Wolfe & Quinn, 1964). Therefore, the WFC is a sort of inter-role conflict experienced by people with multiple roles, such as a spouse, parent, and employee. In this sense, the WFC refers to an inter-role conflict in which role tensions from work and family domains interfere in certain ways. In other words, this type of inter-role conflict arises when work roles interfere with family roles or vice versa (Netemeyer et al. 1996). It means that the WFC has a mutual nature. Netemeyer et al. (1996) specified the WFC as a sort of inter-role conflict in which demands of, and time devoted to the work interfered with family responsibilities. For Greenhaus & Beutell (1985), the WFC occurs when attendance in the work (family) role prevents attendance in the family (work) role, and it has three sources: time-, strain- and behaviour-based conflict. In this context, people may experience the WFC when certain aspects of their work lead to difficulties in their personal lives. For example, an inflexible working program, lengthy working hours, and less time for the family may exacerbate the WFC (Erdamar & Demirel, 2014).

2.2.1 The Relationship between Distance Education and the WFC

After the COVID-19 outbreak, the WFC received researchers' and policymakers' attention again, depending to an increase in full-time home-based telework, particularly for dual-earner households. However, the pre-pandemic studies have no consensus on the effect of home-based telework on the WFC. In this sense, some studies suggested that teleworking had a positive impact on the WFC (Vilhelmson & Thulin, 2016; Fedakova & Lucia, 2017). For instance, Kossek et al. (2006) found that teleworkers, who had more control over their work, were significantly less likely to have turnover intentions, family-work conflict, and depression. On the other hand, others argued that home-based telework had negative effects on WFC. Although telework allows some flexibility for employees in terms of workplace and working time, flexible working schedules can increase work intensification, competition, and work on demand. In some cases, employees can be forced to accept irregular working schedules, which create WFC and negative physical or mental health conditions, including burnout (Vargas-Llave & Weber, 2020: 1) and a source of stress (Poelmans, 2003; Liu et al., 2018). Further, Amstad et al. (2011) concluded that WFC was associated with low job satisfaction, burnout, turnover intention, and increased absenteeism levels because teleworking blurs

the boundaries between work and non-work times (Vargas-Llave & Weber, 2020). In fact, during the lockdown, many workers experienced this scenario (Andrade & Lousã, 2021).
The COVID-19 circumstances made rethinking compulsory about the effects of working from home on the WFC. First, the COVID-19 crisis, which required the closure of schools and workplaces, changed employees' perceptions and anxieties about job security and the new work and life environment (Vargas-Llave & Weber, 2020). In this sense, Vargas-Llave & Weber (2020) suggested that telework assisted employees' work-life balance and mental health by allowing them to sustain their employment during the COVID-19 outbreak. Nevertheless, those who argue the opposite view claimed that mandatory home-based telework brought additional difficulties, leading to the WFC during the COVID-19 lockdown. For instance, Zakaria et al. (2021) reported that teleworkers from Malaysia faced the WFC under pandemic conditions, even if they could spare enough time for their family. Andrade and Lousã (2021) concluded that role overload and after-hours work-related technology use had a positive effect on the WFC during mandatory home-based telework. Because the work was mandatorily moved to the home, and thus the time devoted to work and family roles blurred during the COVID-19 pandemic. Therefore, the availability to work at any time of the day and job activities that exceed daily working time made them primary factors of the WFC for teleworkers (Andrade & Lousã, 2021).

In distance education, where the teaching role is performed at home, it is highly likely that teaching roles easily interfere with family responsibilities or vice versa, since the lines between the work and family domains are eliminated. In this sense, Lizana & Vega-Fernadez (2021) found that distance education during the pandemic increased Chilean teachers' working time and had an adverse effect on their work and family balance. Because teachers who had to study new educational technologies and techniques took on additional responsibilities in mandatory distance education, which created an unprecedented environment, and their workloads increased (Daniel, 2020). Synchronous and asynchronous lessons that required extra preparation in distance education were suddenly substituted for conventional education. Thus, due to mandatory distance education, these modifications in teachers' work environments may have adversely affected their teaching habits (Shoulders et al., 2021). The negative effects of distance education are more obvious for female teachers, especially those with mother or aged-care roles, than for males (Hong et al., 2021). Females are more likely than males to experience WFC due to the additional impact of working from home on their workload and household chores (Chung & Van der Lippe, 2018). For women, working from home means that the time saved from commuting and work is reallocated to caring for others and domestic chores. However, this potentially leads to increased tensions and conflicts between care roles and work responsibilities, which can be a source of stress for those involved (Hilbrecht et al., 2008; Chung & Van der Lippe, 2018). Further, the extraordinary conditions created by the pandemic are more likely to worsen the WFC among women who cannot have an unpaid grandmother assist or paid household service (Çoban, 2022).

2.2.2 The Relationship between the WFC and Job Satisfaction

Admittedly, people are satisfied with their jobs, allowing workers to meet their work and family roles; however, they are more likely to experience the WFC. As the number of dual-earner households having conventional responsibilities and roles at work and family, such as job and career goals, childcare and elderly care enlarge, the WFC increases among employees. Because long-working times or inflexible working schedules make it difficult for employees to meet work and family responsibilities that emerge simultaneously (Wong & Ko, 2009), this kind of role conflict may boost employees' dissatisfaction and stress (Gözükara & Çolakoğlu, 2016). In this sense, the WFC is associated with job dissatisfaction. Furthermore, employees experiencing the WFC cannot spare enough time for their families due to their employer's job demands. As a result, job performance and work-related outcomes are adversely impacted by stimulating job dissatisfaction (Hong et al., 2021). Also, the empirical studies and meta-analytic analyses confirm a significant relationship between the WFC and job satisfaction and indicate that employees experiencing the WFC are dissatisfied with their jobs. For example, Netemeyer et al. (1996) predicted a negative correlation between the WFC and organisational commitment and job satisfaction. Further, Kossek and Ozeki's meta-analysis (1998) found a consistent negative relationship between the WFC and job satisfaction and suggested that the relationship could be more robust for women than men. Similarly, Allen et al. 2000 verified the significant negative correlation between WFC and job satisfaction. In this sense, many studies using samples from different countries and professions concluded that the WFC was negatively related to job satisfaction (Perrewe et al., 1999; Maslach & Leiter, 2001; Turunç & Erkuş, 2010; Amstad et al., 2011; Gao et al., 2013; Buonocore & Russo, 2013; Demirel & Erdamar, 2016; Hong et al., 2021; Zakaria et al., 2021; Al-Alawi et al., 2021).

2.3 Research model and hypotheses

Mediation analysis, frequently used in social sciences, is a statistical method used to predict at least one causal antecedent variable (X) associated with a single consequent variable (Y) through a single mediator (M). The path model is depicted in Figure 1. In the model, X can influence Y through two pathways. The first is a direct pathway from X to Y, which estimates *the direct effect* of X on Y. The second is an indirect pathway from X to Y through a mediator M. This is called *the indirect effect* of X on Y (Hayes, 2022). In our model, distance education (X) is used as the antecedent variable, job satisfaction (Y) as the consequent variable and the WFC (M) as the mediator. As illustrated in Figure 1, the study mainly aimed to examine any mediation effect of the WFC on the relationship between distance education and teachers' job satisfaction. The hypotheses of the study are as follows:
Hypothesis 1: During the COVID-19 pandemic, distance education was positively associated with teachers' job satisfaction.

Hypothesis 2: During the COVID-19 pandemic, distance education was positively associated with the WFC among teachers.
Hypothesis 3: During the COVID-19 pandemic, the WFC was negatively associated with teachers' job satisfaction.
Hypothesis 4: During the COVID-19 pandemic, the WFC played a negative mediating role in the relationship between distance education and teachers' job satisfaction.
The model that will test our hypotheses for the mediation effect of the WFC in the relationship between distance education and teachers' job satisfaction is illustrated in Figure 1.

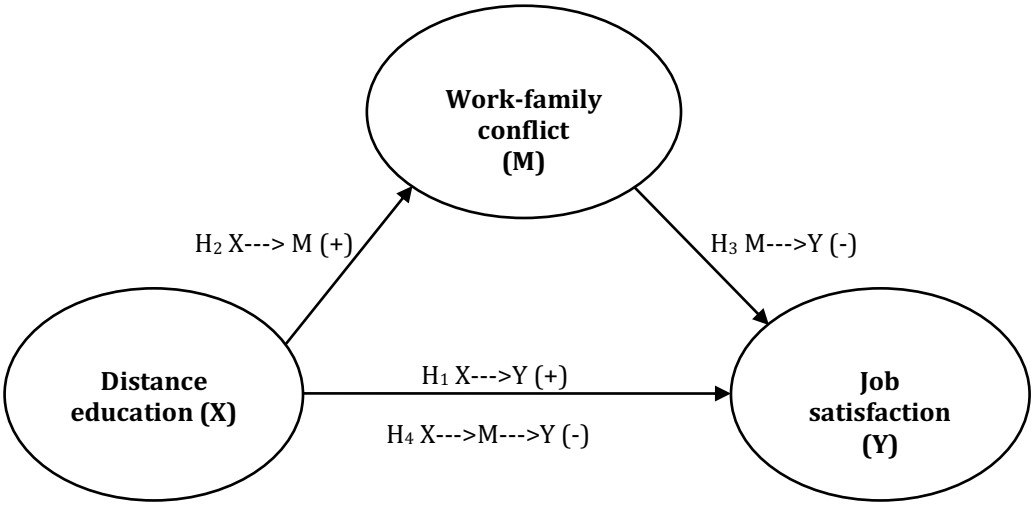


Figure 1. Hypothetical model of the study.

3. METHOD

3.1 Data Collection and Sample

Study data were collected between 05–08.12.2021 as part of a master's project investigating the effect of mandatory distance education on the WFC in Turkish teachers during the COVID-19 pandemic. A Scientific Ethics Commission reviewed and approved all studies involving human participants, and thus, the ethical standards of the 1964 Declaration of Helsinki were met. The minimum sample size required for the survey, with a 95% confidence interval and a 4% margin of error, was calculated to be 546. The survey was electronically sent out to participants, who work for the public nursery, primary, secondary, high schools, special education, and affiliated institutions from 11 districts of Tekirdağ city in Turkey via google forms and filled out by the 602 participants working from home during the COVID-19 lockdown. Before proceeding, confidentiality and anonymity of the survey were ensured by giving all participants information about the project's goals and consent.

3.2 Measures

Distance Education: Various scales were developed to measure distance education with the dimensions of students, parents, and teachers. One of them is the Distance Education Learning Environments Survey (DELES) developed by Walker and Fraser (2005). However, there is no special survey to measure the effects of distance education on teachers under the COVID-19 circumstances. To address this gap, we tried to generate a new questionnaire. The development of the questionnaire entailed the formulation of open-ended questions directed at teachers working from home, intending to elicit their experiences and challenges of the implementation of mandatory distance education during the prevailing circumstances of the COVID-19 crisis. Subsequently, scale was developed through a collaborative process involving the collation of the teachers' responses, a comprehensive review of extant theoretical literature, and the utilisation of the DELES. Following a thorough review of the available literature and consultation with experts in the field, the scale was revised. The scale with 23 items measured the effect of distance education on teachers' work and family balance during the COVID-19 conditions with a 5-point Likert rating scale from 1 = "*I totally disagree*" to 5 = "*I totally agree*". The current study used some items of the scale solely (e.g., "During the COVID-19 pandemic, my educational and/or administrative responsibilities increased"). The content of sample items and their internal consistencies are presented in Table 1.

WFC: This latent construct used the WFC scale with five items developed by Netemeyer et al. (1996) to measure participants' experiences of the WFC during distance education. And this scale was adapted to Turkish by Efeoğlu and Özgen (2007). The WFC consists of 5 items (e.g., "I felt unhappy in my family life as I could not have a work and life balance"). Participants were asked to agree or disagree with each item (1= "*strongly disagree*" to 5= "*strongly agree*"). In our sample, Cronbach's α of the scale was 0.89.

Job Satisfaction: Four items from the scale developed by Spector (1985) measured this latent construct. This scale was adapted into Turkish by Kula (2011). The job satisfaction scale consists of 4 items (e.g., "I am satisfied with working at this institution"). Participants were asked to agree or disagree with each item (1= "*strongly disagree*" to 5= "*strongly agree*"). Cronbach's α of the scale was 0.96 in the current sample.

3.3 Procedure

The data were processed and analysed using IBM SPSS 23.0 and AMOS. The software programme SPSS was utilised in order to conduct exploratory factor analysis (EFA), descriptive statistics, correlation analysis, and reliability analysis. Furthermore, confirmatory factor analysis (CFA) and mediation analysis were performed by AMOS. The present study constructed a mediated path analysis that incorporated one endogenous latent variable (i.e., distance education), one exogenous latent variable (i.e., job satisfaction) and one latent mediator (i.e., WFC). Furthermore, the model incorporated covariates as exogenous variables.

3.4 Factor Loadings

The EFA was processed to measure the factor loadings of the scales in Table 1. The EFA computed by the principal component was employed to analyse the distance education scale, the WFC scale (5 items) and job satisfaction (4 items). Items with all scores suppressed and factors with eigenvalues greater than 1 were deleted from the analysis, since the factor scores of the items were less than 0.40 and the cross-loads between factors were relatively high (Guadagnoli & Velicer, 1988). And then, the distance education scale with 6 items, the WFC scale with 5 items and job satisfaction with 4 items had an acceptable loading score (> 0.5). Cronbach's alpha (α) explored the internal consistency, and α coefficients were good (> 0.7) for three latent constructs (Kline, 2016). At the end of the EFA, we understood that distance education, job satisfaction and the WFC have a one-factor scale, and three factors explained 69.97% of the cumulative variance.

Table 1.
Exploratory Factor Analysis (N= 602)

Factors	Items	Factor loads	Eigenvalues	% of Variance	Cronbach's α
Distance education (X)	Diseduc1	0.576	4.972	33.147	0.85
	Diseduc2	0.780			
	Diseduc3	0.595			
	Diseduc4	0.830			
	Diseduc5	0.840			
	Diseduc6	0.761			
Job satisfaction (Y)	Jobsatis1	0.942	3.542	23.610	0.96
	Jobsatis2	0.935			
	Jobsatis3	0.920			
	Jobsatis4	0.914			
WFC (M)	Wfc1	0.778	1.983	13.219	0.89
	Wfc2	0.821			
	Wfc3	0.875			
	Wfc4	0.838			
	Wfc5	0.784			
KMO and Bartlett's Test					0.871
Approx. Chi-Square					5,932.175
df					105
Sig.					0.000

4. RESULTS

4.1 Descriptive Results

Before descriptive analysis, Mahalanobis, Cooks and Leverage distance methods were processed to detect the outliers. As a result of a set of analyses, the outliers were eliminated from the data set, and the rest of the 575 participants were included in the analysis. Participants comprised females (64.5%) and male (35.5%) teachers aged between 22 and 64 years old (mean= 39.10, SD= 9.06), and 99.5% had a university degree or above. In addition, 14.6% of participants work in nursery school, 31,7% in primary school, 31.5% in secondary school, 14.8% in high school, and 7.5% in special education affiliated institutions.

As seen in Table 2, the standard deviation values are monitored close to the mean. Furthermore, the absolute values of skewness and kurtosis (±2.00) suggest that the data are normally distributed (Lomax & Hahs-Vaughn, 2012; Field, 2009; Garson, 2012). Skewness analysis found that distance education and job satisfaction items are negatively skewed, while the WFC items are positively skewed. The kurtosis values for distance education and the WFC items are the negatives, while those for job satisfaction items are the positives. As illustrated by these figures, the assumption of a normal distribution has been unviolated.

Table 2.
Descriptive Statistics (Valid N= 575)

Items	Range	Mean	Std. Deviation	Skewness	Kurtosis
Diseduc1	1-5	3.504	1.3842	-0.431	-1.134
Diseduc2	1-5	4.090	1.1148	-1.176	0.540
Diseduc3	1-5	2.917	1.3422	0.005	-1.173
Diseduc4	1-5	3.677	1.2381	-0.614	-0.668
Diseduc5	1-5	3.727	1.2213	-0.662	-0.555
Diseduc6	1-5	3.428	1.3439	-0.415	-1.016
Jobsatis1	1-5	4.068	1.1093	-1.169	0.528
Jobsatis2	1-5	3.957	1.1746	-1.026	0.119
Jobsatis3	1-5	4.108	1.1226	-1.211	0.573
Jobsatis4	1-5	4.024	1.1504	-1.092	0.286
Wfc1	1-5	2.812	1.4433	0.111	-1.334
Wfc2	1-5	2.437	1.3248	0.454	-1.000
Wfc3	1-5	2.369	1.3119	0.516	-0.966
Wfc4	1-5	2.203	1.2778	0.764	-0.568
Wfc5	1-5	2.663	1.3758	0.296	-1.175

4.2 Confirmatory Factor Analysis

The measurement models were tested by the CFA tested the measurement models comprising Distance education (6 items), the WFC (5 items), and Job satisfaction (4 items). The Maximum Likelihood method was employed in the analysis by generating a covariance matrix since the data were normally distributed. Also, factor loadings were ≥0.50 (Hair et al., 2021). In the confirmation of model fit, if the goodness-of-fit index (GFI) and the Tucker-Lewis index (TLI) are greater than 0.90, the measurement model is regarded as having absolute goodness of fit when a "*standardised root mean square residual*" (SRMR) and a "*root mean square error of approximation*" (RMSEA) are less than 0.10 (Hu and Bentler, 1999; MacKinnon, 2008; Kline, 2016).

Table 3.
Confirmatory Factor Analysis

	X^2	X^2/df	*p*	GFI	TLI	RMSEA	SRMR
One-constructed model (X+ M +Y)	4232.960	47.03	0.000	0.459	0.231	0.283	0.240
Two-constructed model (X+M, Y)	3131.534	35.18	0.000	0.587	0.429	0.244	0.210
Three-constructed model (X, M, Y)	355.377	4.08	0.000	0.923	0.948	0.073	0.049

Note. X= Distance education; Y= Job satisfaction; M= WFC

The measurement models were examined in different combinations: one-constructed, two-constructed, and three-constructed. As seen in Table 3, the goodness of fit index indicated that the three-constructed model was within acceptable threshold values and well-fitted with the data. These results indicated that the three-constructed model met the goodness of fit.

4.3 Construct Validity

As Fornell & Larcker (1981) recommended, convergent and discriminant validity test the construct validity. The composite reliability score ranged from 0.863 to 0.963, while the average variance extracted (AVE) score ranged from 0.520 to 0.867 (see Table 4). These results confirmed that the WFC and distance education constructs met convergent validity. However, the CR value was at the limit for the job satisfaction construct (0.95). The maximum of 0.95 for the CR value points out indicator redundancy (Hair et al., 2021). Table 4 presents construct validity results.

Discriminant validity is achieved if the correlation values for the latent constructs are less than 0.85 (Hair et al., 2021). In addition, the square root of AVE for the three latent constructs was greater than the inter-construct correlations. Consequently, results proved that the three latent constructs met the discriminant validity criteria (Hair et al., 2021). Furthermore, the WFC was negatively correlated with job satisfaction (r = -0.007) and positively correlated with distance education (r = 0.418). Further, there is a positive correlation between distance education and job satisfaction (r = 0.199). Thus, these results are free from multicollinearity problems and meet the pre-assumptions for testing the mediating effect.

Table 4.
Convergent and Discriminant Reliabilities (N=575)

	CR	AVE	MSV	1	2	3
1 WFC (M)	0.901	0.647	0.175	**(0.804)**		
2 Job satisfaction (Y)	0.963	0.867	0.040	-0,007	**(0.931)**	
3 Distance education (X)	0.863	0.520	0.175	0,418	0,199	**(0.721)**

Note. α= Cronbach's Alpha Coefficients; CR= Composite reliability; AVE= Average variance extracted; MSV= Maximum shared squared variance; √AVE= Bold values in parenthesis.

4.4 Hypothesis Testing

Following the confirmation of the measurement model, the hypotheses were tested for the structural model with the latent variables using a mediated path analysis—Figure 2 and Table 5 display test results. First, Hypothesis 1, the total effect, was tested, and distance education had a significantly positive relationship with job satisfaction (β = 0.20, *p*< 0.001). Also, the 95% confidence interval of Bootstrap with 5000 did not include zero [0.090, 0.324]. It means that hypothesis 1 was confirmed. And then, Hypothesis 2 was tested, and distance education was significantly positively associated with the WFC (β = 0.42, *p*< 0.001). Distance education explained 17% of the variance in the WFC. Therefore, hypothesis 2 was also confirmed.

Table 5.
Hypothesis Testing Results (N=575)

	Effects	**β**	**SE**	**R2**	**Lower bounds 95% CI**	**Upper bounds 95% CI**	**Hypothesis**
H1 (X ---> Y)	Total effect	0.20***	0.045	0.04	0.090	0.324	**Confirmed**
H2 (X ---> M)		0.42***	0.048	0.17			**Confirmed**
H3 (M ---> Y)		-0.11*	0.048	0.05			**Confirmed**
(X--->Y)	Direct effect	0.24***	0.050		0.124	0.368	
H4 (X--->M--->Y)	Indirect effect	-0.045*			-0.091	-0.005	**Confirmed**

Note. *p< 0.05; **p< 0.01; ***p< 0.001. CI: Confidence Interval. The number of bootstrap samples = 5000.

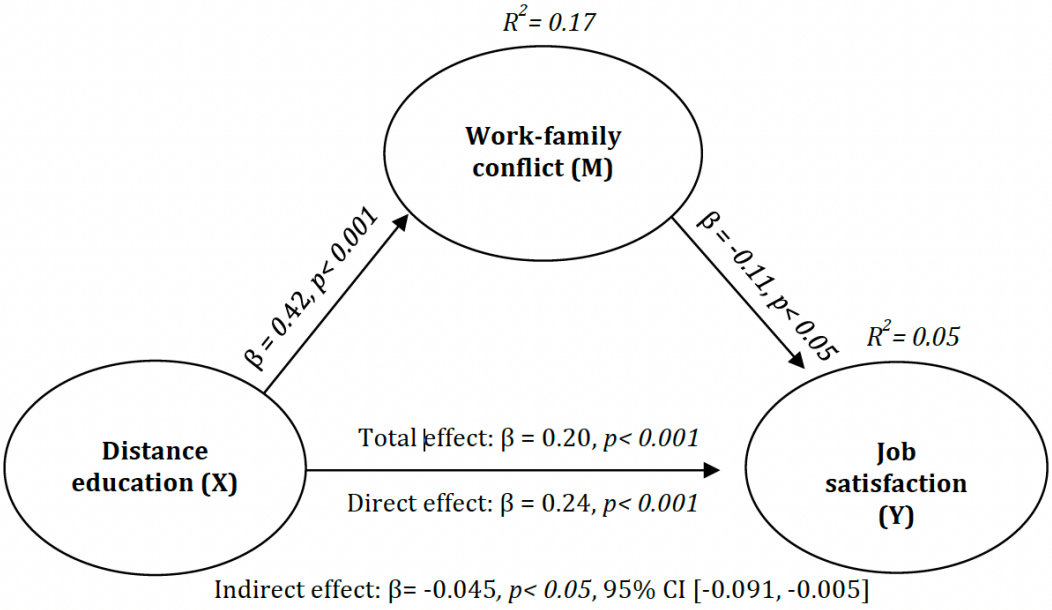


Figure 2**.** Structural equation model results.

A separate structural model tested the mediating effect of the WFC. First, the WFC negatively impacted job satisfaction (β = -0.11, $p< 0.05$). In this case, hypothesis 3 was also confirmed. After the addition of the WFC as a mediator to the model, the coefficient of the path from distance education to job satisfaction (direct effect) was still significant and greater than the total effect (β = 0.24, $p< 0.001$). Furthermore, the 95% confidence interval of Bootstrap with 5000 replicates did not include zero [0.124, 0.368]. It means that distance education had a significant direct effect on job satisfaction.

Finally, hypothesis 4, the indirect (mediation) effect of the WFC in the relationship between distance education and job satisfaction, was tested using the bootstrap sample distribution (Preacher & Hayes, 2008; Zhao et al., 2010; Hair et al., 2021). The WFC had a negative indirect effect on the relationship between distance education and job satisfaction (β=-0.045, $p< 0.05$). The indirect effect model calculated using bootstrap with 5,000 replicates was significant, as the 95% confidence interval did not include zero [-0.091, -0.005]. In this case, hypothesis 4 was confirmed. In the structural equation model (SEM), the positive direct effect and the negative indirect effect point out complementary mediation (Hair et al., 2021). The fact that the path analysis's fit indices were within the threshold values indicated that the model was consistent with the data and acceptable (X^2= 355.377; X^2/df= 4.085; p= 0.000; GFI= 0.923; CFI= 0.957, TLI= 0.948; RMSEA= 0.073; SRMR= 0.049).

4.5 Endogeneity Correction

Hausman's specification test, developed by Hausman (1978), controls for the endogeneity between distance education and teachers' job satisfaction. This was achieved by employing a two-stage least squares model (2SLS) with two instrumental variables: (1) distance education blurred the boundaries between work and family life, and (2) reduced communication between students and teachers. Hausman's test result estimated whether the ordinary least square (OLS) and two-stage least squares (2SLS) estimations were consistent with each other. In this sense, the Hausman Chi-squared difference test confirmed that distance education was not endogenous to job satisfaction among teachers, the F value (2, 572) χ^2= 3.867, p= 0.144). Thus, it was proved that distance education had no endogeneity bias in the path model.

5. DISCUSSIONS

During the COVID-19 pandemic, the internet and television were the two primary channels for distance education in Turkey. Distance education over television was asynchronous, while synchronous education was carried out over the internet with the EBA. However, students in rural areas could not access education due to a limited or a lack of internet infrastructure and TV broadcasting. In this sense, Karagöz and Rüzgar (2021) highlighted that distance education had some challenges resulting from the lack of technological devices, internet quotas, and infrastructure during the COVID-19 lockdown. On the other hand, teachers were dissatisfied with distance education due to the lack of interaction between teachers and students (Hebebci et al., 2020; 278-279). Further, Keskinkılıç Kara et al. (2021) found that female teachers working from home in Turkey, Istanbul, had lower job satisfaction and motivation and higher job stress during the COVID-19 pandemic.

The study found that distance education was positively correlated with teachers' job satisfaction during the COVID-19 pandemic. This finding was consistent with Balasundran et al. (2021) reported that working from home positively affected teachers' job satisfaction in Malaysia during the COVID-19 pandemic. Moreover, Sethi and Saini (2020) suggested that although teachers faced moderate challenges depending on distance education in India, they were highly satisfied with distance education with the assistance of school authorities. Thus, it can be considered that distance education boosted teachers' job satisfaction during the COVID-19 pandemic. However, other studies argued that the association between job satisfaction and teleworking varied by countries' special conditions under the COVID-19 pandemic. For instance, Bhattara (2020) found that employees working from home are less satisfied if they work more than working time in an office, while being more satisfied with virtual meetings for hours due to savings in travel and gas costs during the COVID-19 pandemic. Also, Zakaria et al. (2021) suggested that working from home enhanced job satisfaction in Malaysia during the COVID-19 outbreak. However, Mahmood et. al. (2023), employing data from Eurofound's COVID-19 Working and Living survey, found that an increase in work demand led to a reduction in teachers' job satisfaction during the COVID-19 pandemic. Moreover, possibilities to access adequate resources to overcome the challenges of distance education improved their job satisfaction. Also, they suggested that significant gaps occurred in the usage of technology between younger and older teachers during the COVID-19 period. As for the cases of Turkey, Reyhanoğlu and Akın (2023) concluded that working from home during the COVID-19 outbreak decreased teachers' job satisfaction in the case of Hatay. Furthermore, Dışkaya and Danışman (2025), in their study covering İzmir, suggested that teachers' job satisfaction was negatively affected by the changes in their working conditions during the pandemic, depending on the blurring of times devoted to work and life and an increase in workloads, stress and anxiety. In the post-COVID-19 era, Gökbulut and Öztürk (2024), in their research with 206 teachers in public schools in Zonguldak, found that distance education self-efficacy perceptions were positively, low-level associated with teachers' job satisfaction.

5.1 The Mediating Role of the WFC

The current study investigated whether the WFC mediated the relationship between distance education and teachers' job satisfaction under COVID-19 circumstances. Empirical results implied that the WFC negatively affected the association between distance education and teachers' job satisfaction. Also, path analysis pointed out that distance education had a significant positive effect on the WFC among teachers, while the WFC was negatively associated with teachers' job satisfaction. Thus, the

analysis indicated that mandatory distance education negatively affected job satisfaction perceived by teachers during the COVID-19 pandemic by boosting the WFC. Previous studies revealed a mediated role of the WFC on job satisfaction and other psychological factors. For example, Türker and Çelik (2019) reported that the WFC was associated with job satisfaction perceived by teachers, and job satisfaction played a mediation role in the effect of life satisfaction on the WFC. Further, Al-Alawi et al. (2021) concluded that the WFC had a significant negative effect on the job satisfaction of Saudi female teachers, and job satisfaction had a positive moderating impact on work-life balance. Also, Kafetsios (2007) found that the WFC mediated the association between job satisfaction and psychological distress.

Teaching is already one of the professions that commonly experience the WFC depending on a heavy workload, time pressures and growing competition even before the pandemic circumstances. The teachers have difficulties managing work and family life under these challenges brought by the teaching profession and encounter serious social problems (Chaman et al., 2014). In this regard, Maslach and Leiter (2001) suggested that teachers experiencing high rates of the WFC faced long periods of job stress and poor job satisfaction and got disconnected from their job responsibilities. Demirel and Erdamar (2016) concluded that teachers' job and life satisfaction decreased when the WFC increased. Further, Almutairi (2017) found that the WFC was negatively associated with job satisfaction.

Indisputably, the COVID-19 pandemic created radical changes and challenges in teachers' working forms and conditions. In this sense, conventional face-to-face schooling had to be replaced by mandatory distance education. However, distance education is highly likely to exacerbate stressors, shift their implementation of coping strategies, and impact teachers' job satisfaction (Shoulders et al., 2021). Some studies support these findings. For instance, Mahmood et al. (2023) concluded that although distance education was mandatorily practised to secure the health of teachers and students, the negative impact of unexpected and increased job demands on teachers reduced their job satisfaction during the COVID-19 pandemic. Further, Yu and Wu (2021), in their study on Chinese workers, found that during the COVID-19 pandemic, long-term teleworking adversely influenced job satisfaction in the absence of an appropriate working area, social support and a proper monitoring tool.

Mandatory distance education made significant changes to teachers' work environments and teaching habits since distance education needed extra planning, preparation and presentation during the pandemic habits (Shoulders et al., 2021). However, female teachers with multiple roles, such as work, baby, or aged-care, and chores, had far more adverse effects of mandatory distance education than male teachers (Hong et al., 2021). In this sense, female teachers with multiple roles within work and family were more likely to experience WFC, compared to male teachers. Female teachers with children had to combine their professional duties with family responsibilities. Also, the most common reasons for the WCF among female teachers with children were long and irregular working hours, adapting to new lesson schedules and new, exhausting and unconventional working conditions. Therefore, female teachers are more likely to have experienced higher tensions associated with occupational and family roles and face some challenges in perfectly regulating the role boundaries (Andrade & Lousã, 2021). In this sense, Keskinkılıç Kara et al. (2021) suggested that Turkish female teachers suffered from the WFC while working from home during the COVID-19 crisis. Furthermore, Çoban (2022) found that women were far more at risk during the COVID-19 pandemic in terms of quitting their work, precarisation of their employment and consolidating their traditional family roles due to mandatory teleworking practices. Moreover, Görmüş and Baytur (2023) suggested that the challenges arising from household chores and caregiving, coupled with flexible working hours, caused a blurring of the boundaries between work and family life for female teachers during the COVID-19 pandemic. Similarly, Reyhanoğlu and Akın (2023) found that female teachers working from home were more likely than males to experience the WFC during the outbreak due to tension between work and family responsibilities.

5.2 Theoretical Implication

Previous research mainly focused on the bilateral association between teleworking, job satisfaction, and the WFC. The current study tried to explain the role of the WFC in the relationship between mandatory distance education, which is a form of full-time home-based telework and job satisfaction during the COVID-19 lockdown. In this respect, this study also allows us to rethink the impacts of the COVID-19 pandemic circumstances on the mediating role of the WFC in the association between distance education and job satisfaction by using data from Turkish teachers. Empirical findings indicated that the WFC played a negative mediation role in the association between distance education and job satisfaction during the COVID-19 pandemic. Furthermore, the results suggest that mandatory distance education may have negatively affected teachers' job satisfaction, depending on increased WFC. In this respect, mandatory distance education might have blurred teachers' borders devoted to teaching and family time. Therefore, teachers appear unwilling to teach full-time from home since they frequently experience conflicts between work and family responsibilities. Hence, these findings have confirmed the predictions of border theory, arguing that transferring work to home physically removes the borders between work and non-work domains and increases boundary-blurring between the two spaces. Thus, this study contributed to the literature in this field by re-testing job satisfaction, conflict theory and boundary theory during the COVID-19 pandemic. Further, the study enriched the previous studies on distance education, job satisfaction and the WFC.

5.3 Practical Implications

The current study produced practical implications for reducing job satisfaction and the WFC among teachers due to teaching from home during the COVID-19 crisis. Although the pandemic has recently been taken under control worldwide, it is crucial to take some lessons from the challenges faced by teachers. First, the results indicated that the WFC negatively affected teachers' job satisfaction. In this sense, it is expected that some specific measures should be taken to increase teachers' job satisfaction and reduce their WFC in the post-pandemic period. Second, policies on improving teachers' salaries and working time and conditions will help boost their job and life satisfaction in compensation for the adverse effects of the pandemic. Also, these measures to develop job satisfaction may reduce the WFC among teachers. Third, teachers should be confirmed by re-training programs related to distance education for the possible next crisis (Demirel & Erdamar, 2016). Fourth, the implementation of social support and professional development programs and strategies within educational institutions has been demonstrated to enhance teachers' work-life balance and job satisfaction. For instance, Haslam et al. (2013) propose a workplace parenting intervention for teachers with the objective of reducing their WFC and job stress and developing family roles by balancing work and family. Similarly, Cinamon & Rich (2005) also recommend the implementation of the At-Risk Employees' and the Managers' Programs. The objective of the At-Risk Employees' Program is to assist teachers at risk with learning methods to tackle the WFC and improve their skills in balancing work and family responsibilities. The Managers' Program has been developed with the objective of assisting school managers in enhancing their awareness of teachers' work and family requirements, and in contemplating their administrative approach in relation to organisational policies (Cinamon & Rich, 2005).

5.4 Limitations

The findings of the current study should be considered in the following limitations. First, the findings should be confirmed by longitudinal data since the study employed cross-sectional data, which allows for one-sided causality (Aguinis, et al., 2017). Second, we used only the questionnaire method for data collection to adhere to social distancing rules in the study. The questionnaire may produce different outcomes for different occupation groups, cities, regions, or cultures. Also, face-to-face interviews and observations would be better for obtaining more objective data experienced by participants. Third, the study contains data from only Tekirdağ, with a relatively small sample. Collecting data from several cities with various backgrounds across Turkey would yield more beneficial results. Fourth, this study employed data that only examined the three factors' relationships. However, we could not focus on the organisational climate, such as the role of the management and relationships with colleagues. Future studies can consider these variables. Finally, the analysis results were predicted by the SEM. Alternative research procedures and methods might yield more different and valid inferences or results.

6. CONCLUSIONS

To contribute to the studies on distance education, job satisfaction and the WFC, we tried to explore the relationship between distance education and teachers' job satisfaction during the COVID-19 pandemic and the mediating role of the WFC. The results found that despite the positive effect of distance education on job satisfaction, the WFC negatively mediated the association between distance education and job satisfaction. Therefore, the current study suggested a direct path (increasing teachers' job satisfaction) and an indirect path (reducing the WFC experienced by teachers, particularly females) to enhance the efficiency of distance education.

Research and Publication Ethics Statement

The studies involving human participants were reviewed and approved by the decision date 02.12.2021, and no T2021-779 of the Scientific Ethics Commission of Tekirdağ Namık Kemal University to meet the ethical standards of the 1964 Declaration of Helsinki.

Contribution Rates of Authors to the Article

This article had two authors and derived from the master's project conducted by the second author under the supervision of the first author.

Statement of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Sustainability and Problem-Solving in Science Curricula: A QDA Miner Comparison of Türkiye and Singapore

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ABSTRACT

This study aims to conduct a comparative analysis between the Century of Türkiye Education Model Science Curriculum (2024, Grades 3–8) and Singapore's Science Syllabus (2023 implementation, Primary 3–6 and Lower Secondary 1–2) to examine the role of sustainability competencies and higher-order cognitive skills, which are at the forefront of global educational approaches. In this study, a qualitative document analysis was conducted to thematically evaluate the current curricula of both countries. Thematic coding and content analysis were performed using the QDA Miner qualitative data analysis software. The analysis revealed that sustainability and higher-order cognitive skills are explicitly included in both curricula but with distinct pedagogical priorities. Singapore's curriculum exhibited a significantly greater emphasis on practice-based and inquiry-based higher-order skills, such as *Decision Making* (56.0% vs. Türkiye's 44.0%) and *Problem Solving* (54.8% vs. Türkiye's 45.2%). Conversely, the Turkish curriculum placed a stronger emphasis on the theoretical dimensions of sustainability, specifically *Future-Oriented Thinking* (59.1% vs. Singapore's 40.9%) and *Systems Thinking* (53.7% vs. Singapore's 46.3%). Although the Turkish curriculum has a vision defined at the strategic level, the findings suggest that its implementation could benefit from integrating more explicit, step-by-step guidance and case studies to match its strong theoretical foundation. Overall, the findings reveal the strengths and areas for improvement of both programmes, offering valuable insights for curriculum development, teacher education, and assessment systems. By shedding light on the pedagogical foundations of sustainability-oriented science education, the study contributes significantly to understanding how educational systems are adapting to the demands of 21st-century skills.

Keywords: Science Curriculum, Sustainability, Problem Solving, The Century of Türkiye Education Model, Singapore.

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1.INTRODUCTION

Throughout history, individuals have continuously progressed in their pursuit of knowledge while seeking solutions to the problems they faced. Each new accumulation of knowledge has shaped the intellectual foundation for future generations. Science, which is an important part of this accumulation, serves as a fundamental discipline that develops the individual's ability to understand natural phenomena, explain them, and find solutions (Ministry of National Education [MoNE], 2024; Ministry of Education Singapore [MOE], 2024). With its emphasis on curiosity and inquiry-based structure, science increases the capacity of individuals to solve complex problems. In this context, it plays a crucial role in contributing directly to social development beyond individual growth (Tan et al., 2017).

However, in the 21st century, as digitalization has rapidly become widespread, individuals growing up surrounded by technology have not developed problem-solving skills. On the contrary, a heavy reliance on digital tools has led to the decline in individuals' critical and analytical thinking skills (Chu et al., 2021). This situation has led countries to restructure their education systems, and policies, to enhance students' higher-order thinking, scientific inquiry, and problem-solving skills. In this context, Türkiye has taken steps to become a knowledge society by integrating its traditional educational heritage with modern pedagogical approaches. Recently, restructuring the infrastructure through the Century of Türkiye Education Model, Türkiye aims to raise virtuous and effective individuals while also developing inquisitive, solution-oriented individuals equipped with scientific process skills (MoNE, 2024).

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The integration of cognitive development and higher-order thinking skills into education has become a global priority. In this context, many countries participate in international exams such as PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) to assess students' science literacy levels and problem-solving abilities. As can be seen in Figure 1, according to the 2022 PISA Report, Singapore achieved the highest results in science literacy, together with East Asian countries such as Japan, Macao-China, Taiwan, and South Korea also ranking high (PISA Report, 2022; TIMSS Report, 2023). These accomplishments can be attributed to countries prioritizing science education early, systematically employing inquiry-based learning strategies, adopting interdisciplinary approaches, and continuously improving teacher competencies (Tan et al., 2017; Chu et al., 2021).

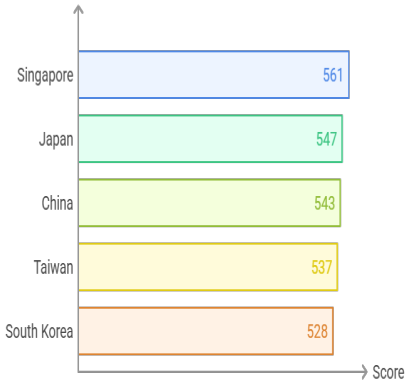


Figure 1. PISA 2022 Science literacy scores (Image created by the researcher using Canva software. Success in school).

As shown in Figure 2, there is a striking difference in balance between Türkiye's 2022 PISA and 2023 TIMSS results. In the PISA 2022, Türkiye ranked 34th out of 81 countries, achieving a score of 476 in science, and ranked 29th among OECD countries (OECD, 2023). While this indicates progress compared to previous assessments, it also reveals areas that need improvement relative to the international average (MoNE PISA, 2022). On the other hand, TIMSS 2023 results published in the same year presented a more positive picture for Türkiye. For 4th-grade science, Türkiye scored 570, ranking 4th among 58 countries globally and 1st among European countries. At the 8th grade level, it ranked 7th among 44 countries with a score of 530 (MoNE TIMSS, 2023). These results suggest that the reforms implemented, particularly in early years science education, have produced positive outcomes.

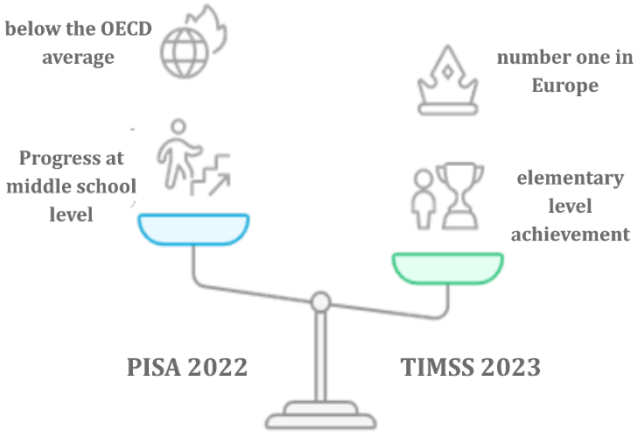


Figure 1. Strengths and Weaknesses in Science Education in Türkiye (Image created by the researcher using Canva software).

At this point, the innovative approach that the Century of Türkiye Education Model brings to education is remarkable. Taking inspiration from high-achieving countries, Türkiye's mdel is built on experiential learning, problem-based structuring, inquiry-based activities, interdisciplinary construct, and value-based teaching (MoNE, 2024). Such an approach helps students to connect science to real life activities, participate, in scientific thinking processes, and develop their ability to create solutions. This model has the potential to improve Türkiye's performance in international assessment systems. It goes beyond the knowledge transfer, focusing on high-level mental competencies such as scientific process skills, curiosity, critical thinking, and systematic analysis. This shows that the Century of Türkiye Education Model has a vision for science education that can compete on a global scale (MoNE, 2024).

The purpose of this study is to compare the secondary science curricula of Türkiye with Singapore, which has ranked the first in PISA and TIMSS exams. We evaluate how students integrate sustainability-based problem-solving skills into their daily lives to develop sustainable solutions. In particular, we discussed the curricula and pedagogical approaches that contribute to

Singapore's exceptional performance in international exams mentioned before (Karalı, Palancıoğlu & Aydemir, 2021). In this context, the following questions will be addressed:

To what extent are the Century of Türkiye Education Model and Singapore's secondary science programs effective in linking sustainability-based problem-solving skills to daily life?
When assessing the problem-solving outcomes in the science programs of both countries through QDA Miner analysis, what differences or similarities can be observed regarding the ability to develop sustainable solutions based on high-level cognitive skills?

In line with these questions, the outcomes of the curricula from both countries will be examined through a qualitative analysis method. Data will be coded thematically using the QDA Miner program, and both implicit and explicit messages related to problem-solving skills will be systematically analyzed. The findings aim to provide concrete recommendations for teachers, policymakers, and curriculum developers in terms of structuring science teaching with a focus on sustainability.

1.1.Background

1.1.1. The Role of Sustainability in Education

Contemporary approaches in science education not only conveys essential knowledge but also empowers students to deal with real-world problems in their daily lives (Martaningsih et al., 2022). In this context, prioritizing the development of solutions for environmental and social issues becomes crucial. Sustainable development has emerged as priority within education systems, leading to the increasing adoption of learning processes based on sustainability principles in science education programs (Aydın & Kıvanç, 2022; Sucuoğlu et al., 2023). Until 2030 UNESCO aims to equip individuals with sustainable life skills and integrate these skills into educational curricula (UNESCO, 2017).

Sustainability-oriented science education helps students understand natural phenomena and develop solutions to real-life problems by empowering them to make environmentally conscious decisions (Alatlı, 2020; MoNE, 2024). It also encourages individuals to create solutions, engage in critical thinking, and uphold social responsibility. High-level cognitive skills like problem-solving are fundamental in this process (Martaningsih et al., 2022). Skills such as analysis, synthesis, evaluation, and decision-making are crucial for solving complex sustainability problems (Varlık, 2025). For that reason, it is important to realize that science education programs have the potential to equip students with the mentioned skills. Science education helps individuals to examine their surroundings using the scientific method to create solutions. In the teaching process, problem-based scenarios related to daily life is regarded as an effective approach for students to better understand scientific concepts and internalize the information (Trott & Weinberg, 2020).

1.1.2. The Global Trend: The Rise of Sustainability and Higher-Order Cognitive Skills in Science Curricula

The global consensus on education is fundamentally shifting, driven by rapid technological advancements, complex socio-scientific issues, and the urgency of climate change (OECD, 2018; OECD 2022). Major international bodies like UNESCO, the Organization for Economic Co-operation and Development (OECD), and the United Nations (through the Sustainable Development Goals – SDGs) have explicitly positioned sustainability competencies and Higher-Order Cognitive Skills (HOCS) as essential learning outcomes (Kim & Care, 2020). This global prioritization stems from the need for students to move beyond rote knowledge to become active citizens capable of critical thinking, complex problem-solving, and future-oriented decision-making in the face of universal challenges (Luckin et al., 2021).

Despite this unified push, a significant implementation gap exists worldwide. While most modern curricula define these competencies at the strategic and visionary level, many systems struggle with integrating them effectively into daily classroom practice, teacher professional development, and standardized assessment methods (OECD, 2024). This divergence between intent and execution highlights a key research need: comparative analysis of how different national frameworks, such as those in Türkiye and Singapore, operationalize these globally critical concepts (Karalı et al., 2021).

1.1.3. Singapore's Science Education Approach

Singapore has developed an innovative science curriculum focusing on 21st-century skills to increase students' scientific literacy (Tan et al., 2017). Inquiry-based learning, sustainability-focused content, and interdisciplinary structure stand out as the three fundamental component for Singapore's curriculum (MOE, 2024). The inquiry-based learning approach focuses on the effective use of scientific process skills. It aims to improve students' fundamental competences including observation, hypothesis development, data collection, and interpretation. This program helps students to create knowledge rather than consuming it.

Moreover, the interdisciplinary learning strengthens students' ability to create multidimensional solutions to complex issues by connecting science with mathematics, engineering, technology, and social sciences (MOE, 2024). It helps students to make

connections between different disciplines, systemic analysis, and critical thinking (Boncukçu & Gök, 2023). Furthermore, sustainability-oriented content encourages students to become aware of environmental responsibility, in addition to acknowledging environmental issues, and adopting a solution-oriented approach (Karaarslan & Teksöz, 2024). This stratified structure provides a holistic approach for science education, aiming to increase students' competencies to solve problems in academic and everyday contexts. This structure also helps students develop high-level thinking skills and cope with real-life problems (Tan et al., 2017; Boncukçu & Gök, 2023; MOE, 2024).

1.1.4. Science Education in the Century of Turkiye Education Model

Prioritizing high-level thinking skills, the Century of Türkiye Education Model Curriculum has been established on a student-centred and value-oriented holistic structure. Its main purpose is to ensure that individuals acquire knowledge, gain the competence to understand this knowledge, associate it with different contexts, and effectively transform it (MoNE, 2024). In this curriculum, interdisciplinary relationships characterized by science, engineering, technology, and design are emphasized, while learning outcomes are integrated with components of conceptual understanding, values education, literacy, social-emotional learning, and field skills (MoNE, 2025).

The model aims to enhance students' individual and environmental awareness. It uses interdisciplinary and transdisciplinary learning scenarios to improve students' understanding of the natural world by emphasizing their active participation. It is designed to develop students' living skills by placing a great emphasis on sustainability (MoNE, 2024). In line with this approach, it seeks to enhance sensitivity to environmental issues, awareness of natural resource use, and capacity to create solutions to local and global issues. Additionally, using sustainability-oriented learning experiences, it aims to create social responsibility, entrepreneurship, and productivity (MoNE, 2025).

OECD's report on the 21st-century skills defines a set of fundamental skills for Türkiye, including creative thinking, critical thinking, problem solving, decision making, communication, research, and literacy related to information and communication technologies (ICT). However, OECD's (2018) report also mentions that assessment evaluation policies and teacher training programs have not yet been systematically structured. This indicates that there are still areas of growth to integrate these skills into the education system, through implementation and evaluation (OECD, 2018).

2. METHODOLOGY

2.1.Research Method and Data Collection

Within the scope of the study, document analysis, a qualitative research method, was employed (Fraenkel et al., 2023). We thematically analyzed the Science Curricula of Türkiye and Singapore, covering Grades 3–8, with a focus on sustainability competencies and Higher-Order Cognitive Skills (HOCS), in order to reveal the structural and pedagogical differences between the two countries. The data were collected from the 2024 Century of Türkiye Education Model Science Curriculum (Grades 3–8) and Singapore's 2023 Science Syllabus (Primary 3–6 and Lower Secondary 1–2), both officially published online by the respective Ministries of Education (MoNE, 2024; MOE, 2024). These curricula include all content standards, instructional approaches, and learning outcomes for their respective grade levels. During the data collection phase, both science curricula underwent a preliminary review in terms of sustainability competencies and problem-solving skills. The objectives, descriptions, and expected learning outcomes were examined to identify how these skills are represented and operationalized in each program.

2.2.Data Analysis

We analyzed the data employing the thematic analysis method utilizing QDA Miner software. The six-stage thematic analysis method proposed by Braun and Clarke (2006) was used. The stages included familiarizing with the data, generating initial codes, searching for themes, reviewing themes, and defining and naming themes.

The open coding method was applied following an inductive approach. During this process, codes were grouped into related themes based on similarity and conceptual relationships. These themes were then compared across both curricula to identify convergences and differences.

2.1.1. Coding Reliability

To ensure methodological rigor, several measures were implemented to enhance the reliability of the coding structure and findings. These measures included defining codes clearly, ensuring coding consistency, and verifying interpretations through validation procedures. The process aimed to maintain both internal and external validity of the results.

2.1.2. Code Definition and Reliability

The analysis utilized a focused coding frame consisting of 10 core competencies—seven for Sustainability (e.g., Systems Thinking, Future-Oriented Thinking, Taking Responsible Action) and three for Higher-Order Cognitive Skills (Problem Solving, Decision Making, Critical Thinking). Quantitative comparison was achieved by calculating word density for each competence within the curriculum texts, as presented in Table 1. Internal consistency was maintained, exemplified by the identical code count for Critical Thinking between Türkiye and Singapore (100 instances each).

A detailed coding manual defining each competency's operational criteria was developed. A second experienced researcher independently coded a subset of data using this manual. Consensus meetings were conducted until satisfactory inter-coder reliability was achieved.

2.1.3. Reliability and Interpretive Validity

Credibility was ensured by grounding thematic interpretations in quantitative evidence. For instance, the high coding rates for Systems Thinking (Türkiye: 53.7%) and Future-Oriented Thinking (Türkiye: 59.1%) reflected Türkiye's theoretical and strategic focus, whereas Singapore's higher Problem Solving (54.8%) and Decision Making (56.0%) rates indicated a practice-based pedagogical model. These interpretations were directly linked to the coded data and numerical outcomes.

Dependability was achieved through the audit trail maintained by QDA Miner software. Each coding step, from raw text to the 13 comparative codes and final themes, was systematically documented. This traceable process enhanced transparency and reproducibility.

Transferability was supported through detailed quantitative descriptions of all 10 competencies. Comparative percentages were presented in the findings section (Table 1; Figures 4 and 5) to allow contextual evaluation by other researchers. This detailed presentation provides opportunities to adapt the findings to similar curriculum studies.

3. FINDINGS

3.1.Comparison of Competences by Countries



Figure3. Code distribution of Türkiye and Singapore secondary science curricula (Image created from the data analysed by the researcher using QDA Miner software).

As shown in Figure 3, the comparative analysis shows the distribution of codes related to sustainability competencies and high-level skills that are prominent in the secondary science curricula of Türkiye and Singapore. These findings summarize the specific competencies and skills emphasized in the science programs of both countries.

Table 1.
Türkiye and Singapore Secondary Science Curricula Code Distribution

Competences	Competence Codes	Countries	
		Singapore	**Türkiye**
Sustainability Competences	Systems Thinking	163.64	210
	Future Oriented Thinking	81.82	130
	Values Alignment	90.91	110
	Cooperation	90.91	100
	Creative Solution Generation	118.18	110
	Self-Reflection	90.91	110
	Taking Responsible Action	163.64	150
Higher Order Thinking Skills	Problem Solving	145.45	200
	Decision Making	109.09	180
	Critical Thinking	100	100

As can be seen in Table 1 the analysis of curriculum texts in the Turkish Education Model reveals a strong emphasis on "Systems Thinking" and "Problem Solving" skills, as indicated by their high word density. This suggests that problem-solving processes and inter-system relationships are thoroughly defined in this model (MONE, 2025). On the other hand, Singapore's model address "Generating Creative Solutions" and "Taking Responsible Action" skills in a more comprehensive manner, focusing on environmental action strategies and innovation-oriented approaches (Ertan & Kaplan, 2023). Both countries have the same word count for "Critical Thinking" category. This indicates that this competency is equally distributed as a fundamental component of 21st-century skills (Gök & Sayıcı, 2022; Ülçay, 2024).

The high word count in the Turkish curriculum on "Future-Oriented Thinking" and "Decision Making" skills shows that the Century of Türkiye Education Model prioritizes decision-making mechanisms to achieve long-term sustainability goals (MoNE, 2025).

3.1.1. Comparison of Sustainability Competences by Code

The analysis of the data presented in Figure 4 reveals both similarities and significant differences in how sustainability competencies are addressed in the science curricula of Singapore and Türkiye. Systems Thinking competence plays a significant role in the science curricula of both countries. In Türkiye, this is represented by a rate of 53.7%, whereas in Singapore it is 46.3%. This shows that the Turkish curriculum places greater emphasis on Systems Thinking. The difference can be attributed to the theoretical emphasis on the concept of sustainability in the recent updates to the Turkish curriculum (Aydın & Kıvanç, 2022). In contrast, Singapore might be addressing this competence through systematic and well-established pedagogical structures (Gök & Sayıcı, 2022).

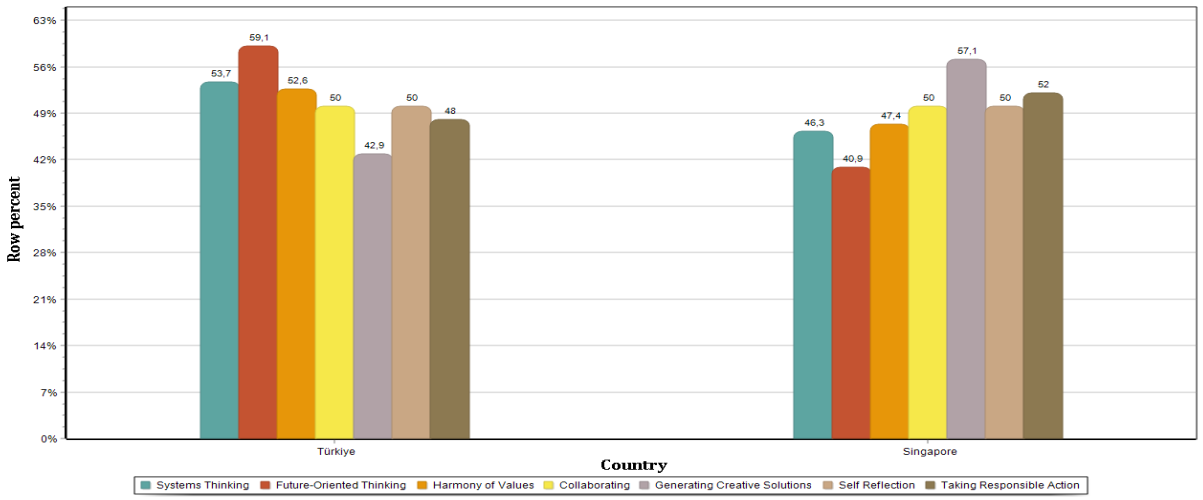


Figure4. Code ratios for sustainability competencies in Türkiye and Singapore (Image created from data analysed by the researcher using QDA Miner software).

A similar trend can be observed in the future-oriented thinking competency. Türkiye includes this skill in its curriculum at a high rate of 59.1%, while in Singapore, the rate remains at 40.9%. This high percentage in Türkiye reflects the Century of Türkiye Education Model's commitment to deeply integrating sustainability messages for future generations into the curriculum. Despite Singapore's lower rate, it could be compensated by its practice-oriented and integrated approaches (Tan, 2021). This notable difference indicates that Türkiye has made a significant investment in future-oriented sustainability. The Century of Türkiye Education Model strongly emphasizes environmental and ethical responsibility as part of the 21st-century skills for future generations (MoNE, 2025).

There is a similar situation concerning the competence of values congruence. While 52.6% of the Turkish curriculum incorporates this competency, the rate in Singapore stands at 47.4%. Although these percentages are relatively close, it is noteworthy that the Turkish curriculum explicitly addresses ethical, social, and environmental values. This indicates that Türkiye prioritizes value-based education at the program level (MoNE, 2025). In contrast, Singapore seems to integrate these values more holistically and implicitly through practice-based activities and STEM scenarios (Yeo & Tan, 2021).

Regarding collaboration competence, Singapore's science curriculum scores higher at 57.1%, compared to Türkiye's 42.9%. This difference may stem from Singapore's extensive and systematic use of project-based learning and teamwork practices within STEM education (Teo & Choy, 2021). On the other hand, in the Turkish curriculum, collaboration skills appear to be addressed primarily in the planning and content explanations, while the implementation aspect remains relatively limited (MoNE, 2024).

In the Singapore science curriculum, the competency for generating creative solutions is 52.6%, which is higher than Türkiye's 47.4%. This difference can be attributed to Singapore's long-standing focus on design thinking and innovation-based science education (Tan et al., 2021). In contrast, in Türkiye, these skills have had limited application in practical contexts. Türkiye's science curriculum positions creative problem-solving and innovation as goals, but previous programs in Türkiye have not effectively integrated these objectives into practical experiences (Gök & Sayıcı, 2022). The new "Century of Türkiye Education Model" aims to change this issue by providing students with concrete experiences to develop these skills (Ülçay, 2024). Self-reflection competence is equally represented in both countries, with a rate of 50%. This indicates that reflective skills such as evaluating learning processes, self-awareness, and self-assessment are considered important goals in the science curricula of both countries, particularly in Türkiye's new educational model (MoNE, 2025).

Regarding the competence to take responsible action, Singapore's program shows a slightly higher rate of 52%, compared to Türkiye's 48%. The science curricula in both countries aim to enhance students' awareness of responsibility and sensitivity to environmental issues (Karalı et al., 2021). The Singapore curriculum emphasizes concrete behavioral patterns, particularly through the 3R approach (Reduce, Reuse, Recycle), which aligns with sustainable resource management and raising scientifically literate individuals (Yazıcıoğlu, 2017). In contrast, the Century of Türkiye Education Model does not directly define these concepts with specific structured strategies like "5Rs." Instead, it addresses broader themes such as sustainable development awareness, career awareness, and entrepreneurship (MoNE, 2025). This suggests that Türkiye conveys environmental responsibility through value-based and holistic learning outcomes, with a growing diversification of practices in terms of content (MoNE, 2024; Ülçay, 2024).

Sustainability competencies are explicitly integrated into the curricula of both countries. However, the observed differences in percentages can be attributed to the maturity of each country's curriculum implementation. Singapore's curriculum provides a well-established and practice-oriented framework (Tan, 2021), while Türkiye's curriculum has been evolving to more clearly define and plan these competencies in light of recent comprehensive updates (MoNE, 2025; Ülçay, 2024). Consequently, some codes in Türkiye that show high representation may reflect a targeted vision; their practical application will become clearer over time. In contrast, Singapore is believed to incorporate these values and responsibilities through a transactional and experiential approach (Bayırlı, 2020). It is crucial to assess these differences not only through quantitative metrics but also by examining the depth of implementation, teacher competencies, and student experiences. The findings indicate that both countries are at different stages and have varying priorities in their approaches to sustainability literacy.

3.1.2. Comparison of Higher-Level Cognitive Competences by Codes

In Figure 5, the ratios of three essential competencies—Problem Solving, Decision Making, and Critical Thinking—coded under "Higher Level Cognitive Skills" in Türkiye and Singapore are presented. The data shows that all skills are represented at higher rates in the Singapore sample compared to Türkiye. Singapore places a 54.8% emphasis on problem-solving competence in its curriculum, which is higher than Türkiye's 45.2%. This considerable emphasis in Singapore can be attributed to the rich content in its problem-based learning (PBL) sessions, case studies, and project-based activities, which actively engage students in processes such as hypothesizing, designing experiments, and testing with evidence (Martaningsih et al., 2022; Ministry of Education Singapore [MOE], 2021). Although Türkiye also has a strong emphasis on problem-solving, the inclusion of standardized laboratory experiments and instruction focused on knowledge consolidation in its curricular materials suggests that Türkiye may lag slightly behind Singapore regarding content diversity and the richness of scenarios (Gök & Sayıcı, 2022; Karalı et al., 2021).

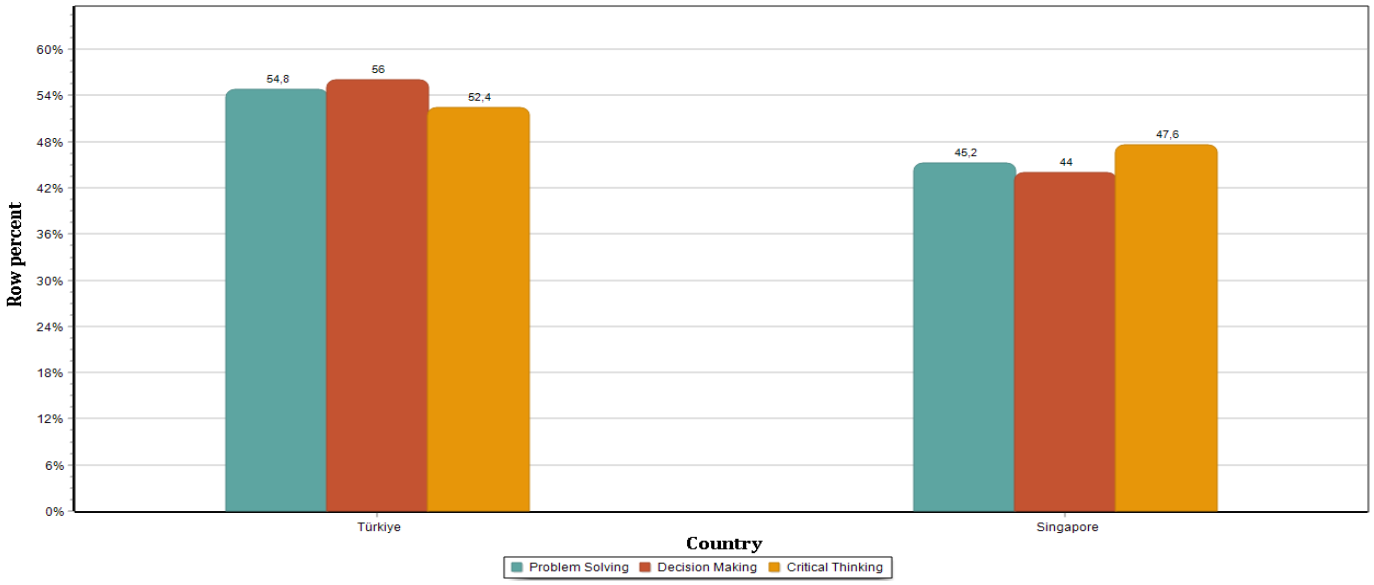


Figure 5. Ratios of codes related to high-level cognitive skills in Türkiye and Singapore (The figure was created from the data analysed by the researcher using QDA Miner software).

To enhance pedagogical approaches, incorporating more case examples—both in quantity and quality—into the Century of Türkiye Education Model science program's revisions will enable students to develop their problem-solving skills more comprehensively (MoNE, 2025; Ülçay, 2024). The international PISA 2022 report also indicates that problem-based and case-based learning approaches enhance students' deep-thinking skills, particularly in analyzing and solving complex real-world problems in science (OECD, 2024).

When analyzing decision-making competence, Singapore's curriculum, at 56.0%, is significantly higher than Türkiye's, which stands at 44.0%. This strong representation in Singapore can be attributed to the consistent inclusion of explicit steps related to systematic decision-making processes in the curriculum, such as "goal setting, comparing options, criteria-based evaluation, and drawing conclusions." In particular, constructs like "formulating research questions" and "comparing alternative technological solutions" are notable (Yeo et al., 2021; MOE, 2021; Muhammad Ariff et al., 2024). Although the Century of Türkiye Education Model supports decision-making elements through "end-of-unit assessments" and "in-class debates," these elements are infrequently presented in a clear, step-by-step roadmap in the curriculum, unlike in Singapore (Gök & Sayıcı, 2022; MoNE, 2024). This gap highlights the potential to enhance students' criterion-based reasoning skills by incorporating more pedagogical case studies and checklists (MoNE, 2025; Yazıcıoğlu & Pektaş, 2018).

The narrow difference of 4.8% between the curricula of Türkiye (47.6%) and Singapore (52.4%) in terms of critical thinking competence suggests that both educational systems emphasize skills like evaluating evidence, generating alternative hypotheses, and constructing scientific arguments with nearly equal intensity (MOE, 2024; MoNE, 2024). This indicates that critical thinking is addressed in a balanced manner as a universal requirement (Asigigan & Samur, 2021; International Labour Organization, 2021; Morgado, Leite, Dourado & Varela, 2025). The higher percentage in Singapore can be attributed to the inclusion of advanced topics in their curriculum, such as science ethics, decision-making under uncertainty, and multidimensional risk analysis (MOE, 2021-2024; Yeo & Tan, 2021). In Türkiye, utilizing socio-scientific case scenarios—such as environmental dilemmas and technology ethics—to enhance critical thinking skills is recommended (MoNE, 2024; Ülçay, 2024). The high rate in Singapore can be attributed to its focus on advanced topics such as decision-making in uncertain situations, multidimensional risk analysis, and science ethics (MOE, 2021-2024; Yeo & Tan, 2021).

These findings indicate that Singapore's science program addresses higher-order cognitive skills using case-based, systematic approaches as well as clear templates for decision-making processes. In contrast, while Türkiye's mdel has a solid structure, it could benefit from diversity in examples and step-by-step guidance (Gök & Sayıcı, 2022). This suggests that Türkiye has the potential to create practical applications using its theoretical strength (Ülçay, 2024).

These findings reveal that Singapore's curriculum emphasizes students' active involvement in decision-making and problem-solving using their scientific knowledge (Weng & Eng, 2021). On the other hand, higher-order cognitive skills may become more prominent in the new curriculum of Türkiye (Ülçay, 2024). This implies that Türkiye can effectively link high-level cognitive skills with practical applications in the new curriculum texts.

3.2. Comparative Analysis of Frequency Distributions of Competency Codes by Countries

In this section, we analyzed the frequency distributions of codes of sustainability competencies and higher-order cognitive skills. Doing this comparative analysis, we aimed to determine the extent to which specific competencies are emphasized in the texts. By examining the total coding rates, we can assess the pedagogical priorities of both programs from a quantitative perspective (Williams et al., 2021). This examination might help us to identify dominant skills in the curricula and highlights areas potential for development (Fraenkel et al., 2023). This finding can offer significant insights for curriculum development and implementation process.

3.2.1. Total Distribution of Code Frequencies of Sustainability Competencies in the The Century of Türkiye Education Model and Singapore Curricula

As seen in Figure 6, the "Systems Thinking" skill has the highest representation rate among sustainability competencies at 25.3%. This indicates that both countries address the relationships between science, nature, and society in a holistic manner, prioritizing cause-and-effect relationships (Karalı et al., 2021; MOE, 2024; MoNE, 2025). This shows that interdisciplinary thinking skills play a crucial role in both curricula.

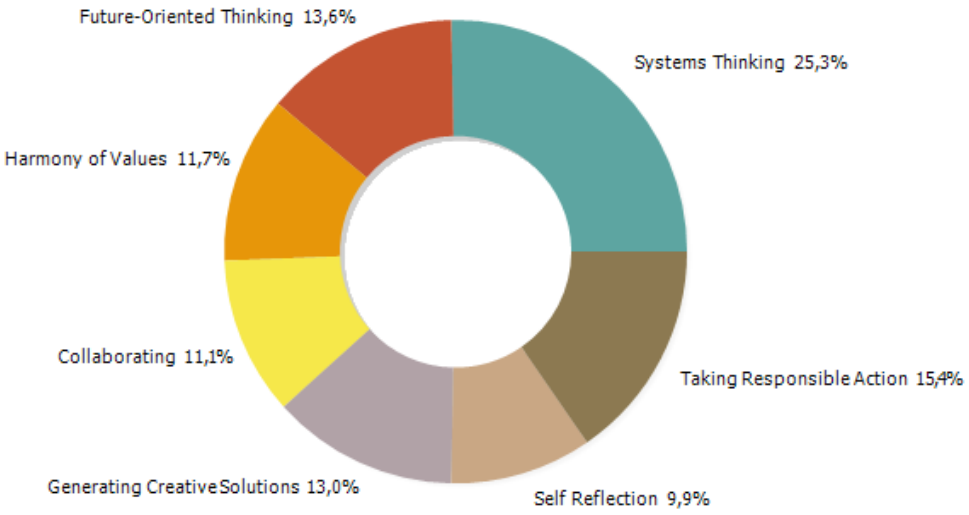


Figure 6. Code frequency distribution of Türkiye and Singapore's sustainability competencies (Visual created by the researcher using data analyzed with QDA Miner software).

The second code, "Taking Responsible Action" (15.4%), shows the importance of practices in environmental awareness as in 3R strategies (Reduce, Reuse, Recycle), and social responsibility (Gök & Sayıcı, 2022; OECD, 2022). This emphasis indicates that sustainability is addressed not only at a conceptual level but also through behaviors. Additionally, the strong focus on "Future Thinking" (13.6%) and "Creative Solution Generation" (13.0%) competencies suggests that sustainable development-oriented approaches, including long-term planning and the development of innovative solutions, are incorporated into educational curricula (Gorski et al., 2023). The ratios for "Values Alignment" (11.7%) and "Collaboration" (11.1%) are quite close, indicating that awareness of scientific ethics, social responsibility, and teamwork is addressed to a moderate extent in the curricula (Karaarslan & Teksöz, 2024; OECD, 2018). However, the "Self-Reflection" competence (9.9%) has the lowest percentage. This suggests that metacognitive processes such as self-evaluation, insight, and awareness of learning have not yet found adequate representation in the curriculum regarding sustainability (MoNE, 2023; Nguyen, 2023). When evaluating the frequency distribution of sustainability competencies, it becomes evident that the curricula strike a balanced approach between conceptual knowledge and practical action skills. The inclusion of individual-centered cognitive processes, such as self-awareness and self-evaluation, in curriculum structures can help students develop deep and lasting learning experiences. This is achieved by integrating their knowledge and actions related to sustainability issues with self-reflection skills (Ülçay, 2024).

3.2.2. Total Distribution of Code Frequencies of Higher-Level Cognitive Competencies in The Century of Türkiye Education Model and Singapore Curricula

Analysis of the coding data in Figure 7 shows that among higher-order cognitive skills, Problem Solving had the highest frequency at 40.3%. This indicates that science education curricula in both Türkiye and Singapore encourage students to adopt solution-oriented approaches by addressing real-life problems and prioritizing strategic thinking (Gök & Sayıcı, 2022; Karalı et al., 2021). The Decision-Making competency was represented with a 32.5% frequency, suggesting that skills such as comparing alternatives, predicting potential outcomes, and making informed choices hold significant value in the curricula (MOE, 2021; MoNE, 2024). This skill supports students' analytical thinking and their ability to take responsibility, especially when dealing with environmental issues characterized by uncertainty and complex scientific problems (Morgado et al., 2025).

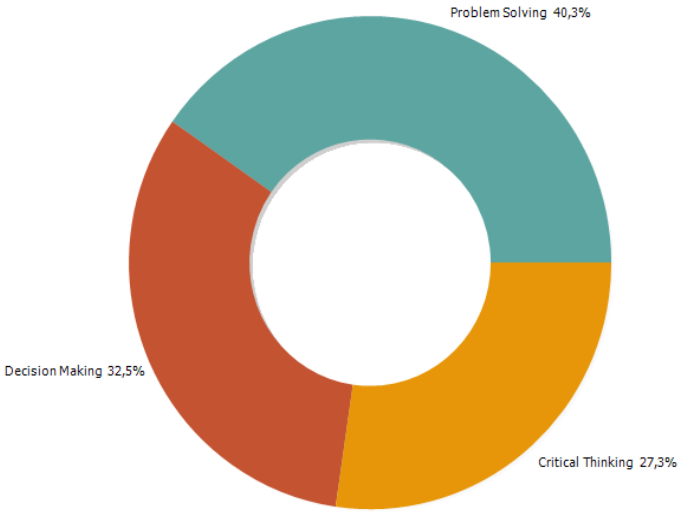


Figure 7. Code frequency distribution of Türkiye and Singapore's high-level cognitive competencies (Visual, created from data analyzed by the researcher using QDA Miner software).

The Critical Thinking skill, rated at 27.3%, aims to develop students' abilities in processes such as making evidence-based reasoning, analyzing arguments, and evaluating various perspectives (MoNE, 2025). This competency is particularly important for making informed decisions on socio-scientific issues, participating in scientific debates, and fostering critical attitudes towards information pollution (Gorski et al., 2023; van Laar et al., 2017). Upon analyzing the overall distribution, it becomes clear that these three high-level cognitive skills are integrated into a complementary structure within the curricula. However, problem-solving practices are emphasized more intensively (MOE, 2023; MoNE, 2024). This suggests that constructivist approaches in science education align well with pedagogical principles that encourage student learning through real-life problems (OECD, 2022; Tan et al., 2021). Nonetheless, the application of these principles in classroom practices may differ based on teachers' training, teaching strategies, and other contextual factors (Karaarslan & Teksöz, 2024; Nguyen, 2023).

3.3. Thematic Code Distribution of Competencies

This section presents the thematic distribution of sustainability and higher-level cognitive competencies identified in the curricula of Türkiye and Singapore. The visual representations generated by QDA Miner software were used to analyze the frequency and relationships of the codes, providing a comparative overview of how these competencies are structured and emphasized within each curriculum. In the following sub-sections (3.2.1 and 3.2.2), the thematic distributions of sustainability and higher-order cognitive competencies are discussed in detail, supported by graphical outputs obtained from QDA Miner analyses.

3.3.1. Thematic Code Distribution of Sustainability Competencies

The radar graph numbered 8 below, created using the thematic coding method, illustrates the representation of sustainability competencies in the science curricula of Türkiye and Singapore. An analysis of the graph shows that the dimensions of "Systems Thinking," "Taking Responsible Action," and "Generating Creative Solutions" are well represented in the programs of both countries. This finding aligns with previous analyses, indicating that sustainability competencies are integrated into the curricula with a holistic and solution oriented approach (Gök & Sayıcı, 2022; MoNE, 2025).

Notably, Singapore exhibits higher representation rates in "Creative Solution Generation" and "Future Thinking" competencies compared to Türkiye. This suggests that Singapore prioritizes design thinking, innovation, and future foresight skills in its curricula (Tan, 2021; Weng & Eng, 2021). Conversely, Türkiye shows strong representation in "Systems Thinking" and "Taking Responsible Action," highlighting its emphasis on helping students understand the interactions between nature, society, and science, as well as fostering environmental responsibility (MoNE, 2025; Ülçay, 2024).

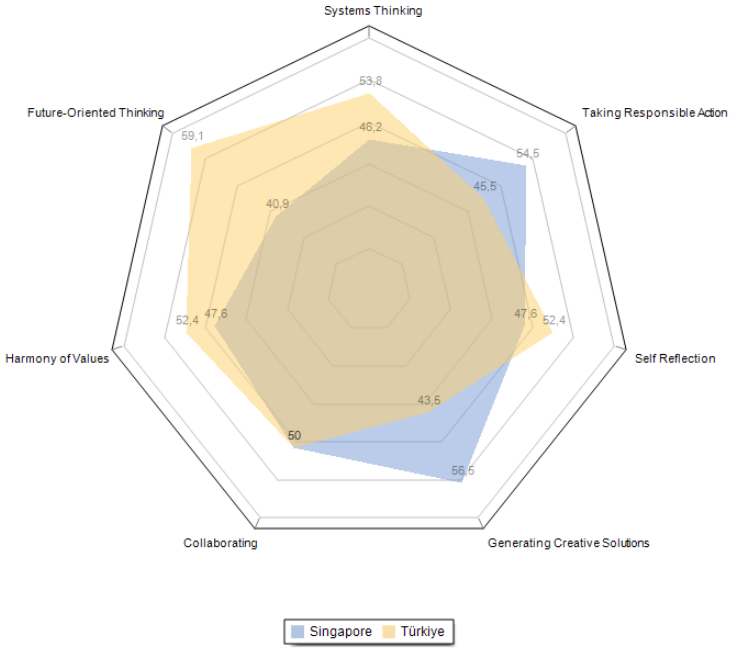


Figure 8. Thematic code distribution of Türkiye and Singapore's sustainability competencies (Visual created by the researcher using data analyzed with QDA Miner software).

Another significant finding reveals that "Self-Reflection" competence is underrepresented in both countries compared to other competencies. This indicates that metacognitive processes, such as internal awareness, self-assessment, and personal responsibility for learning should definitely be addressed in the curricula (Karaarslan & Teksöz, 2024; Silva et al., 2023). Overall, the thematic comparison of sustainability competencies via radar graphs shows areas for development in the curricula of both countries, providing valuable insights for future curriculum development processes.

3.3.2. Thematic Code Distribution of Higher-Level Cognitive Competences

A radar graph offers a meaningful comparison of higher-order thinking skills in the science curricula of both countries. As can be seen in Figure 9, cognitive processes such as "Analyzing," "Interpreting," and "Decision Making" are strongly represented in the programs of both countries.

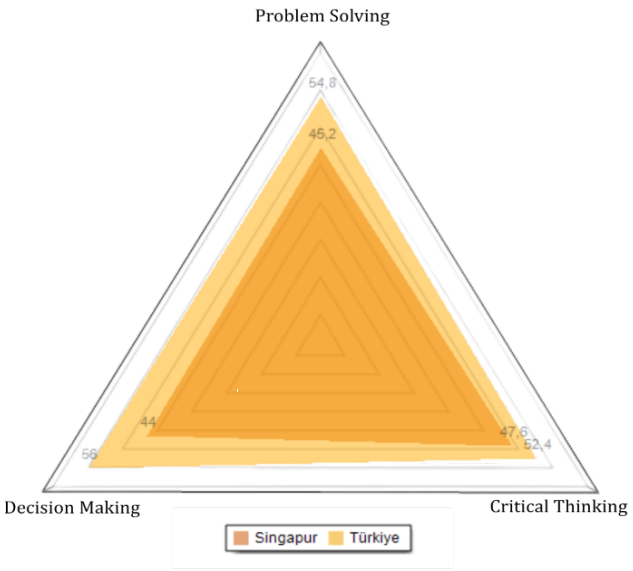


Figure 9. Thematic code distribution of Türkiye and Singapore's high-level cognitive competencies (Visual, created from data analyzed by the researcher using QDA Miner software).

This indicates that both countries aim for students to acquire knowledge as well as develop a deeper understanding through analysis, associating, and evaluation (Karalı et al., 2021). Singapore shows a higher representation in "Creative Thinking," "Problem Solving," and "Decision Making" compared to Türkiye. It indicates that Singapore places more emphasis on design-

oriented learning, creativity-based problem-solving, and alternative thinking (Gök & Sayıcı, 2022). This approach suggests that Singapore aims to raise adaptable individuals equipped with 21st-century skills (Tan et al., 2021).

On the other hand, Türkiye exhibits a high level of representation in the "Interpreting" and "Analyzing" dimensions. It might indicate that Türkiye prioritizes developing a critical perspective on information, establishing cause-and-effect relationships, and making connections between concepts (MoNE, 2025). In this regard, the Turkish curriculum emphasizes fostering students' data-driven inference and critical thinking abilities (MoNE, 2024). The graph highlights that skills such as "Complex Problem Solving" and "Synthesizing" are represented at relatively low rates in both countries. This may suggest that students' ability to handle multidimensional and interdisciplinary problems is not adequately supported in the educational programs (Ülçay, 2024). In conclusion, the graphs above shows that both Türkiye and Singapore include higher-order cognitive skills in their science programs at different levels, revealing the priorities and areas for development.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

In this study, we conducted a comparative analysis of science curricula of Türkiye and Singapore, focusing on sustainability-based problem-solving skills and higher-order cognitive competencies. The findings indicate that both countries systematically and clearly include sustainability and higher-order cognitive skills in their curricula (MOE, 2024; MoNE, 2025). However, while Singapore prioritizes practice-based and experience-oriented strategies (Tan et al., 2021), Türkiye demonstrates a strong vision at the content level but shows room for improvement in applying this vision to practices (MoNE, 2024).

The science curriculum in Singapore is structured around interdisciplinary, scenario-based, and inquiry-based approaches. This design particularly emphasizes skills such as creative solution generation, decision-making, and problem-solving (Tan, 2021). This approach is closely aligned with Singapore's educational policies focused on developing 21st-century skills (Teo & Choy, 2021). This observation strongly corroborates the global research emphasizing that education systems must translate aspirational goals into specific pedagogical practices for effective implementation. In contrast, Türkiye demonstrates a strong commitment to a holistic curriculum by incorporating competencies like systems thinking, future-oriented thinking, and values congruence at the text level, aiming for a long-term sustainability vision (MoNE, 2025). The pronounced emphasis on these macro-level competencies in the Turkish curriculum (evidenced by the highest coding rates in Future-Oriented Thinking at 59.1% and Systems Thinking at 53.7%) aligns with the global pattern of countries embedding skills primarily at the strategic, policy-driven level without robust implementation guidance. However, unless supported by teacher competencies, teaching materials, and effective assessment and evaluation systems, the impact of these advancements on classroom practices may remain limited.

Regarding higher-order cognitive skills, Singapore systematically cultivates abilities such as decision-making and problem-solving through case-based activities, multiple scenarios, and project-based learning initiatives (Gök & Sayıcı, 2022). This approach fosters a learning culture that encourages students not only to gain knowledge but also to apply it in the process of developing solutions (OECD, 2024). This confirms the international literature that the effective development and assessment of Higher-Order Cognitive Skills (HOCS) requires moving instruction beyond knowledge consolidation toward complex, authentic tasks embedded in real-world contexts (Aydın & Kıvanç, 2022; Sucuoğlu et al., 2023). In Türkiye, these skills are clearly outlined in the curriculum (MoNE, 2025); however, the lack of comprehensive implementation guidance could hinder their integration into learning processes (Ülçay, 2024). This implementation gap mirrors the structural challenge identified in many global education systems where the translation of conceptual understanding of 21st Century Skills into practical pedagogical support remains the major impediment to curriculum reform (Kim & Care, 2020).

The following suggestions are directly derived from the comparative analysis and are focused on addressing the observed gap between Türkiye's strong theoretical vision (high code counts in Systems Thinking/Future-Oriented Thinking) and the need for practice-based operationalization (where Singapore's coding rates for Decision Making/Collaboration were higher).
Curriculum Application Focus: To effectively promote sustainability and higher-level cognitive skills within the Century of Türkiye Education Model, the focus must shift from macro-level vision to scenario-based and experience-based teaching materials. This is essential to enhance abilities such as problem-solving and decision-making, where analysis showed a need for deeper integration compared to Singapore.

Targeted Teacher Professional Development (PBL/STEM): In-service training for science teachers should prioritize practical implementation of methods, specifically Problem-Based Learning (PBL), STEM approaches, and cognitive strategies. This must address the weak representation of implementation guidance observed in the curriculum text and support competencies like Collaboration (where Singapore scored 57.1% vs. Türkiye's 42.9%). Additionally, structures similar to those in Singapore that continuously support teachers' professional development should be established. Assessment Reform for HOCS: To accurately assess students' acquisition of higher-order thinking skills, alternative and non-dichotomous measurement tools that align with systemic and application-based skills should be utilized and integrated into the teaching process. This is crucial for effectively capturing complex processes like decision-making and problem-solving, rather than focusing solely on knowledge recall.

Systematic Monitoring and Evidence-Based Revision: Given the Century of Türkiye Education Model's strong theoretical foundation, small-scale pilot implementations of the updates should occur in various regions to gather empirical, practice-based evidence. Ongoing monitoring of the curriculum's effectiveness must be based on feedback from both teachers and students to

verify if the theoretical emphasis (e.g., in Systems Thinking) is translating into tangible classroom outcomes. Strategic Knowledge Exchange: Collaborative projects should be developed with successful education systems such as Singapore, specifically focusing on translating theoretical strengths into consistent pedagogical methods and structured teacher support systems. Mutual experience sharing should be facilitated through teacher exchange programs, student projects, and observed examples of curriculum implementation, particularly in structuring robust inquiry-based activities.
In conclusion, while the Century of Türkiye Education Model offers a solid theoretical framework for sustainability and higher-order thinking skills, systematic actions must be taken to strengthen this framework with practical classroom applications. Singapore's practice-based pedagogical richness can serve as a valuable guide for Türkiye. These comprehensive recommendations can make significant contributions to embedding sustainability and advanced cognitive competencies within the education system.

Research and Publication Ethics Statement

This research did not require ethical approval because it utilized secondary data and did not involve humans or animals. The authors used an AI translator in order to translate the manuscript into English. After using this AI tool, the authors reviewed and edited the content and take full responsibility for the content of the publication.

Contribution Rates of Authors to the Article

This article is a product of cooperative effort, with each author contributing according to their abilities, while the distribution of tasks and responsibilities aligned with individual circumstances and needs.

Statement of Interest
The authors confirm that there are no conflicts of interest.

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Pre-service Music Teachers' Views on the Effectiveness and Implementation of the Undergraduate Program

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ABSTRACT

This study aimed to explore the views of pre-service music teachers enrolled in the 2018 undergraduate music teacher education program, which was developed and mandated by the Council of Higher Education (CoHE, 2018), regarding the curriculum and its implementation. The research was designed as a descriptive survey, which is one of the survey models. The study group consisted of pre-service music teachers enrolled in the Music Education Programs within the Departments of Fine Arts Education at the Faculties of Education of various universities. For data collection, a questionnaire regarding the undergraduate program was administered to the participants. The instrument included both qualitative and quantitative questions related to the courses.

Some findings can be drawn from the study: Pre-service music teachers generally considered the proportion and content of the "Field Education Courses," "Pedagogical Knowledge Courses," and "General Culture Courses" in the program to be adequate. However, students believe that the program placed excessive emphasis, time, and effort on "General Culture" courses. Nevertheless, pre-service music teachers predominantly requested an increase in the hours allocated to music-related courses, and to some extent, the hours allocated to certain pedagogical skill courses.

Keywords: Vocational Music Education, Teacher Education Program, Pre-service Music Teacher

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1. INTRODUCTION

Music education is one of the fundamental disciplines in formal general education institutions. The training of music teachers, who provide instruction in this field, is conducted in alignment with the curricula of the school levels where general music education is delivered. During the Republican era, various initiatives in arts education placed particular emphasis on the preparation and training of teachers in these fields.

Regarding the efforts to train music teachers during the Republican period, Uçan (2005, p. 180) states:

> *"As a consequence of these endeavors, the view that it was imperative to establish a teacher school exclusively dedicated to training music teachers, in addition to the existing teacher schools, swiftly gained prominence and widespread acceptance within a year following the founding of the Republic. In line with this viewpoint, decisions were immediately implemented. In September 1924, the Musiki Muallim Mektebi (School of Music Teachers) was established in Ankara with the aim of training music teachers for middle schools, high schools, and teacher schools. In November 1924, the school commenced its educational activities, marking the inaugural establishment of an institution in the Turkish music education system dedicated exclusively to the training of music teachers".*

Since 1982, teachers responsible for delivering music courses have been trained in the relevant departments and divisions of the Faculties of Education affiliated with universities. This process has continued in alignment with a unified undergraduate teacher education program framework established by the Council of Higher Education (CoHE). Over the years, new undergraduate programs have also been introduced through various revisions. The CoHE has summarized this process as follows:

> *"The initial restructuring initiatives concerning Faculties of Education/Educational Sciences and undergraduate teacher education programs were executed in 1997–1998 under the auspices of the CoHE, as part of the Ministry of*

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> *National Education's (MNE) Project for the Development of National Education. Partial revisions were also made in 2006 and 2009. Subsequently, due to evolving conditions and needs, further adjustments concerning Faculties of Education were implemented in 2012 in line with structural changes in the education system. Departments, divisions, and undergraduate programs were reviewed, and necessary updates and revisions were applied. The new programs commenced implementation in the 2018–2019 academic year. In the 2018 updated teacher education undergraduate programs, courses were again categorized into three categories, consistent with prior frameworks: Field Education Courses (FEC) comprising 45–50%, Pedagogical Knowledge Courses (PKC) 30–35%, and General Culture Courses (GCC) 15–20%" (CoHE, 2018)."*

The Ministry of National Education published the "General Competencies for the Teaching Profession" in 2017. In this document, teachers' general competencies are grouped under the headings of Professional Knowledge, Professional Skills, and Attitudes and Values. Furthermore, comprehensive "Competency Indicators" have been defined under each competency area (MEB, 2017).

Davidova (2019) emphasises that today's music teachers need to be proficient in communication and building positive relationships, collaborating with parents, colleagues, musicians, composers, and experts in other fields. Davidova (2019) expresses this based on three pedagogical principles: personalisation, participation, and productivity. Davidova (2019) also states that students need to develop their creative and social skills and that 21st-century music teacher education should emphasise instructional design, team building, developing skills in new information technologies, and new ways of encouraging creativity and innovation.

Teacher training programmes at education faculties are organised to develop these competencies in prospective teachers. This process is implemented through centrally developed common compulsory teacher training programmes. In this context, the most recent common compulsory teacher training programmes developed in 2018 are still being implemented in some departments.

It is well known that CoHE initiated the authority delegation process with its circular dated August 18, 2020. Within this process, a new practice was introduced, allowing each university to have the authority to prepare its own teacher education undergraduate programs (CoHE, n.d.). In the 2022–2023 academic year, each Faculty of Education began revising their music teacher education undergraduate programs in accordance with this framework, and they have partially implemented these revisions.

This research focuses on the views and opinions of pre-service music teacher candidates regarding the undergraduate programme in which they are receiving their education. Pre-service music teacher training programmes aim to equip prospective music teachers with the knowledge and skills necessary to teach music in classrooms (Ballantyne and Packer, 2010).

Collecting and describing prospective teachers' views on the undergraduate programme also implies evaluating the programme from the perspective of its stakeholders. 'Programme evaluation is the process of collecting data on the effectiveness of educational programmes through observation and various measurement tools, comparing and interpreting the data obtained with criteria that are indicators of the programme's effectiveness, and making decisions about the programme's effectiveness' (Erden, 1998, p.10). Sönmez and Alacapınar (2015) state that because education is an open system, the evaluation of the learner can also be carried out according to the elements and characteristics of this system, and they describe various programme evaluation models. One of these models, Stufflebeam's Context, Input, Process, Product Model (CIPP), emphasises that evaluations must be useful, applicable, appropriate, and accurate. It also highlights that this model enables evaluators and target audiences to design, implement, and use sound evaluations. Thus, it is stated that the model is designed to help continuously improve services and outcomes (Stufflebeam, 1999). In another evaluation model, Provus's Difference Evaluation Model (DEM), Provus (1971-1972, pp. 41-42) states that the model consists of three main programme design dimensions. These are Inputs (research and conditions), Processes (threats and operations), and Outputs (products and performance). It emphasises that, as predicted in the entire programme model, if the output is linked to the input, an evaluation based on the resulting difference can be made, indicating inconsistent information about the programme's success or failure.

Examples of studies on the evaluation of music teacher training degree programmes include Huh and Kim (2020), Horowits (2024), Blankson (2022), Öztürk (2022), Albuz (2004), and Sönmezöz (2016).

In this research, the views of pre-service music teachers, who were enrolled in the mandatory 2018 updated undergraduate program in music teacher education and were in their final year during the year of the study, were analyzed regarding this mandatory program.

1.1. Significance of the Study

Undergraduate programs geared towards the teaching profession have generally been implemented across all faculties of education with centrally determined content and standards. In recent years, the criteria guiding program development have

been the "Turkish Qualifications Framework", established by the Vocational Qualifications Authority under the Ministry of Labor and Social Security, and the "General Competencies for the Teaching Profession" determined by the Ministry of National Education.

The effectiveness of an educational program can only be assessed once its implementation outcomes are obtained. Program implementation occurs through the interactions of multiple variables and stakeholders. Students, as key participants in the program, represent one of its most important stakeholder groups. Their views, expectations, and the extent to which the program fulfills these expectations provide crucial data for its operation and further development.

Therefore, students' views on undergraduate programs are important for understanding the meaning and value of the program from the students' point of view. Furthermore, ascertaining students' perceptions of their own success in developing teaching competencies constitutes a significant domain of research. This aspect has gained increased importance, especially since the adoption of the "delegation of authority" approach, which allows each university to organize its programs independently rather than adhering strictly to a centralized framework.

This study analyzed students' views on the mandatory 2018 undergraduate music teacher education program, which was implemented before the delegation of authority. Accordingly, the study aimed to examine, from the perspective of pre-service music teachers, certain implications concerning the rationale and appropriateness of granting universities the authority to organize their own undergraduate programs.

In general terms, this study makes sense and important because:
1. Determining what students think about the music teaching degree programme established by central regulations,
2. Identifying students' complaints, requests and suggestions regarding the programme's content and implementation conditions,
3. Enabling the generalisation of the views of university students from different regions of Turkey on this subject,
4. Being usable in justifications for the revision of degree programmes and their implementation conditions,
5. Having the potential to serve as an important data source for new regulations arising from the delegation of authority.

1.2. Purpose of the Study

This study aimed to examine the views of pre-service music teachers, who are key stakeholders of the implemented music teacher education undergraduate programs, regarding the mandatory 2018 undergraduate program and its implementation.

1.3. Problem of the Study

In line with this purpose, the six research objectives of this study are to examine the views of pre-service music teachers regarding: (1) the proportions and content of all courses, (2course delivery, (3) the content of Field Education Courses, (4) the content of Pedagogical Knowledge Courses, (5) the Teaching Practice course, and (6) the content of General Culture Courses within the mandatory 2018 updated undergraduate music teacher education program
In line with these objectives, the study addresses the following research questions:

1.3.1. Sub-problems of the study

First Research Question: What are students' views on the proportions and content of all courses in the undergraduate program?
Second Research Question: What are students' views on course delivery in the undergraduate program?
Third Research Question: What are students' views on the content of "Field Education Courses?"
Fourth Research Question: What are students' views on the content of "Pedagogical Knowledge Courses"?
Fifth Research Question: What are students' views on the "Teaching Practice" course?
Sixth Research Question: What are students' views on the content of "General Culture Courses"?

2. METHODOLOGY

2.1. Research Design

This study is a descriptive survey research and employs the general survey model, which is one of the survey models.

Survey research refers to studies in which participants' views or characteristics, such as interests, skills, abilities, attitudes, and similar traits, regarding a particular topic or event are identified, and which are generally conducted with larger samples compared to other types of research (Büyüköztürk et al., 2022, p. 184). The general survey model, on the other hand, involves survey arrangements carried out on the entire population or on a sample drawn from it, within a population consisting of a large number of elements, with the aim of reaching a general conclusion about that population (Karasar, 2022, s.111).

Within this model, the study described the perspectives, opinions, and suggestions of pre-service music teachers regarding the content of the 2018 undergraduate program in which they were enrolled and the way the program was implemented. The necessary approvals have been obtained from the ethics committee prior to the implementation of this study.

2.2. Study Group

The research study group comprises 105 senior pre-service music teachers enrolled in the Departments of Fine Arts Education at the Faculties of Education of Trabzon University, Giresun University, Atatürk University, Ondokuz Mayıs University, Gazi University, Onsekiz Mart University, and İnönü University during the 2024–2025 academic year. The pre-service teachers left some of the multiple-choice questions unanswered and did not provide complete responses in the survey section. As a result, while 105 participants provided responses to the general survey items, some specific items received responses from only 58–65 participants. Fourth-year students were chosen for this study due to the revision of curriculum at certain institutions following the "delegation of authority". During the research, the existing fourth-year students were still following the 2018 undergraduate curriculum.

When selecting the study group for the research, inspiration was drawn from the 'Similarity Sampling Method,' one of the 'Purposive Sampling' types under the heading 'Non-Random Sampling Methods.' "This sampling method is defined as selecting a homogeneous subgroup or situation from the population that is relevant to the research problem and conducting the study within this subgroup" (Büyüköztürk et al., 2022, pp. 91–94). Within this context, given that the 2018 undergraduate program in music teacher education is uniformly implemented throughout all music education departments, it was presumed that the opinions forming the data share the same purpose; therefore, the sample was deemed homogeneous.

2.3. Data Collection

The data for this study were acquired using a opinion form. The opinion form was designed to focus on describing students' views on the types, relative weights, effectiveness, and delivery of the courses in the undergraduate programs under investigation. The form consisted of semi-structured items designed for this purpose. Copies of the opinion form were made for each student in the study group, and they were asked to complete it voluntarily by writing their opinions in the spaces provided under each item.

The opinion form included the names and proportions of all courses in the undergraduate program, specifically the "Field Education Courses", "Pedagogical Knowledge Courses", and "General Culture Courses". In addition, items related to the delivery of these courses were included, as well as items specifically designed to capture students' views on the Teaching Practice courses. The prepared opinion form was initially submitted to five faculty members who are experts in the field, and revisions were made based on their feedback. The final version was then reviewed by an additional field expert and finalized. Subsequently, it was administered to the students in the study group during the spring semester of the 2024–2025 academic year.

2.4. Data Analysis

For the quantitative data obtained from the survey responses, percentage calculations and arithmetic mean computations were performed, whereas content analysis was conducted for the qualitative data. Valid percent has been used in items with Likert-type response options, and the percentage values provided by the programme have been used in the tables. On the other hand, only frequency distribution has been used in items with qualitative characteristics where more than one option is marked. In these questions, the number of selections is important; therefore, percentage values have not been used as more than one option can be selected.

"Percentage refers to a point value used to determine the position of a given score relative to other scores within a distribution. The percentage of a score indicates its position within the distribution, showing the proportion of scores that are higher and lower on the same scale" (Karasar, 2022, s. 260). Content Analysis implies the methodical evaluation of written and verbal materials, converting non-verbal documents into quantitative data (Balcı, 1997, p. 230). In this framework, the quantitative responses provided by students on the feedback form were converted into percentages, while the qualitative responses were categorized and coded.

Two approaches were followed in qualitative data analysis. Frequency determination and common expression identification were performed, excluding items with quantitative characteristics and Likert-type response options. For items requiring students to indicate whether they found courses good, bad, insufficient, or excessive, only the frequency distribution was determined by keeping a tally sheet. As more than one option could be marked in these questions, the intensity was determined. In open-ended items containing opinions, a summary of the written responses was extracted. Expressions referring to the same topic were grouped under the same heading. The responses written by the students were summarized briefly, such as under a topic heading (theme), tabulated, and frequency calculations were performed on these data. During this process, the researchers worked independently and met once a week to compare their findings. The outputs obtained were also read by two academics who were experts in the field to ensure expert review (peer review). According to Saldańa (2021, p.53), some sample studies

require discussion during the coding process. This discussion provides researchers with suggestions and cautionary advice. In this process, the evaluation by experts (peer review) is important in terms of the accuracy, consistency, and comprehensibility of the work, and experts examine the research from its methodology to its results (Arslan, 2022; Tutar, 2022).

During the quantitative analysis phase, procedures were first carried out to measure the validity and reliability of the multiple-choice items. Cronbach's Alpha coefficient was computed for all quantitative items included in the analysis. The Cronbach's Alpha value was found to be 0.87, indicating high reliability of the items. In addition, item-total correlations, exploratory factor analysis and Alpha coefficients for individual items were also computed. Detailed examination was conducted with the help of these item analyses, and the results are presented in the analysis table below. Kılıç (2016) stated that the Alpha coefficient determines the overall reliability and suggested that it should be above 0.70. Similarly, Taber (2018), in a study compiling various views, considered a level of 0.70 or higher sufficient for reliability. Marianti et al. (2023) recommended a minimum item-total correlation of 0.30 for the confidence interval and discriminative power of items. Additionally, Büyüköztürk (2004) and Tavşancıl (2014) proposed lower limits between 0.20 and 0.30 for this value and for the lower limits of factors in surveys and emphasized that the result should be positive.

Table 1
Item Analyses

Course Proportions and Contents				**Course Delivery**				**Teaching Practice**			
Items	**r**	**α**	**a_{ij}**	**Items**	**r**	**α**	**a_{ij}**	**Items**	**r**	**α**	**a_{ij}**
M_1	0,44	0,86	0,77	M_A1	0,48	0,88	0,72	D_1	0,70	0,90	0,45
M_2	0,38	0,87	0,66	M_A2	0,45	0,87	0,66	D_2	0,65	0,87	0,65
M_3	0,47	0,86	0,65	M_A3	0,65	0,87	0,70	D_3	0,68	0,86	0,60
M_4	0,38	0,86	0,45	M_A4	0,68	0,87	0,75	D_4	0,55	0,86	0,62
M_5	0,46	0,86	0,66	M_A5	0,55	0,86	0,55	D_5	0,48	0,86	0,50
M_6	0,55	0,85	0,78	M_A6	0,58	0,86	0,65				
M_7	0,51	0,86	0,60	M_A7	0,70	0,86	0,61				
M_8	0,49	0,86	0,61	M_A8	0,58	0,86	0,48				
M_9	0,48	0,86	0,70	M_A9	0,55	0,87	0,65				
				M_A10	0,45	0,87	0,60				
				M_A11	0,48	0,88	0,75				
				M_A12	0,44	0,86	0,70				
				M_A13	0,45	0,86	0,78				
				M_A14	0,39	0,86	0,58				
				M_A15	0,44	0,86	0,62				
				M_A16	0,45	0,86	0,55				
				M_A17	0,45	0,87	0,56				
				M_A18	0,48	0,87	0,55				
				M_A19	0,52	0,87	0,78				
				M_A20	0,66	0,87	0,71				
				M_A21	0,67	0,86	0,56				
				M_A22	0,65	0,86	0,60				
Tot. Var.	%74,7										
KMO	0,82										
X^2 - p	2432,4 - ,000										

On examining the table, it is apparent that the item analyses generally meet or exceed the lower thresholds (0.30 for item-total correlations and 0.70 for Cronbach's alpha). The Alpha values for the items ranged between 0.86 and 0.90, indicating a high level of reliability. Furthermore, the item-total correlation coefficients ranged from 0.38 to 0.70, suggesting that the items possess adequate and good discriminative power. According to the results of the exploratory factor analysis applied to the items, the factor loadings of the items ranged between 0.45 and 0.78. The total variance explained by the questionnaire was found to be 74.7%, while the KMO sample adequacy was 0.82. The Bartlett's sphericity data for the questionnaire was also found to be significant at the p<.05 level. Accordingly, it was understood that the quantitative part of the questionnaire adequately explained each factor and met sufficient adequacy norms.

After confirming that the quantitative items of the measurement instrument met the necessary conditions for validity and reliability, frequency and percentage calculations were conducted for each item. Total scores for the items were computed to perform item analyses. Percentage distributions for each item were then determined to construct the findings. Finally, the items were organized into a table according to their distributions and order within the measurement instrument.

3. FINDINGS

In the findings section, firstly the quantitative survey data were presented and interpreted by using tables. For other response types and qualitative responses, tables were also prepared, but frequencies were reported instead of percentages. Distributions

for questions where multiple courses could be selected were tabulated as frequencies. Some qualitative responses included percentage representations. Overall, the findings are presented in accordance with the order of the objectives.

3.1. Findings Related to the First Research Question

The first research question of the study is: "What are the students' views on the proportions and content of all courses in the undergraduate program?" Accordingly:

Table 2.
Pre-Service Music Teachers' Views on the Proportions and Content of All Courses in the Undergraduate Program

	Items	Yes	Partially	No
1	Do you consider the weight of Field Education Courses to be sufficient?	%53,3	%21	%25,7
2	Do you consider the weight of Pedagogical Knowledge Courses to be sufficient?	%56,2	%15,2	%28,6
3	Do you consider the weight of General Culture Courses to be sufficient?	%62,9	%15,2	%21,9
4	Do you think that excessive importance, time, and effort are given to Field Education Courses?	%19	%24,8	%56,2
5	Do you think that excessive importance, time, and effort are given to Pedagogical Knowledge Courses?	%37,1	%21	%41,9
6	Do you think that excessive importance, time, and effort are given to General Culture Courses?	%41,9	%23,8	%34,3
7	Do you consider the elective courses in the undergraduate program to be necessary	%13,3	%32,4	%54,3
8	Do you consider the elective courses in the undergraduate program to be sufficient?	%35,2	%25,7	%39
9	Do you think that the courses in the undergraduate program should be organized according to branches such as preschool music teacher, primary school music teacher, middle school music teacher, and high school music teacher?	%61,9	%19	%19

On examining the students' views on the proportions and content of courses in the undergraduate program, it can be stated that their positive and negative tendencies varied across the items.

The pre-service music teachers in the study group consider the proportions and content of Field Education Courses, General Culture Courses, and Pedagogical Knowledge Courses to be "sufficient". Furthermore, the participants consider the emphasis, time, and effort allocated to Field Education Courses and Pedagogical Knowledge courses to be sufficient, whereas they believe that excessive emphasis, time, and effort are devoted to General Culture courses in the program.

Regarding the sufficiency of elective courses, the distribution of responses was relatively balanced, with participants considering them "sufficient"; however, a considerable proportion (54.3%) perceived these courses as "unnecessary." For the last item in the relevant section, it observed that 61.9% of the pre-service music teachers responded "Yes." Based on this result, the view that the undergraduate program should be branched to represent preschool, primary, middle, and high school levels is prevalent.

3.2. Findings Related to the Second Research Question

The second research question of the study is: "What are the students' views on the delivery of courses in the undergraduate program?" Accordingly, in this section, pre-service music teachers were first asked: "What are your thoughts on the adequacy of the technical infrastructure and classrooms for course delivery?" The students' responses are presented on the table below.

Table 3.
Views on the Adequacy of Classroom Numbers and Technical Infrastructure

Items	Yes	Partially	No
Technical Infrastructure	%24	%12	%64
Number of Classrooms	%20	%10	%70

Examination of the table revealed that the participants perceived both the number of classrooms and their technical infrastructure as significantly inadequate. The distributions of 70% and 64% for the "No" responses indicated this situation, while the other response options remained in the range of 10–20%.

In another item of the survey form, the study group was asked whether they considered the number of instructors to be sufficient. Accordingly:

Table 4.
Views on the Adequacy of the Number of Instructors

Items	Yes	Partially	No
Do you consider the number of instructors for these courses to be sufficient?	%46,7	%20	%33,3

The students in the study group expressed a relatively positive view regarding the adequacy of the number of instructors managing the undergraduate program. However, a considerable proportion also indicated that the number is 'insufficient' (33.3% No, 20% partially), suggesting that a notable share of students perceive it as inadequate.

In the subsequent section of the feedback form, students were asked to evaluate the instructors' expertise in the courses they manage in the undergraduate program not personally, but "in general." Accordingly:

Table 5.
Students' Views on the General Expertise of Instructors Teaching "Field Education Courses," "Pedagogical Knowledge," and "General Culture" Courses

Field Education Courses					
	Very Good	**Good**	**Moderate**	**Insufficient**	**Very Insufficient**
Technical-Theoretical Knowledge Level:	%31,4	%38,1	%19	%3,8	%7,6
Familiarity with and Use of Technology in the Course:	%17,1	%39	%26,7	%13,3	%3,8
Effective Lesson/Classroom Management:	%26,7	%34,3	%29,5	%5,7	%2,9
Ability to Employ Different Teaching Methods and Techniques:	%21	%35,2	%28,6	%13,3	%1,9
Effective Communication with Students:	%21,9	%38,1	%25,7	%10,5	%3,8
Ability to Relate One's Course to the Objectives of the Undergraduate Program:	%19	%36,2	%36,2	%5,7	%2,9

Ability to Connect Course Content with Daily Life	%17,1	%39	%31,4	%7,6	%4,8

Pedagogical Knowledge

	Very Good	Good	Moderate	Insufficient	Very Insufficient
Technical-Theoretical Knowledge Level:	%17,1	%43,8	%24,8	%11,4	%2,9
Familiarity with and Use of Technology in the Course:	%10,4	%41	%32,4	%12,4	%3,8
Effective Lesson/Classroom Management:	%12,4	%37,1	%31,4	%15,2	%3,8
Ability to Employ Different Teaching Methods and Techniques:	%12,4	%31,4	%31,4	%20	%4,8
Effective Communication with Students:	%12,4	%32,3	%40	%10,5	%4,7
Ability to Relate One's Course to the Objectives of the Undergraduate Program:	%14,2	%32,3	%35,4	%14,3	%3,8
Ability to Connect Course Content with Daily Life	%12,4	%37,1	%32,4	%11,4	%6,7

General Culture

	Very Good	Good	Moderate	Insufficient	Very Insufficient
Technical-Theoretical Knowledge Level:	%15,2	%39	%34,3	%7,6	%3,8
Familiarity with and Use of Technology in the Course:	%11,4	%35,2	%41	%9,5	%2,9
Effective Lesson/Classroom Management:	%9,5	%36,2	%38,1	%12,4	%3,8
Ability to Employ Different Teaching Methods and Techniques:	%11,4	%33,3	%39	%11,4	%4,8
Effective Communication with Students:	%12,4	%30,4	%40	%12,4	%4,8
Ability to Relate One's Course to the Objectives of the Undergraduate Program:	%12,4	%31,4	%37,1	%12,4	%6,7

Ability to Connect Course Content with Daily Life	%8,6	%38,1	%34,2	%14,3	%4,8

On examining students' views regarding course delivery and, in this context, the instructors' overall expertise, we observe that responses at the "good" and "moderate" levels were more prevalent. Students generally perceive the instructors' expertise during the Field Education Courses phase as "Good." The highest percentages are observed in the areas of "Technical-Theoretical Knowledge Level," "Effective Lesson and Classroom Management," and "Effective Communication with Students." However, it is noteworthy that some students rated the items "Effective Communication with Students," "Familiarity with and Use of Technology in the Course," and "Ability to Use Different Teaching Methods and Techniques" as "Insufficient."

One can state that students generally exhibited a positive tendency in their responses regarding Pedagogical Knowledge courses. Under this heading, students indicated that instructors were particularly "good" in terms of "Familiarity with and Use of Technology in the Course" and "Effective Lesson/Classroom Management." Meanwhile, items such as "Effective Communication with Students" and "Ability to Relate One's Course to the Objectives of the Undergraduate Program" show a tendency toward "moderate" level.

Looking at the responses regarding General Culture courses, the data revealed that a similar distribution of views exists. Under this heading, items such as "Familiarity with and Use of Technology in the Course," "Effective Communication with Students," and "Ability to Employ Different Teaching Methods, Approaches, and Techniques" stand out with responses at a "Moderate" level. Similarly, the relatively "Inadequate" option is notable in the item "Ability to Relate Course Content to Daily Life."

3.3. Findings Related to the Third Research Question

The third research question of the study is: "What are the students' views regarding the content of Field Education Courses?" Accordingly, in the feedback form, students were asked:

Whether there are any courses within the Field Education Courses whose hours they think should be increased,
Whether there are any courses whose hours they think should be decreased,
Whether there are any courses they consider "optional" or "unnecessary" within the Field Education Courses, and
Which courses within the Field Education Courses do they believe contribute the most to their teaching competencies.
The responses were arranged from the highest to the lowest frequency. Accordingly:

Table 6.
Students' Views on the Class Hours and Program relevance of Field Education and Elective Courses

Field Education Courses perceived to need more class hours	**N**
Piano Education	75
Harmony and Accompaniment	69
Western Music Theory and Practice	67
Individual Instrument Education	66
Orchestra – Chamber Music	57
Vocal Training	49
Polyphonic Choir	41
Elective Courses perceived to need more class hours	**N**
Music Ensemble Conducting	23
Composition Techniques for Educational Music	22
Western Music Theory and Practice	20
Field Education Courses Within Music Education Perceived to Require Fewer Class Hours	**N**
Music Culture	20
History of Turkish Music	18
Elective Courses Perceived to Require Fewer Class Hours	**N**
Popular Music and Applications	12
Field Education Courses Within Music Education That Could Be Omitted from the Curriculum	**N**
Orff Instruments	20
Elective Courses That Could Be Omitted from the Curriculum	**N**
Popular Music and Applications	17
Field Education Courses Contributing the Most to Teaching Profession Competencies	**N**
Individual Instrument Instruction	72
Piano Education	65

Harmony and Accompaniment	54
Western Music Theory and Practice.	50
Orchestra – Chamber Music	46
Vocal Training	44
Elective Courses Contributing the Most to Teaching Profession Competencies	**N**
Composition Techniques for Educational Music	27
Early Childhood Music Education	26

On examination of the table, it was suggested that some Field Education courses within the music education curriculum, which might be considered important, are perceived by students as having insufficient class hours. The frequency counts revealed that within the Field Education courses, "Individual Instrument Instruction, Western Music Theory and Practice, Orchestra–Chamber Music, Piano Education, Vocal Training, and Harmony and Accompaniment" were the most frequently indicated. Among the elective courses, "Music Ensemble Management, Composition Techniques for Educational Music, and Western Music Forms and Styles" were similarly highlighted.

According to the table, the majority of the students participating did not show a predominant tendency regarding the reduction of course hours. Although some selections were observed for courses such as "History of Turkish Music and Music Culture," most participants did not demonstrate a clear tendency for this item. Only a small number of responses indicated courses that should be reduced, while the majority of students left this item unanswered.

When asked about courses that could be omitted from the curriculum, it was observed that, aside from two courses, there was no significant tendency. Among the Field Education courses, "Orff Instruments," and among the elective courses, "Popular Music and Applications" were relatively more frequently indicated. However, it is noteworthy that most students did not make any selections for this item when considering the total number of participants. Apart from these two courses, the frequency counts were low.

In this table, students were finally asked to identify the Field Education courses that contribute the most to teaching competencies. Among the Field Education courses in music education, "Individual Instrument Instruction, Orchestra–Chamber Music, Western Music Theory and Practice, Piano Education, Harmony and Accompaniment, and Vocal Training" were selected, while among the elective courses, "Composition Techniques for Educational Music" and "Early Childhood Music Education" were indicated. Although some responses were also given to other courses, these were the most prominent and were perceived as the courses making the greatest contribution.

3.4. Findings Related to the Fourth Research Question

The fourth research question of the study: "What are the students' opinions regarding the course contents of the Pedagogical Knowledge courses?"

Accordingly, in the opinion form, students were asked:
Whether there were any courses within the Pedagogical Knowledge courses that they thought should have more class hours,
Whether there were any courses they thought should have fewer class hours,
Whether there were any courses they considered could be omitted from the curriculum, and
Which courses they believed contributed the most to their teaching competencies.
The responses were ranked from the highest to the lowest frequency. Accordingly:

Table 7.
Students' Views on the Course Hours and Curriculum Relations of Field Education and Elective Pedagogical Knowledge Courses

Courses within Pedagogical Knowledge considered to require more class hours	**N**
Classroom Management	28
Teaching Practice	26
Educational Psychology	23
Elective Pedagogical Knowledge Courses considered to require more class hours	**N**
Drama in Education	17
Courses within Pedagogical Knowledge considered to require fewer class hours	**N**
Philosophy of Education	29
Sociology of Education	27
History of Turkish Education	23
Inclusive Education	22

Critical and Analytical Thinking	21
Elective Pedagogical Knowledge Courses considered to require fewer class hours	**N**
Museum Education	32
Project Preparation in Education	23
Courses within Pedagogical Knowledge considered to be omitted from the curriculum	**N**
Philosophy of Education	23
Microteaching	20
Elective Pedagogical Knowledge Courses considered to be omitted from the curriculum	**N**
Museum Education	39
Project Preparation in Education	27
Courses within Pedagogical Knowledge considered to contribute the most to teaching competencies	**N**
Classroom Management	34
Teaching Practice	31
Principles and Methods of Teaching	22
Educational Psychology	20
Special Education and Inclusion	20
Elective Pedagogical Knowledge Courses considered to contribute the most to teaching competencies	**N**
Drama in Education	32

According to the data presented in the table, students partially expressed a desire for an increase in class hours for Field Education courses such as "Classroom Management", "Teaching Practice", and "Educational Psychology", as well as for the elective course "Drama in Education". Although there was not a high frequency of responses, a partial demand for these courses is noticeable.

Regarding the question on whether class hours should be reduced in "Pedagogical Knowledge" courses, students indicated a few courses, albeit at a relatively low frequency. Among the Field Education courses, "Philosophy of Education", "Sociology of Education", "History of Turkish Education", "Critical and Analytical Thinking", and Inclusive Education were primarily marked, while among the elective courses, "Museum Education" and "Project Preparation in Education" were notable. Although some students did not make any choices, a partial tendency for these courses can be observed.

According to the table, the tendency regarding courses that students considered could be omitted from the Pedagogical Knowledge curriculum was low. Among the Field Education courses, "Philosophy of Education" and Microteaching were minimally indicated. While some students did not make any selections, a small number of students marked the elective courses "Museum Education" and "Project Preparation in Education".

Examining the table revealed that within the Pedagogical Knowledge courses, students marked "Teaching Practice", "Classroom Management", "Principles and Methods of Teaching", "Educational Psychology", and "Special Education and Inclusion" as the courses contributing the most to their teaching competencies. Among the elective courses, "Drama in Education" was the most frequently indicated. Although not marked very intensively, students associate these courses with their own music field and professional experience.

3.5. Findings Related to the Fifth Research Problem

The fifth sub-problem of the study is formulated as: "What are the students' opinions regarding the Teaching Practice course?" Accordingly:

Table 8.
Pre-Service Music Teachers' Views on the "Teaching Practice" Course in the 2018 Music Teaching Undergraduate Program

Items	Yes	Partially	No
Do you consider the course hours and practice hours of the Teaching Practice course to be sufficient?	%54,5	%17,2	%28,3
Do you think your supervising teacher provided you with adequate guidance?	%48,5	%26,2	%25,3

Do you think your supervising faculty member provided you with adequate guidance?	%48,5	%25,2	%26,3
Do you consider it sufficient that the Teaching Practice course is offered in two semesters during the final year?	%45,5	%17,1	%37,4
Do you consider the overall training you received in your undergraduate program to be sufficient for the Teaching Practice course?	%42,4	%23,3	%34,3

Overall, students exhibit a generally positive tendency regarding the sufficiency of the Teaching Practice course. Although some students focused on the "partially" option, the distribution of positive responses at 45% or higher for almost every item supports this finding. Course hours, guidance from the supervising faculty members, and guidance from the supervising teacher are the items showing the highest levels of positive responses. However, the proportion of students who do not consider it sufficient that the course is offered in two semesters during the final year (37.4%) and those who do not believe that the overall training received in their undergraduate program is adequate for the Teaching Practice course (34.3%) is notable and warrants further consideration.

Table 9.
Students' Views on the Problems Experienced in the Teaching Practice Course

Reported Problems	**N**
Dissatisfaction with the supervising teacher (e.g., undervaluing students, lack of motivation)	30
Difficulties in classroom management	25
Low preparedness levels of students	20
Problems during the feedback and correction process	17
Insufficient physical condition of the school	1
Time management issues related to adjusting class duration	8
Assignments outside of the defined responsibilities	5
Transportation difficulties to the practice school	2
Feeling of being closely monitored during the practice	2

Students generally reported the problems they experienced in the Teaching Practice course at the level of the course teacher and the classroom. Some students also focused on external factors such as physical conditions, additional assignments, and transportation, as well as internal factors like class duration and the feeling of being monitored. However, the issues most frequently emphasized were related to student-centered difficulties in the school, including problems in providing feedback and corrections, low readiness levels of school students, and challenges in classroom management, as well as the perceived lack of attention from the supervising teacher.

Table 10.
Students' Views on the Implementation of the Teaching Practice Course

Adherence to the Curriculum in the Teaching Practice Course	**N**
The curriculum is followed	17
The curriculum is not followed	12
The curriculum should be flexible	4
Opinions on Class Size in the Teaching Practice Course	
Classes are overcrowded for practice	18
The number of classes is sufficient for practice	32
Opinions on Instructional Elements in the Teaching Practice Course	
Advantages	
Highly beneficial for classroom management skills	25
Provides general teaching experience	12
Offers the opportunity to get to know students closely	10
Allows for the development of teaching methods and techniques	5
Enhances mastery of content and confidence during lesson delivery	3
Disadvantages	
Problems encountered during preparation for the practice course	28
Issues related to class scheduling	15

Of the 33 students who responded to the question regarding adherence to the music curriculum in the Teaching Practice course, a partial majority (52%) indicated that the curriculum was followed, while 36% stated that it was not followed. Four students who expressed differing opinions suggested that the program should be flexible. Pre-service music teachers considered the number of students in the classes where they conducted their practice to be appropriate. Of the 50 students who responded to this question, 64% indicated that the class size was "appropriate," while 32% found the classes to be "overcrowded".

In their responses regarding the most instructive aspects of the positive and negative experiences encountered in the Teaching Practice course, pre-service music teachers highlighted classroom management and teaching experience. Other advantages included gains in teaching skills and opportunities to get to know students, while the main disadvantages involved problems encountered during the preparation stage and difficulties in managing class time.

3.6. Findings Related to the Sixth Research Problem

The sixth research problem of the study is formulated as: "What are the students' opinions on the content of General Culture courses?"

In the feedback form, students were asked regarding this item whether:
There were any General Culture courses for which they believed the course hours should be increased,
There were any General Culture courses for which they believed the course hours should be decreased,
There were any General Culture courses they considered "optional" or "could be omitted" from the program, and
Which General Culture courses they believed contributed most to their teaching competencies.
The responses were arranged in descending order of frequency. Based on this.

Table 11.
Students' Views on the Class Hours and Curriculum Relevance of Field Education and Elective General Culture Courses

General Culture Courses Considered to Require More Class Hours	**N**
Foreign Language	20
Elective General Culture Courses Considered to Require More Class Hours	**N**
Art and Aesthetics	11
General Culture Courses Considered to Require Fewer Class Hours	**N**
Community Service Practices	27
Foreign Language	21
Elective General Culture Courses Considered to Require Fewer Class Hours	**N**
Traditional Turkish Handicrafts	21
General Culture Courses That Could Be Omitted from the Curriculum	**N**
Community Service Practices	17
Elective General Culture Courses That Could Be Omitted from the Curriculum	**N**
Traditional Turkish Handicrafts	**27**
Science and Research Ethics	**21**
Addiction and Addiction Prevention	**21**
Art and Aesthetics	**21**
General Culture Courses Contributing Most to Teaching Competencies	**N**
Community Service Practices	**25**
Elective General Culture Courses Contributing Most to Teaching Competencies	**N**
Art and Aesthetics	**39**
History of Turkish Art	**32**

The pre-service music teachers in the study group reflected a certain indecisiveness in their opinions regarding the General Culture and Elective General Culture courses in their undergraduate program. In their opinions on increasing class hours within the General Culture courses, the majority of students believe that the Foreign Language course should have more hours, while among the elective General Culture courses, Art and Aesthetics is considered in need of additional class hours.

Responses indicated that Community Service Practices and Foreign Language should have reduced class hours within the General Culture curriculum, while students suggested a reduction in hours for Traditional Turkish Handicrafts among the

elective General Culture courses. The courses that the students in the study group considered as "could be omitted" from the curriculum included "Community Service Practices" among the Field Education General Culture courses, and Traditional Turkish Handicrafts, Science and Research Ethics, Addiction and Addiction Prevention, and Art and Aesthetics among the elective General Culture courses.

Pre-service music teachers also indicated the courses they believed contributed most to their teaching competencies among the General Culture courses: from the Field Education courses, the "Community Service Practices" course, and from the elective courses, "Art and Aesthetics" and "History of Turkish Art." Although not selected by a large number of students, these three courses were considered important in terms of their contribution to the profession within the General Culture curriculum.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

4.1. Results and Discussion

Pre-service music teachers enrolled in the 2018 Music Teaching Undergraduate Program generally consider the proportion and content of the program's "Field Education Courses", "Pedagogical Knowledge Courses", and "General Culture Courses" to be "adequate."

Pre-service music teachers consider the emphasis, time allocation, and effort devoted to "Field Education Courses" and "Pedagogical Knowledge" courses to be "adequate", whereas they believe that "General Culture" courses receive excessive attention, time, and effort within the program (Yes 41.9% and partially 23.8%). This finding indicates that pre-service music teachers' adoption of the General Culture courses in the undergraduate program is not at a sufficient level. This may be due to a more active focus on field-oriented courses and a hidden curriculum perspective in which the technical aspects of music itself are prioritized. In his study, Yüksel (2007) found that having teaching staff who are constantly present in the main field of study for subject education courses, while having teaching staff who are from outside the main field of study for teacher training courses and who only attend classes one day a week, can activate a certain implicit programme in favour of subject education. In his study, Eldemir (2011) found that in institutions training teachers in the arts, the problem of subject courses taking precedence over other content categories to a certain extent and courses in other content categories being perceived as less important still persists.

Although students consider the elective courses in the program to be quantitatively "sufficient," they largely perceive them as "unnecessary" (Unnecessary 54.3%, partly unnecessary 32.4%). This finding indicates that pre-service music teachers are not sufficiently convinced of the importance and necessity of the elective courses in the undergraduate program. This may be due to the perception that elective courses should be positioned slightly outside the programme, that elective courses carry too much weight, or that elective courses do not fully respond to student interests and needs.

In Gökçe's (2019) study, participants were asked about their views on the weighting of field courses and educational sciences courses. She found that the majority of the study group believed that Field Education courses should have greater emphasis, whereas they considered the teaching profession knowledge courses to be not particularly beneficial.

With a participation rate of 61.9%, prospective music teachers indicated that the undergraduate program should allow for grade-level specialization, representing preschool, primary, middle, and high school levels. This finding suggests that the candidates perceive music teaching as a discipline that requires and supports specialization within the field.

Gökçe (2019) stated that music teacher training programs in Turkey produce a uniform type of music teacher and do not differentiate in terms of training music teachers specialized for different educational levels. The study also emphasized that music education practices for younger age groups are insufficient and highlighted the need to expand the content of courses related to this area.

2-Pre-service music teachers largely found the number of classrooms (%70) and the technical infrastructure of the classrooms (%64) in which their undergraduate program was conducted to be significantly "**inadequate**." Although they expressed a relatively positive view regarding the number of instructors delivering the program, responses indicating "**Insufficient**" (33.3%) and "**Partially Sufficient**" (20%) also point to notable deficiencies in this area. This finding suggests that the physical and technical conditions of the classrooms where music teacher education programs are conducted, as well as the number of instructors executing the program, are inadequate. Uçaner (2015) found that, when evaluated generally, audiovisual tools and equipment in music education departments are largely inadequate.

Examining students' views on the overall expertise of the instructors revealed that opinions were predominantly at "**good**" and "**moderate**" levels. However, it also revealed the presence of students who rated the instructors as "**moderate**" or "**insufficient**" in aspects such as "effective communication with students," "familiarity with and use of technology in class," "ability to apply different teaching methods and techniques," and "ability to relate their course to the objectives of the undergraduate program." This finding provides important indications that, while instructors are generally qualified, they need to be more sensitive and conscious regarding certain components of course delivery.

3-Pre-service music teachers in the study group considered the course hours of the following Field Education courses to be insufficient: "Individual Instrument Education," "Western Music Theory and Practice," "Orchestra and Chamber Music," "Piano Education," "Vocal Training," and "Harmony and Accompaniment." Among the elective courses, they also regarded the course hours of "Music Ensemble Management," "Techniques of Composing Educational Music," and "Western Music: Forms and Genres" as inadequate.

This finding indicates that pre-service music teachers wish to engage with the Field Education courses that constitute the technical field component of music teacher education for longer periods. In their study, Gün and Özkasnaklı (2020) identified the following elective courses as important for pre-service music teachers: "Percussion Instruments," "Techniques of Composing Educational Music," "Preschool Music Education," "Popular Music and Its Practices," "Western Music: Forms and Genres," "Drama and Musical Plays," "Musical Organization and Communication," "Polyphonic Arrangement of Turkish Music," "Music Ensemble Management," and "Turkish Folk Music: Forms and Genres." Similarly, Gökçe (2019) reported that pre-service music teachers wished for their principal instrument course to be offered more intensively in the program, emphasizing that the low credit allocation for this course limited students' opportunities to benefit sufficiently from it.

Pre-service teachers indicated that, among the "Pedagogical Content Knowledge" courses, they would like to see increased course hours for Field Education courses such as "Classroom Management," "Teaching Practice," and "Educational Psychology," as well as for elective courses such as "Drama in Education." In their study, Gün and Özkasnaklı (2020) identified the following elective Pedagogical Content Knowledge courses as the most preferred by pre-service music teachers: "Child Psychology," "Character and Values Education," "Drama in Education," "Attention Deficit and Hyperactivity Disorder," "Out-of-School Learning Environments," "Critical and Analytical Thinking," "Learning Difficulties," and "Individualization and Adaptation of Instruction.".

These findings indicated that pre-service music teachers most strongly associate the development of their professional identity as future teachers with courses such as "Classroom Management", "Teaching Practice", and "Educational Psychology". Moreover, this can be interpreted as a desire for increased course hours. However, student attitudes toward many of the other courses within the pool of Pedagogical Content Knowledge remain insufficient. Gökçe (2019) reported that the majority of pre-service music teachers believed that educational sciences courses were not conducted with the desired level of effectiveness. She interpreted the underlying reasons as the courses being primarily theoretical rather than practical, classroom management issues arising during instruction, and overcrowded classes limiting practical application. Yüksel (2007), in his research, found that pre-service teachers were weak in terms of pedagogical content knowledge and demonstrated inadequate attitudes toward the teaching profession. Author noted that the hidden curriculum, which runs parallel to the official program, aimed to train students as subject-matter specialists rather than as teachers of the subject. Furthermore, he determined that the pressure of this hidden curriculum not only distanced students from the teaching profession but also made it more difficult for instructors to deliver Pedagogical Content Knowledge courses.
Among the "General Culture" courses, the views regarding the need for an increase in course hours were predominantly directed toward the "Foreign Language" course, while within the elective general culture courses, the "Art and Aesthetics" course was most frequently emphasized for having its hours extended. Gün and Özkasnaklı (2020) found that pre-service music teachers identified the following courses as elective general culture courses they wished to take within the undergraduate program: "Turkish Folk Dances," "Turkish Sign Language," "Human Relations and Communication," "Career Planning and Development," "Art and Aesthetics," "Science and Research Ethics," and "Addiction and Struggle Against Addiction.

These findings suggest that pre-service music teachers generally hold positive views toward courses defining the music teacher education; namely, Field Education Courses, pedagogical knowledge, and general culture, while highlighting certain key ones among them. The balance among these three areas closely affects the efficiency to be gained from these courses. Indeed, Gün and Özkasnaklı (2020) found that pre-service music teachers believed their strong focus on Field Education courses had prevented them from fully benefiting from the elective courses they had taken thus far.

4. Within the Field Education courses, the courses that pre-service music teachers considered to contribute most to their teaching formation were the Field Education courses: "Individual Instrument Instruction", "Western Music Theory and Practice", "Orchestra and Chamber Music", "Piano Instruction", "Vocal Training", and "Harmony and Accompaniment". Among the elective Field Education courses, Music Composition Techniques for Education and Early Childhood Music Education were also identified. Gökçe (2019) found that pre-service music teachers had a positive view on Field Education courses and considered these courses beneficial for their teaching profession

Among the pedagogical courses that pre-service music teachers considered most contributive to their teaching formation, the Field Education courses identified were "Teaching Practice," "Classroom Management," "Principles and Methods of Teaching," "Educational Psychology," and "Special and Inclusive Education," while the elective course "Drama in Education" was also highlighted

This finding indicates that the pedagogical courses pre-service music teachers evaluated as most effective are those primarily representing in-class teaching practices and directly related to the practical field of teaching. However, their distance from

courses such as “Assessment and Evaluation,” “Turkish Education System and School Management,” and “Research Methods in Education” is notable from the perspective of pedagogical training. This outcome may stem from a lack of practical application in these courses or insufficient awareness-raising regarding them. Eldemir (2011), in his study, reported that students did not consider pedagogical courses sufficient in terms of achieving learning outcomes. On the other hand, the students participating in the research provided negative feedback regarding the impact of these courses on acquiring the professionally necessary skills.

Pre-service music teachers also identified the general culture Field Education and elective courses they considered to contribute most to their teaching profession. Among the Field Education courses, “Community Service Practices” was marked, while among the elective courses, “Art and Aesthetics” and “History of Turkish Art” were marked. Within the study group, pre-service music teachers, when asked which Pedagogical Knowledge courses should have reduced hours, focused, albeit to a relatively low extent, on Field Education courses such as “Philosophy of Education,” “Sociology of Education,” “History of Turkish Education,” “Critical and Analytical Thinking,” and “Inclusive Education.” They also marked elective courses like “Museum Education” and “Project Preparation in Education.” Overall, the tendency to indicate courses that could be omitted within the Pedagogical Knowledge curriculum was observed to be low. This finding indicates that some pre-service music teachers lack full recognition of the courses that are more theoretically oriented as important complements for music teacher education.

5-One of the important courses in the Music Teacher Education undergraduate program is the “Teaching Practice” course. Overall, students exhibit a “**positive**” tendency regarding the sufficiency of this course. Although some students tended to choose the “**partially**” option, the distribution of positive responses above 45% for almost every item supports this finding. The highest levels of distribution were observed in the items related to course hours, instructor guidance, and teacher mentoring.

However, the proportion of students who do not consider it sufficient for the course to be offered over two semesters in the final year (37.4%) and those who think that the education they received in the undergraduate program is generally insufficient for the “Teaching Practice” course (34.3%) is not negligible and warrants careful consideration. In his study with music teacher candidates, Gökçe (2019) reported that the majority of participants emphasized that courses providing school experience were not conducted efficiently enough. She also found that factors such as the physical and technical infrastructure of the practice schools, the attitudes of the teachers at these schools, the large number of students participating in the practice, and insufficient supervision by faculty members were perceived to contribute to these inefficiencies.

Students reported the problems they experienced in the teaching practice course as issues in providing feedback and corrections, low readiness levels of the school students, difficulties in classroom management, lack of engagement from the mentor teacher, and the physical conditions of the practice school.

Pre-service teachers indicated that the teaching practice course **adhered to the music curriculum at a rate of 52%,** while 36% stated that it did not. Four students offered a different opinion, suggesting the idea of a flexible program. Sixty-four percent of the pre-service music teachers indicated that the number of students in the practice classrooms was “**appropriate**,” while 32% stated that the class sizes were “**crowded**”.

Pre-service music teachers reported that the Teaching Practice course was highly beneficial for acquiring classroom management skills and teaching experience. However, they also indicated experiencing difficulties in preparing for lessons and effectively managing class time during the practicum. Gökçe (2019) found that both students and teachers faced challenges in communicating with students during their internships as well as in the early years of their profession. Additionally, the study identified challenges in maintaining classroom order, planning lessons, handling certain school-related paperwork, and conducting assessment and evaluation.

6-The pre-service music teachers in the study group largely believe that the number of hours for the “Foreign Language” course within the “General Culture” courses, and for the “Art and Aesthetics” course within the General Culture elective courses, should be increased. In the responses advocating a reduction in the hours of General Culture courses, the “Community Service Practices” and “Foreign Language” courses stand out, while among the General Culture elective courses, the “Traditional Turkish Handicrafts” course is highlighted.

Among the courses that the study group considered can be “**omitted**” in the program, the Field Education course “Community Service Practices” and the elective courses “Traditional Turkish Handicrafts,” “Science and Research Ethics,” “Addiction and Combating Addiction,” and “Art and Aesthetics” stand out.

In summary, while students’ views on the 2018 undergraduate program in music teacher education are generally positive, negative attitudes stemming from significant structural issues in the implementation of the program persist to some extent. These are reflected in students’ perceptions of insufficient physical facilities, technical infrastructure problems, issues concerning the number and qualifications of instructors, certain challenges encountered during teaching practice, the emphasis on Field Education courses in the hidden curriculum, and some imbalances in the credit distribution of courses within the program. Notably, due to the elective course pool planned in the program and the mandatory completion of elective course credits, many music Field Education courses had to be assigned 1–2 ECTS credits, while all elective courses were allocated 3–4

ECTS credits. This structure has particularly contributed to some negative student perceptions regarding elective and general culture courses.

4.2. Recommendations

During the implementation of the Music Teaching undergraduate program, pre-service teachers should be provided with complementary information indicating that music Field Education courses, teaching profession knowledge courses, and general culture courses collectively constitute the teacher education formation.

In the undergraduate program, hidden curriculum practices implying a major course–elective course relationship among the three main areas, namely Field Education courses, pedagogical knowledge courses, and general culture courses, should be avoided.

Adjustments should be made to focus on students' opinions and requests, particularly regarding elective courses in the undergraduate program, in order to eliminate the perception that these courses are "unnecessary."

The number of music studios, individual study rooms, and technologically equipped classrooms should be increased to improve undergraduate program delivery conditions.

Adjustments should be made to resolve problems encountered in the "Teaching Practice" component of the undergraduate program, both within the program itself and in the field placement settings.

Faculty members implementing undergraduate programs can be provided with in-service training on topics such as "technology use" and "communication skills."

In the processes of developing new undergraduate programs initiated under the CoHE's delegation of authority it is recommended that the views and views of pre-service teachers regarding the previous program be analyzed in detail and that these views be leveraged in the relevant revisions.

4.3. Limitations

This research is limited to the views of 105 students enrolled in the music teacher training programmes of seven different universities included in the study group. Therefore, the generalisability of the study should be considered within these limitations.

Furthermore, as the study concerns the most recent compulsory music teacher training degree programme, it is limited to analysing student responses regarding the number of courses and course content for the 2018 degree programme.

The study is based on describing responses provided remotely via a questionnaire. In this context, responses obtained through face-to-face interviews, for example, may have higher validity and reliability.

Research and Publication Ethics Statement
Ethical approval for this research was obtained from the Publication Ethics Committee of the Faculty of Social and Human Sciences at Trabzon University 2024-10/2.6 on 24 October 2024. Based on this approval document, other relevant universities were contacted and permissions were obtained to ensure the voluntary participation of students.

Contribution Rates of Authors to the Article
In this article, the authors' contribution is 50 percent for both authors.

Statement of Interest
There is no conflict of interest for this article.

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Middle School Students' Perceptions of Desirable and Un-desirable Teacher Characteristics in Türkiye and Kazakhstan*

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ABSTRACT

The purpose of this research is to determine the desirable and undesirable characteristics of teachers according to the perceptions of secondary school students in Türkiye and Kazakhstan, and to make suggestions for teacher training program on how to avoid training teachers with undesirable characteristics and how to cultivate teachers with desirable characteristics in education faculties. Data were collected through in-depth individual interviews. The study group was selected by purposeful sampling method, specifically maximum diversity sampling, and from secondary school 8th grade students studying in schools in Ankara and Astana, the capitals of Türkiye and Kazakhstan, during the autumn and spring semesters of the 2023-2024 academic year. The data were analyzed by descriptive and content analysis using MAXQDA software. The results revealed that the perceptions of the 8th grade students in Türkiye and Kazakhstan were largely similar. Based on the results of the research, suggestions were made regarding the issues that should be considered in teacher training programs to train teachers with desirable characteristics in education faculties by taking into account the characteristics that students value in teachers to better understand the lessons, to increase their effectiveness in the lesson and to participate willingly in the lesson.

Keywords: desirable teacher characteristics, student perceptions, teacher education, undesirable teacher characteristics

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1. INTRODUCTION

As one of the basic elements of the education system, the teacher plays a major role in preparing a generation that embodies the best values of the society (Hattie, 2003; Kozikoğlu, 2016; Sidash, 2014). No matter how effective the education program is, it cannot yield the desired results if teachers are ineffective (Hattie, 2003; Senemoğlu, 1988a). Deficiencies and inadequacies in teachers can negatively affect the educational environment. In other words, a teacher who does not have sufficient professional knowledge, who does not approach students with respect and care, who does not know how to communicate effectively, who cannot adopt an individualized approach for each student may fail to foster the desired behaviors in students (Senemoğlu, 1991). Therefore, the success of an education system depends on whether the teachers operating within it possess the necessary characteristics (Ball & Cohen, 1999; Bykova & Chirkina, 2020; Darling-Hammond, 2000; Ferguson, 1991; Irsaliev et al., 2019; Rockoff, 2004; Sanders & Rivers, 1996; Senemoğlu, 1988a, 1988b; Wright et al., 1997). Similarly, Karaca (2003) stated that the main factor directly influencing the quality of education is the competence or quality of teachers.

Expectations regarding what teachers should know and be able to do are constantly evolving. This is largely due to the fact that societies around the world are undergoing complex, dynamic and often unpredictable processes of transformation, which inevitably have a profound impact on education systems and schools (Ball & Cohen, 1999; Senemoğlu, 1991). As a result of these constant changes, questions about the essential qualities and competencies that teachers should possess have become even more important. In particular, there is growing interest in understanding what characteristics define an effective teacher and how teacher education programs can be structured to develop these qualities in future teachers. For a long time, these issues

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have been the subject of scientific research and remain highly relevant today, as the role of teachers continues to change in response to societal needs and educational challenges (Darling-Hammond et al., 2017; Senemoğlu, 2001; Slambekova & Agzamova, 2013).

A growing body of research in the field of teaching has emphasized the importance of preparing qualified teachers to ensure quality education for students (Harris & Sass, 2009). The way a teacher treats or teaches a student has a ripple effect that spreads and continues throughout one's educational journey (Wang et al., 2007). Teachers can accelerate children's development with a rich and stimulating environment or they can limit them and hinder their development by creating an inappropriate environment (Senemoğlu, 1994). Similarly, Wang et al. (2007) stated that students may either flourish or decline depending on the behaviors, influences and methods used by teachers. Therefore, the impact of teacher behaviors on students can be positive or negative (Strikwerda-Brown et al., 2008). To mitigate the risk of negative impacts and promote effective teaching, it is essential to train competent and well-prepared teachers through structured pre-service education programs (Senemoğlu, 1990).

Students' perceptions of teachers play a critical role in terms of the quality of the educational process. Teacher-student interaction shapes not only academic achievement but also students' school belonging, motivation and attitudes towards learning (Hattie, 2009; Pianta et al., 2003). In this context, it is important to understand how teacher qualities are perceived by students in order to include student voice in educational decision-making processes.

Students' evaluations of teachers can provide strong indicators of teaching quality (Ferguson, 2012). Therefore, understanding how teacher characteristics are perceived by students not only improves teacher evaluation systems but also contributes to the restructuring of teacher education programs. Especially students at the secondary school level are highly sensitive to teacher attitudes due to their cognitive and affective development, and experiences in this period can have lasting effects on the bond that students establish with education (Eccles & Roeser, 2011).

When the literature on desirable and undesirable characteristics of teachers is reviewed, many studies on good, effective, successful, expert, and ideal teacher characteristics can be found. Researchers have examined teacher quality from various aspects, including content knowledge, pedagogical competence, personality traits, classroom practices, and relational skills (Anderson & Taner, 2023; Berliner, 1987, 2001; Carroll et al., 2024; Darling-Hammond et al., 2017; Dulay, 2023; Grant et al., 2024; Harris & Sass, 2009; Lupascu et al., 2014; Mullock, 2003; Petrova et al., 2020; Raufelder et al., 2016; Semenova & Khanolainen, 2024; Senemoğlu, 2001; Shindley Elliott, 2010; Strikwerda-Brown et al., 2008; Stronge, 2007, 2010; Stronge et al., 2011; Szűcs Ida, 2017; Valcarcel et al., 2021; Wang et al., 2007; Whitty, 1996). While a significant number of these studies address teacher qualifications from the perspectives of teachers, administrators or parents, some of them include analyses based directly on student perceptions. However, the number of qualitative studies that examine the student perspective in depth remains limited and this field is still open to further development. Nevertheless, the vast majority of studies that address the student's perspective focus only on desirable teacher characteristics, while studies that comprehensively address desirable and undesirable characteristics are relatively rare. Furthermore, comparative qualitative studies focusing on culturally related yet educationally distinct contexts such as Türkiye and Kazakhstan remain scarce. This study addresses this gap by providing a cross-cultural, student-centered analysis, offering insights that can inform teacher education and professional development in both national and broader international contexts.

Within the scope of this study, Türkiye and Kazakhstan are considered together because both cultural proximity and differences in education systems provide a rich ground for comparative analysis. The two countries share historical, linguistic, and cultural commonalities within the Turkic World, but differ significantly in terms of the structural features of their education systems, teacher training models and policy priorities. This study aims to make original contributions to both national and international educational literature by analyzing the perceptions of 8th grade students in Türkiye and Kazakhstan on teacher characteristics in depth. By highlighting these perceptions, the study seeks to raise awareness in teacher education about the qualities that contribute to effective teaching and those that hinder it. By adopting a student-centered perspective, this study emphasizes the value of student voice in education and supports a participatory understanding of education by revealing students' perceptions of desirable and undesirable teacher characteristics. The comparative analysis of the cultural similarities and differences in the education systems of Türkiye and Kazakhstan provides an opportunity to examine how perceptions of teaching are shaped within a cultural context. In addition, the findings obtained can provide concrete data to policy makers and educators in terms of improving teacher training programs, restructuring professional development practices, and improving classroom interactions. In this respect, the research also aims to provide recommendations for teacher training programs in education faculties that foster desirable teacher qualities and prevent the emergence of undesirable ones.

The research problem statement is “What are the desirable and undesirable teacher characteristics according to the perceptions of secondary school students in Türkiye and Kazakhstan?”. Based on this problem statement, answers were sought to the following sub-problems:

1. a. What are the characteristics of desirable teachers according to the perceptions of secondary school 8th grade students in Türkiye?

b. What are the characteristics of undesirable teachers according to the perceptions of secondary school 8th grade students in Türkiye?
2. a. What are the characteristics of desirable teachers according to the perceptions of secondary school 8th grade students in Kazakhstan?
b. What are the characteristics of undesirable teachers according to the perceptions of secondary school 8th grade students in Kazakhstan?
3. What are the similarities and differences in terms of desirable and undesirable teacher characteristics according to the perceptions of secondary school 8th grade students in Türkiye and Kazakhstan?

2. METHODOLOGY

This research was designed as a qualitative study using a phenomenological approach. Phenomenology focuses on exploring and describing individuals' lived experiences of a particular phenomenon and understanding how they make sense of these experiences (Creswell, 2013; Moustakas, 1994). In this research, the phenomenon analyzed is 8th grade students' perceptions of the characteristics of desirable and undesirable teachers in Türkiye and Kazakhstan. Phenomenology was deemed appropriate as the study aimed to capture students' shared experiences, meanings and interpretations rather than testing predetermined hypotheses (van Manen, 1990; Yıldırım & Şimşek, 2021).

To achieve this, data were collected through in-depth, semi-structured individual interviews, which provided participants with the opportunity to reflect on their experiences and articulate their perspectives in detail. As Miles and Huberman (1994) noted, qualitative data are rich, holistic and well suited to understanding the subjective realities of participants. Moreover, these techniques are suitable for identifying the meanings and perceptions that people attribute to events and processes in their lives and for relating these meanings to the social world.

2.1. Participants

The study group of this research consisted of 8th grade secondary school students attending public schools in Ankara and Astana, the capitals of Türkiye and Kazakhstan, during the autumn and spring semesters of the 2023-2024 academic year. Participants were selected using the purposeful sampling method, specifically maximum diversity sampling. In order to ensure maximum diversity, two schools representing each level were selected from lower, middle and upper secondary schools located in the central districts of Ankara Province. The levels of the schools were determined based on the six service areas defined in the Teacher Appointment and Relocation Regulation of the Turkish Ministry of National Education. Accordingly, the 5th and 6th service areas were taken as the lower level, the 3rd and 4th service areas as the middle level, and the 1st and 2nd service areas as the upper level. In Astana city, two schools were selected from each of the five central districts representing different socio-economic backgrounds. This selection aimed to ensure maximum diversity by capturing the views of students from varying socio-economic levels.

The purpose of maximum diversity sampling is to create a relatively small sample that reflects, to the greatest extent possible, the diversity of individuals who may be involved in the phenomenon under study (Yıldırım & Şimşek, 2021). In determining the sample size, priority was given to ensuring that the opinions received from a group reached saturation and become repetitive (Miles & Huberman, 1994). Therefore, face-to-face individual interviews were conducted with forty-five students from each group, with a nearly equal gender distribution. As shown in Table 1, the number of female and male students in both groups was almost evenly distributed.

Table 1.
Gender distribution of participants

Group	Female (n)	Male (n)	Total (n)
Türkiye	23	22	45
Kazakhstan	24	21	45

2.2. Data Collection Tool

In this research, a semi-structured interview form prepared by the researchers was used as a data collection tool. The questions were developed in line with the main research question and were informed by similar studies in the relevant literature. The initial draft consisted of 12 questions, including deepening and closing questions. To ensure content validity and clarity, the draft form was reviewed by seven experts in Educational Sciences. The experts evaluated each question regarding its relevance to the research purpose and language clarity. They provided structured feedback, indicating whether each question was appropriate or needed modification, and offered specific suggestions for improvement. Based on this feedback, two questions were revised, and the revised form was returned to the experts for confirmation. Full consensus was achieved in this process, resulting in a final interview form of 12 questions, including both deepening and closing questions. Then, a pilot interview was conducted with five students from the target group. Based on the data obtained in the pilot interview, the quality of the questions was improved, and the final Turkish version of the Semi-structured Interview Form was created. The Semi-structured Interview Form was translated into Kazakh by the researcher. Expert opinion was then sought from six individuals who are native Kazakh

speakers, proficient in Turkish at the C1/C2 level, and hold a PhD in Türkiye. To determine whether the questions were understandable by the students in Kazakhstan society, a pilot interview was conducted with five students, and it was ensured that the interview questions had the same meaning in Kazakh.

2.3. Data Collection Process

Data collection was conducted by the first author, who personally visited both research sites and carried out all interviews. In Kazakhstan, data were collected in Astana during the fall semester, while in Türkiye, the data collection took place in Ankara during the spring semester of the same academic year. A detailed schedule was arranged to ensure the researcher's physical presence in each city for the required period. In total, interviews were conducted with 90 students across both sites. Each interview was conducted face-to-face and individually in school settings outside of class hours, lasting between 25 and 40 minutes. Prior to the application, approval was obtained from the Hacettepe University Ethics Committee, followed by official permission from the Ministry of National Education of the Republic of Türkiye and the Methodological Centre of the Astana Governorate of the Republic of Kazakhstan. After receiving these approvals, informed consent was obtained from both students and their parents/guardians, and a voice recorder was used to ensure accurate data capture.

2.4. Data Analyses

Descriptive and content analysis were used to analyze the data collected in the study. In the descriptive analysis of qualitative data, a thematic framework for data analysis was created based on the interview questions, which were prepared according to the problem statement and sub-problems of the research. Subsequently, themes were added according to desirable and undesirable teacher characteristics in line with the student perceptions collected through individual interviews. The main purpose of content analysis was to identify concepts and relationships that can explain the collected data. Content analysis requires first conceptualizing the collected data, then organizing them logically according to the emerging concepts and defining the topics that explain the data appropriately (Yıldırım & Şimşek, 2021). For this purpose, the audio recordings from the interviews were listened to repeatedly by the researcher and transcribed verbatim, transferred to the digital environment and analyzed by extracting codes, categories, themes using MAXQDA software. The advantage of using MAXQDA software is that it provides ease in the coding process, complete transparency in the study process, and always provides a link between the original data, analytical categories, the researcher's own notes, comments, analysis results, and developed interpretations and theories (Rädiker & Kuckartz, 2020). The students whose opinions were included in the analysis were given code numbers. Turkish students were labeled as TS1, TS2, TS3 … TS45, while Kazakhstani students were labeled as KS1, KS2, KS3 … KS45.

2.5. Procedures for Validity and Reliability

Reliability in qualitative research refers to the consistency of the research process. To ensure reliability, the two authors of the study independently coded a subset of the data using an inductive approach. Ten interview transcripts were randomly selected for this purpose. Both coders imported the transcripts into MAXQDA software and conducted blind coding, generating codes directly from the text without using any predefined categories or themes. After initial coding, tools such as the Document Comparison and the Code Matrix Browser were used to compare which text segments were assigned which codes. For each segment, the number of agreements and disagreements between the two authors was determined. Inter-coder reliability was calculated using the formula proposed by Miles and Huberman (1994). The inter-coder reliability coefficient was 0.92, indicating a high level of agreement. Subsequently, the authors collaboratively reviewed the codes and organized them into categories and themes for the entire dataset. Additionally, one of the authors re-coded the same units at two different time points, with a 12-day interval, which confirmed the consistency of the coding (Schreier, 2012). In addition, direct quotations were included to reflect the perspective of the students (Yıldırım & Şimşek, 2021).

3. FINDINGS

The findings of the study are presented below in line with the research sub-questions. For each sub-question, the themes, categories and codes obtained from data analysis are described and sample quotations are used where appropriate.

3.1. What are the characteristics of desirable teacher according to the perceptions of 8th grade secondary school students in Türkiye?

The data obtained for part (a) of the first sub-problem were coded. These codes were then evaluated and grouped into four categories. The detailed findings are presented in Table 2 and Figure 1 under the theme of Desirable Teacher Characteristics.

Table 2.
Desirable teacher characteristics according to the perceptions of 8th grade secondary school students in Türkiye

Theme	Category	Codes	f
Desirable Teacher	Subject Matter Knowledge	gives satisfactory answers to questions	21

		has strong command of subject knowledge	15
		provides the nature of knowledge	13
General Culture		knowledgeable and intellectual	23
Professional Knowledge	*Teaching and Classroom Management Skills*	teaches according to students' level	36
		makes lessons fun	35
		fair/non-discriminatory	33
		re-explaining the lesson when necessary	31
		teaches effectively	27
		makes students love the lesson	26
		disciplined	22
		shows interest in students	19
		informs us about the target and behavioral objectives	17
		encourages students to ask questions	17
		provides lessons with games and activities	15
		does not leave questions unanswered	11
		provides additional learning materials	9
		motivates students for exams	9
		has classroom authority	8
		uses positive reinforcement	8
		supportive	7
		gives practice tests	5
		well organized	5
		supports each student individually	4
		explains lessons using stories	4
		organizes extracurricular activities	3
		gives corrective feedback	2
		acts as a guide	2
		uses the lesson time efficiently	1
		promotes learner autonomy	1
	Assessment and Evaluation Skills	evaluates fairly	29
		asks whether students understand	11
		gives easy exams	2
Personal Traits	*Effective Communication Skills*	maintains good relations with students	25
		understands students' mood	20
		acts like a friend	17
		approaches like a parent	6
		considers student requests	4
		avoids slang	2
		does not swear	2
	Positive Social and Emotional Traits	understanding	31
		affectionate	26
		funny	17
		loves teaching	12
		not quick-tempered	12
		emotionally controlled	11
		helpful	9
		empathic	8
		positive	8
		uses gestures and facial expressions	7

energetic	7
sincere	7
smiling	7
respectful to students	6
kind	5
serious when necessary	5
calm	5
humorous	4
optimistic	4
honest	4
role model	3
intelligent	3
compassionate and merciful	3
friendly	3
patient	2
protective	2
values religious and national culture	1
keeps secrets	1
ambitious	1

As illustrated in Tablo 2 and Figure 1, the statements of the students interviewed were analyzed under four main categories: Subject Matter Knowledge, General Culture, Professional Knowledge, Personal Traits. Within the category of Subject Matter Knowledge, students emphasized the importance of having teachers who possess a strong command of their discipline, are capable of conveying the essence of knowledge, and provide clear, satisfactory answers to students' questions. Furthermore, they highlighted that it is essential for teachers to be both knowledgeable and intellectually engaged. Selected excerpts from student responses are presented below:

> *"Other than that, I would like him not to just give information, but to tell us how to use that information in our lives." (TS1)*

> *"More information and general culture are important to me. In other words, a teacher who is knowledgeable about the subject he teaches and has up-to-date knowledge in different fields, and an intellectual teacher who integrates them in classes, is a good teacher for me." (TS18)*

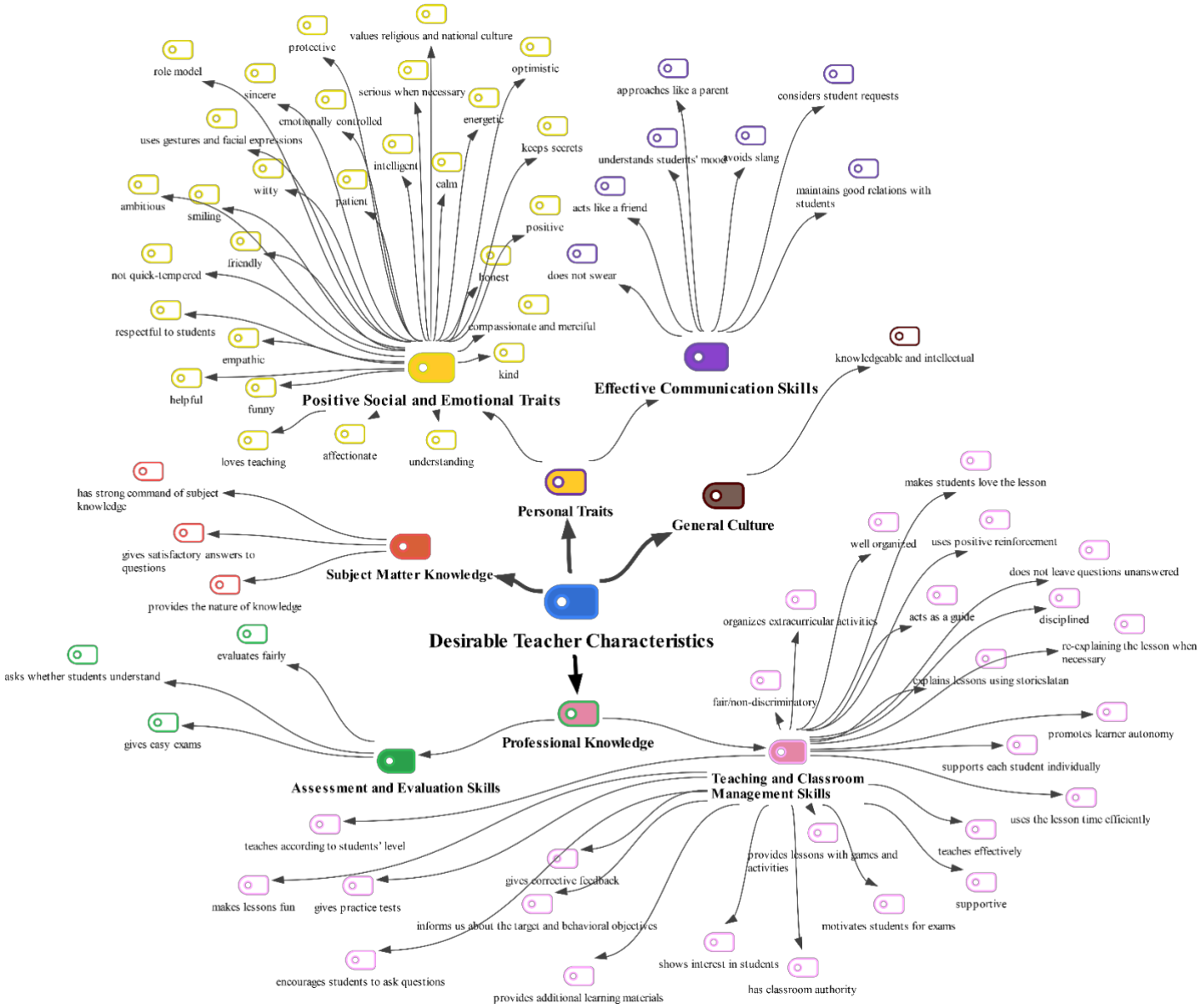


Figure 1. Characteristics of desirable teachers according to the perceptions of 8th grade secondary school students in Türkiye (The Hierarchical Code-Subcode Model exported from MAXQDA software).

Under the Professional Knowledge category, there are subcategories of Teaching and Classroom Management Skills and Assessment and Evaluation Skills. When it comes to Assessment and Evaluation Skills, students expressed a preference for teachers who check for understanding during lessons, conduct fair assessments, and develop exams that are not too difficult. In the sub-category of Teaching and Classroom Management Skills, students expressed a wide range of expectations regarding the qualities they value in teachers. These include the ability to answer students' questions, provide additional learning materials, clearly articulate learning objectives and behavioral goals, encourage testing practices, and show genuine concern for students. They also emphasized the importance of constructive feedback from teachers, maintaining discipline, leadership, fairness and non-discrimination, and an individual approach to each student. Support, the ability to instill a love of the subject, effective use of teaching time, high activity in the classroom and the inclusion of extracurricular activities were also noted. In addition, students appreciated organized teachers who encourage curiosity by asking leading questions, use storytelling in their lessons, are willing to revisit material if necessary, motivate students to take exams, and make learning fun. Other desirable qualities include the use of engaging activities or games, the use of positive reinforcement, adapting teaching to the level of the students, and encouraging student independence. Representative student comments illustrating these expectations are provided below:

> *"The teacher should ask those who did not understand at the end of the lesson nicely, to see if they understood the subject." (TS1)*

> *"It is also nice when the teacher provides us with extra content about the subject we are learning, such as photocopying assignments etc." (TS35)*

> *"For me, an ideal teacher is one who can explain the subject in an entertaining way." (TS20)*

The Personality Traits category includes the subcategories of Effective Communication Skills and Positive Social and Emotional Traits. In the sub-category of Effective Communication Skills, it was found that eighth-grade students in Türkiye generally value teachers who are sensitive to their emotional state, listen to their requests, communicate with them in a friendly manner, and treat them with parental care. They also appreciate teachers who avoid slang and profanity and maintain positive relationships with their students. In terms of Positive Social and Emotional Traits, students described the ideal teacher as sensitive, kind, emotionally balanced, expressive through gestures and facial expressions, and a positive role model. Other frequently mentioned traits include energy, respect for religious and national values, enthusiasm for teaching, sincerity, patience, calmness, understanding, and intelligence. Students also emphasized qualities such as reliability, optimism, warmth, cheerfulness, a good sense of humor, helpfulness, honesty, determination, and the ability to be serious when necessary. Compassion, mercy and emotional closeness were also considered important characteristics. Below are quotes from student responses illustrating these characteristics:

"After that, I would like to have a teacher who communicates well with the students." (TS43)

"He should teach us about every subject I think the teacher who helps is an ideal teacher. For me, the personal characteristics of the teacher are a little more important." (TS13)

3.2. What are the characteristics of undesirable teachers according to the perceptions of 8th grade middle school students in Türkiye?

The data related to part (b) of the first sub-problem were also coded, the codes were evaluated in three categories and collected under the theme of Undesirable Teacher Characteristics and are given in detail in Table 3 and Figure 2 below.

Table 3.
Characteristics of undesirable teachers according to the perceptions of 8th grade middle school students in Türkiye

Theme	Category		Codes	f
Undesirable Teacher Characteristics	Lack of Subject Matter Knowledge		does not provide the nature of knowledge	15
	Lack of Professional Knowledge	*Lack of Assessment and Evaluation Skills*	makes unfair assessments	32
			does not check for understanding	11
			does not check homework	5
		Lack of Teaching and Classroom Management Skills	unfair/discriminating	29
			ineffective in teaching	29
			does not explain the lesson	16
			does not respond to questions	15
			who does activities unrelated to the lesson	12
			who has one dimension thought	11
			fails to re-teach when necessary	11
			uses only one teaching method	11
			provides no emotional or academic support	11
			becomes angry when asked questions	9
			merely transmits knowledge	7
			restricting freedom of thought	5
			only asks students to write	1
			excludes students from lessons	1
			does not allow students to speak	1
	Negative Personal Traits	*Negative Communication*	poor relationship with students	29
			scolds students	13
			lacks emotional warmth	13
			does not act like a friend	12
			undisciplined	7
			ignores students' requests	6
			uses slang	5
			humiliates students	4
			talks about irrelevant topics	3
		Negative Social and Emotional Traits	nervous	39
			dislikes teaching	23
			not fun	17
			indifferent to students	17
			insensitive	14

harsh	14
insincere	12
strict and oppressive	12
disrespectful to students	11
rude	10
does not make jokes	9
lacks empathy	9
prone to violence	8
breaks promise	7
not a good role model	5
has too many rules	5
cold-blooded	5
overly relaxed	5
his/her face is sullen	4
hurtful	3
impatient	2
assigns excessive homework	2
uses phone during class	2
does not like students	1

As seen in Table 3 and Figure 2, the codes were analyzed under the general theme of Undesirable Teacher Characteristics, grouped into the following categories: Lack of Subject Matter Knowledge, Lack of Professional Knowledge, Negative Personal Traits category. In the category Lack of Subject Matter Knowledge, students noted that they do not need teachers who are unable to convey the essence and depth of knowledge. Under the Lack of Professional Knowledge category, there are subcategories of Lack of Teaching and Classroom Management Skills and Lack of Assessment and Evaluation Skills. Regarding Lack of Teaching and Classroom Management Skills, students described a number of undesirable traits. These include unfairness or discrimination, a narrow or one-sided approach to teaching, incomplete coverage of the required material, participation in activities unrelated to the subject, inability to repeat or retell the material, when necessary, use of only one teaching method, assigning an excessive amount of written assignments without proper instructions, and demonstrating an ineffective, mechanistic approach to teaching. Students also criticized teachers who exclude students from participating in class, get annoyed when asked questions, ignore their requests, deprive them of their right to speak, suppress freedom of thought, and provide no academic or emotional support. Under Lack of Assessment and Evaluation Skills, students stated they do not appreciate teachers who neglect to check for understanding, grade unfairly, or ignore homework assignments altogether. The Negative Personal Traits category includes the subcategories of Negative Communication and Negative Social and Emotional Traits. In the subcategory of Negative Communication, students reported negative experiences with teachers who frequently talk off-topic, avoid building friendly rapport, humiliate or scold students, lack discipline, fail to develop positive relationships, disregard student concerns, show emotional detachment, or use inappropriate, slang language. Finally, in the subcategory of Negative Social and Emotional Traits, students described ineffective teachers as those who lack a sense of humor, fail to demonstrate empathy, are not good role models, and make no effort to create an enjoyable classroom environment. Other frequently mentioned traits include being disrespectful, insincere, quick-tempered, impatient, overly strict, indifferent toward teaching, emotionally detached, prone to aggressive behavior, authoritarian, overly demanding with homework, disengaged, moody, rude, cold, hurtful, apathetic toward students, overly relaxed, unreliable, distracted by their phones in class, or excessively harsh.

> *"...and I definitely do not want to have a teacher who does not contribute anything to the children because not contributing anything to the children means that they come to school empty-handed and go home and learn nothing else." (TS45)*

> *"He/she interacts only with his/her favorite students who are successful and ignores other students, this is one of the characteristics of a bad teacher." (TS44)*

> *"A teacher who does not have a good relationship with students is a characteristic I do not want" (TS10)*

> *"He skips the whole subject without asking whether you understand or not." (TS8)*

> *"A bad teacher is a teacher who doesn't like his/her students. Because I believe that love is mutual. If the student doesn't like the teacher, the student won't like him/her either and he/she won't be able to listen to the lesson and he/she won't be able to add anything to students because there is no mutual love each other." (TS17)*

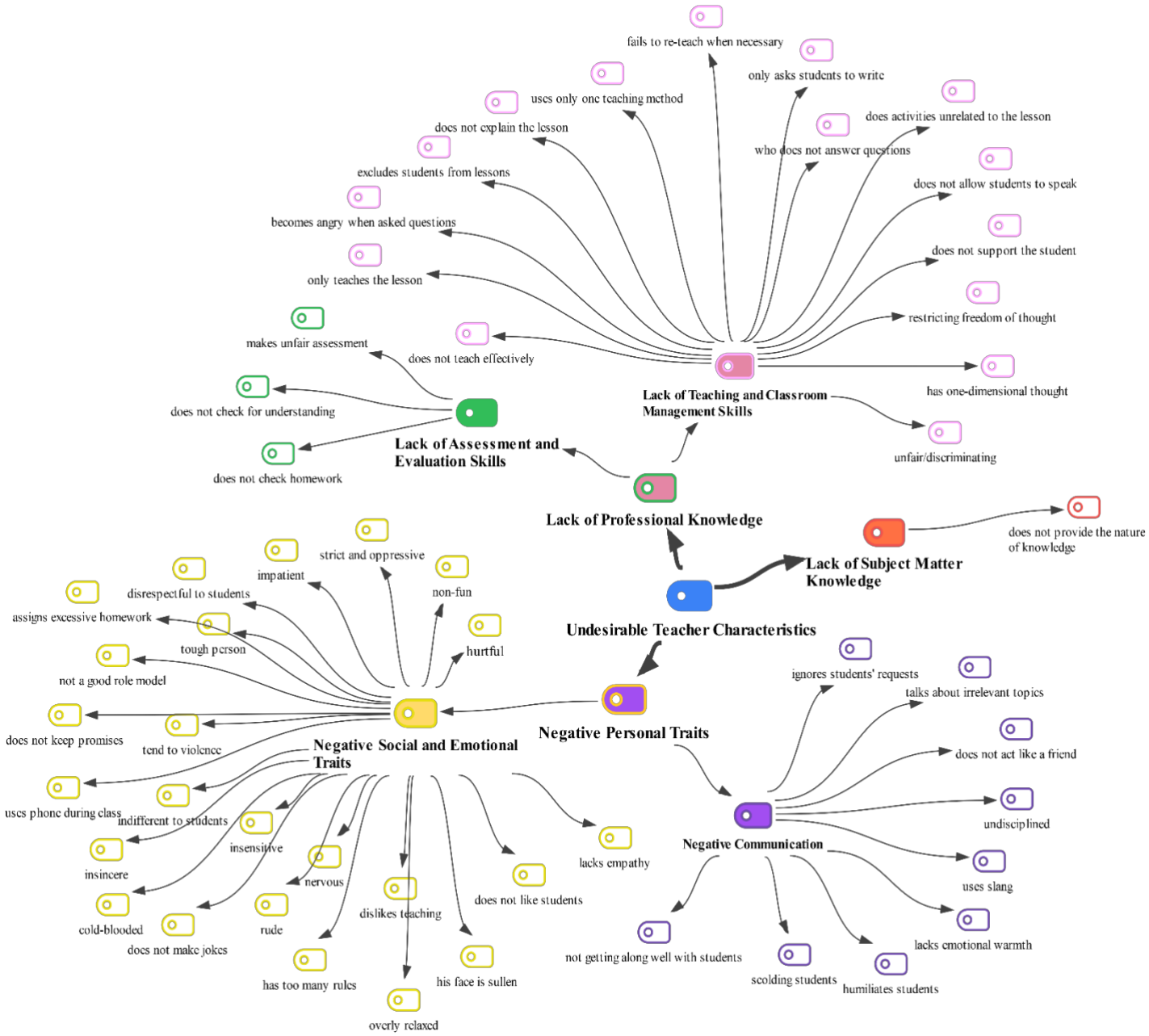


Figure 2. Characteristics of undesirable teachers according to the perceptions of 8th grade secondary school students in Türkiye (The Hierarchical Code-Subcode Model exported from MAXQDA software).

3.3. What are the characteristics of desirable teacher according to the perceptions of 8th grade secondary school students in Kazakhstan?

The data regarding part (a) of the second sub-problem was coded and the codes were collected under four categories. The codes examined under the categories of Subject Matter Knowledge, General Culture, Professional Knowledge, Personal Traits were collected under the Desirable Teacher Characteristics Theme and are given in detail in Table 4 and Figure 3 below.

Table 4.
Characteristics of a desirable teacher according to the perceptions of 8th grade secondary school students in Kazakhstan

Theme	Category	Codes	f
Desirable Teacher Characteristics	Subject Matter Knowledge	has strong command of subject knowledge	22
		gives satisfactory answers to questions	15
		provides the nature of knowledge	13
	General Culture	knowledgeable and intellectual	26
		enriches students' vision	13

Professional Knowledge	*Teaching and Classroom Management Skills*	teaches according to students' level	39
		fair/non-discriminatory	30
		teaches effectively	27
		does not leave questions unanswered	23
		makes lessons fun	23
		re-explaining the lesson when necessary	18
		shows interest in students	15
		provides lessons with games and activities	14
		uses various learning methods	13
		motivates students	13
		acts as a guide	13
		encourages asking questions	13
		well organized	7
		supports each student individually	6
		creates an enjoyable lesson environment	5
		used peer-to-peer learning	5
		has a contemporary approach	4
		disciplined	4
		supportive	3
		gives less homework	1
	Assessment and Evaluation Skills	evaluates fairly	19
		asks whether students understand	13
		has strong observation skills	3
Personal Traits	*Effective Communication Skills*	maintains good relationships with students	24
		understands students' mood	16
		considers students' requests	5
		approaches like a parent	2
		speaks in proper language (e.g., Kazakh)	2
	Positive Social and Emotional Traits	understanding	37
		kind	31
		calm	18
		helpful	16
		loves teaching	15
		respectful to students	15
		funny	14
		honest	14
		not easily angered	13
		a role model	9
		smiling	9
		interesting	7
		empathic	7
		sincere	6
		patient	6
		creative	5
		positive	5
		caring	5
		serious when necessary	4
		a leader	3
		responsible	3
		humorous	3
		tough when necessary	2
		intelligent	2
		demanding	1
		self-confident	1

	inquisitive / researcher	1
	determined	1

When we look at the codes under the Subject Matter Knowledge category in Table 4 and Figure 3 above, we have seen that Kazakh students believe effective teachers are the ones who give satisfactory answers to questions, teach the nature of knowledge, and know their field well. When we look at the codes under the General Culture category, we see that students want to have a knowledgeable and intellectual teacher who broadens the student's horizons. As an example, some of the students' responses are given below.

"Sometimes we feel that teachers do not like us. Even if he does not like his students, I would like to have someone who can answer every student's questions well and sufficiently." (KS4)

"In my opinion, if the teacher explains the lesson well and explains the subject by giving examples from life." (KS12)

"I want her/him to be a smarter than Google and much more interested than YouTube. To me, a good teacher should be knowledgeable (intellectual), as well." (KS21)

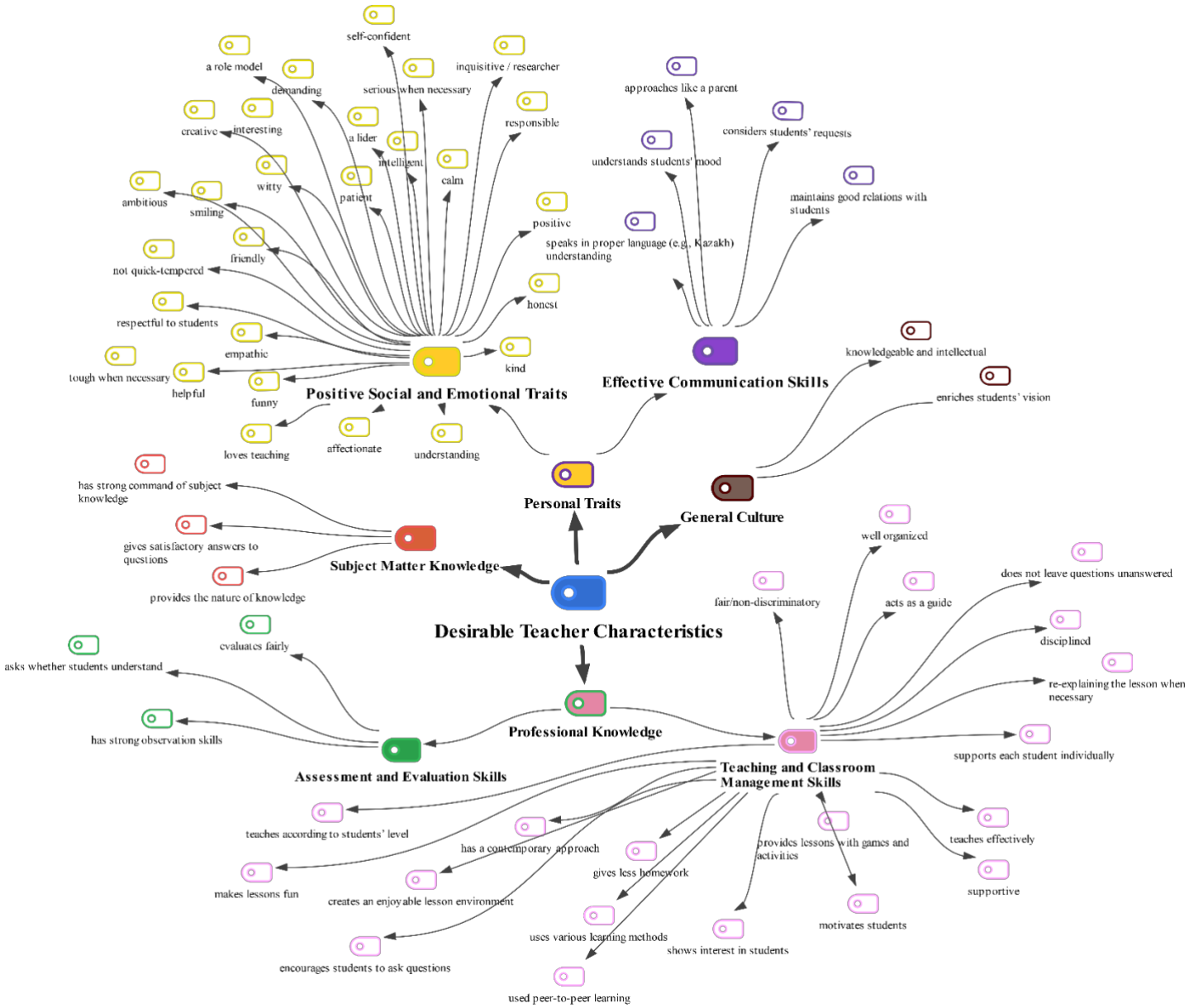


Figure 3. Characteristics of desirable teachers according to the perceptions of 8th grade secondary school students in Kazakhstan (The Hierarchical Code-Subcode Model exported from MAXQDA software).

Under the Professional Knowledge category, there are subcategories of Teaching and Classroom Management Skills and Assessment and Evaluation Skills. In the sub-category of Teaching and Classroom Management Skills, students believed teachers who use a variety of teaching methods, assign a reasonable amount of homework, and answer students' questions without leaving them unanswered are effective teachers. They value teachers with a modern approach who genuinely care about their

students and create a pleasant atmosphere in the classroom. In addition, students emphasized the importance of motivation, discipline and fairness in teachers who serve as guides and give individual attention to each student. Other frequently mentioned qualities included: organization, aesthetic attention, support for mutual learning, encouraging students to ask questions, and a willingness to revisit and re-explain material as needed. Students also highly valued teachers who make lessons engaging and interesting, use games and interactive activities, teach effectively, and adapt their teaching to the students' level of knowledge. In the Measurement and Evaluation Knowledge category, students expressed their preference for teachers who make fair assessments, have strong observation skills, and constantly check students' understanding of the course content. Examples of student responses reflecting these perceptions are given below.

"I think that teachers should not only teach lessons but also encourage students if they are not participating in various activities, encourage them to participate, and encourage them to be active." (KS41)

"Each student has their own characteristics, talents and interests. As a teacher, he/she should be able to look at each child individually and understand their strengths and weaknesses." (KS28)

"I want him to be honest and give grades accordingly." (KS42)

The Personality Traits category includes the subcategories of Effective Communication Skills and Positive Social and Emotional Traits. In the sub-category of Effective Communication Skills, students emphasized the importance of having teachers who treat them with parental affection, understand their manner of speaking, take into account their wishes, build positive relationships with students and communicate using an appropriate and culturally respectful language (e.g. Kazakh). In the sub-category of Positive Affective Personality Characteristics, students' perceptions of desirable teacher behaviors were defined as demanding yet fair, creative, inspiring leaders, and engaging in their approach. They value teachers who do not abuse their responsibilities, demonstrate empathy and kindness, and are firm when necessary. Being a positive role model, self-confident, passionate about teaching, sincere, and patient were also frequently mentioned characteristics. Moreover, students highlighted traits such as being intellectually curious, emotionally balanced, respectful, understanding, optimistic, intelligent, affectionate, and cheerful. They appreciated teachers who are serious when appropriate, but also fun, humorous, helpful, honest, determined, and calm in their demeanor. As an example, direct quotes from some of the student answers are given below.

"I think the teacher's communication with the student is one of the important things that affects the success of the lesson." (KS28)

"What is important for me is that the teacher knows the student well." (KS29)

"I want a teacher to be more interesting than YouTube." (KS21)

"I want to have a teacher who not only educates students but also disciplines them and can be a role model." (KS40)

3.4. What are the characteristics of undesirable teachers according to the perceptions of 8th grade secondary school students in Kazakhstan?

The data regarding part (b) of the second sub-problem was also coded and the codes were collected under four categories. The codes examined under the categories Lack of Subject Matter Knowledge, Lack of General Culture, Lack of Professional Knowledge, Negative Personal Traits. were collected under the Undesirable Teacher Characteristics Theme and are detailed in Table 5 and Figure 4 below.

Table 5.
Characteristics of undesirable teachers according to the perceptions of 8th grade secondary school students in Kazakhstan

Theme	Category		Codes	f
Undesirable Characteristics	Lack of Subject Matter Knowledge		does not know the field well	36
			does not provide the nature of knowledge	11
	Lack of General Culture		not knowledgeable and intellectual	21
	Lack of Professional Knowledge	*Lack of Assessment and Evaluation Skills*	makes unfair assessment	24
		Lack of Teaching and Classroom Management Skills	does not teach effectively	30
			unfair/discriminating	23
			who does not answer questions	17
			does not explain the lesson	14

		does not inform about the goal and subject	12
		non-guide	11
		does not conduct entertaining lessons	9
		does not support the student	8
		who teaches with Soviet sociological education	7
		has one-dimensional thought	6
		only teaches the lesson	5
		does activities unrelated to the lesson	3
		only asks students to write	3
		explains incorrectly	2
		does not know students' rights	1
Negative Personal Traits	*Negative Communication*	not getting along well with students	25
		scolding students	14
		not understanding student mood	12
		comparing students	5
		humiliates students	5
		undisciplined	3
		not speaking in proper language (Kazakh)	2
	Negative Social and Emotional Traits	nervous	31
		dislikes teaching	26
		strict and oppressive	17
		insensitive	14
		does not like students	14
		tough person	13
		indifferent to students	12
		non-fun	11
		rude	9
		does not keep promises	7
		not improving oneself	5
		tend to violence	4
		stubborn	2
		egoistic	2
		prejudicial	1

In the categories Lack of Subject Matter Knowledge and Lack of General Culture (as shown in Table 5 and Figure 4), Kazakh students reported that they did not want teachers who were incompetent in their subject, unable to convey the essence of knowledge, or intellectually incompetent. Under the Lack of Professional Knowledge category, there are subcategories of Lack of Teaching and Classroom Management Skills and Lack of Assessment and Evaluation Skills. In the subcategory Lack of Teaching and Classroom Management Skills, students identified a number of undesirable characteristics of teachers. These include teaching based on outdated Soviet-style sociological approaches, unfairness or discrimination, ignorance of students' rights, a one-sided or narrow-minded point of view, inability to teach or incorrect teaching, avoidance of exciting or interesting lessons, conducting activities unrelated to the subject, giving only written assignments, and ineffective teaching. They also criticized teachers who simply convey information without engaging in meaningful interaction, do not answer students' questions, do not fulfil their role as guides, do not explain the aims and objectives of the lesson, and do not provide academic or emotional support. In the category Lack of Assessment and Evaluation Skills students considered unfair assessment practices to be a key negative characteristic. Below are direct quotes from students' responses reflecting these views.

"Also, the shortcomings of a bad teacher are lack of professionalism, lack of organizational skills, lack of content knowledge, i.e. lack of field knowledge." (KS14)

"I would not want to have a teacher who teaches with Soviet sociological education, I mean I would not want the authoritarian teacher characteristic that uses the traditional teaching method." (KS36)

"A bad teacher is a teacher who does not treat his students equally, who discriminates, who chooses students." (KS22)

"I don't want to have a teacher who doesn't give fair grades." (KS19)

The Negative Personal Traits category includes the subcategories of Negative Communication and Negative Social and Emotional Traits. In the subcategory Negative communication, students described undesirable traits in teachers, such as comparing students to each other, not understanding the students' language, humiliating or swearing at students, being undisciplined, not being able to get along with students, and using the Kazakh language incorrectly. In the subcategory Negative Social and Emotional Traits, students expressed that they do not want teachers who fail to improve themselves, are biased, stubborn, humorless, quick-tempered, egoistic, lack passion for teaching, show no empathy, are prone to aggression, overly strict or oppressive, indifferent toward students, rude, dislike students, break promises, or behave harshly. The following section presents direct quotes from students that illustrate these perspectives.

> *"It is to apply too much psychological pressure to the student. For example: saying that you are behind some students in terms of IQ due to your brain's lack of information or saying derogatory things about a student. For example: This Enlik (name taken as an example) is always superior to you in terms of knowledge, examples of why you are so stupid/lazy." (KS11)*
>
> *"A teacher who shouts at students, asks if they don't know, doesn't understand, makes students feel afraid, scolds, is a bad teacher." (KS32)*
>
> *"To me, the bad teacher is the one who doesn't care about the students' lesson and problems." (KS30)*

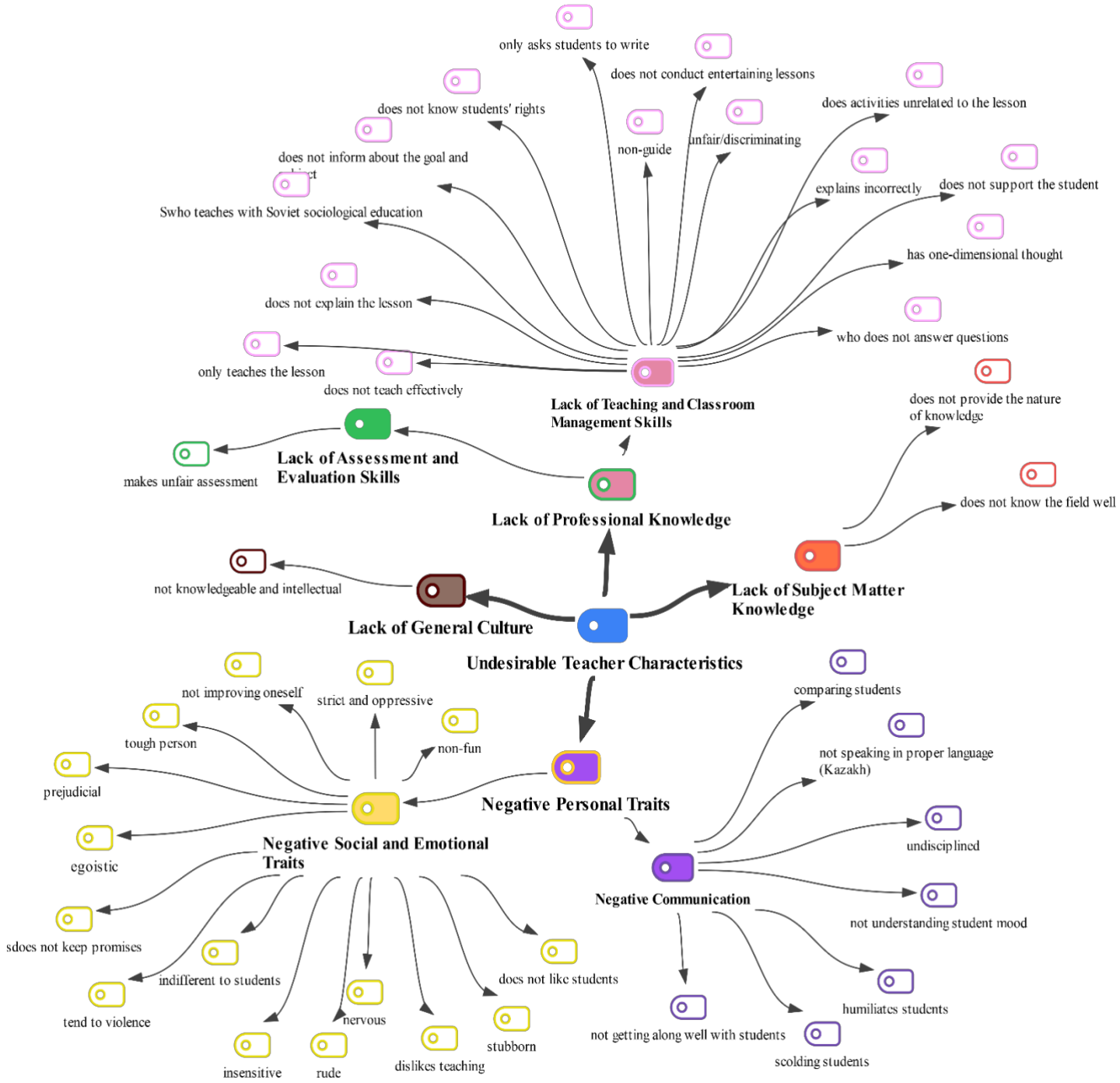


Figure 4. Characteristics of Undesirable teachers according to the perceptions of 8th grade secondary school students in Kazakhstan (The Hierarchical Code-Subcode Model exported from MAXQDA software).

3.5. What are the similarities and differences in terms of desirable and undesirable teacher characteristics according to the perceptions of 8th grade secondary school students in Türkiye and Kazakhstan?

The similarities and differences in desirable and undesirable teacher characteristics, as perceived by 8th-grade students in Türkiye and Kazakhstan, are presented in Tables 6 and 7 below.

Table 6.
Similarities and Differences in Desirable Teacher Characteristics According to the Perceptions of 8th- Grade Students in Türkiye and Kazakhstan

Türkiye-Specific	Shared Characteristics	Kazakhstan-Specific
informs us about the target and behavioral objectives	has strong subject matter knowledge	uses various teaching methods
has classroom authority	provides satisfactory answers to questions	creates an enjoyable lesson environment

provides additional learning materials	explains the nature of knowledge	uses peer-to-peer learning
uses positive reinforcement	knowledgeable and intellectual	has a contemporary approach
gives practice tests	teaches lessons to students' level	gives less homework
makes students love the lesson	fair / non-discriminatory	has strong observation skills
explains lessons using stories	teaches effectively	speaks in proper language (e.g., Kazakh)
organizes extracurricular activities	does not leave questions unanswered	creative
gives corrective feedback	makes lessons fun	a leader
uses lesson time efficiently	re-explains the lesson when necessary	demanding
promotes learner autonomy	shows interest in students	self-confident
gives easy exam	supports each student individually	inquisitive / researcher
acts like a friend	provides lessons with games and activities	determined
avoids slang and swearing	encourages students to ask questions	
energetic	well organized	
uses gestures and facial expressions	supportive	
protective	disciplined	
motivates students for exams	acts as a guide	
optimistic	evaluates fairly	
values religious and national culture	asks whether students understand	
keeps secrets	understands students' mood	
ambitious	considers student requests	
	maintains good relations with students	
	approaches like a parent	
	understanding	
	kind	
	helpful	
	loves teaching	
	emotionally controlled	
	empathic	
	positive	
	sincere	
	smiling	
	respectful to students	
	serious when necessary	
	patient	
	honest	
	role model	
	intelligent	
	calm	
	caring	
	compassionate and merciful	
	funny	
	humorous	

As shown in Table 6, when we compare the perceptions of 8th- grade students in Türkiye and Kazakhstan, we see many similarities in how they define desirable teacher characteristics. Students in both countries want teachers who answer questions clearly and have strong subject knowledge. They value teachers who explain the nature of knowledge and do not leave questions unanswered.

Both Turkish and Kazakh students prefer teachers who care about students and treat them fairly. They want teachers who are disciplined, supportive and organized. Being a good guide, encouraging questions and making lessons enjoyable are also seen as important. Students appreciate when teachers use games and activities, explain topics clearly, and adapt teaching methods to the level of the students.

They also expect their teachers to understand their language, listen to their requests and build good relationships. Qualities such as kindness, sincerity, patience, calmness, respect and positivity are highly valued. Students admire teachers who love their job, smile often, empathize, serve as role models, and are helpful, honest and intelligent.

Turkish students also mentioned some unique preferences. They want teachers who provide additional materials and clearly explain the learning objectives. They prefer teachers who give practice tests, correct mistakes and make them enjoy the lesson. Managing time well, using storytelling and motivating for exams were also emphasized. Students in Türkiye expect teachers to use positive reinforcement, avoid slang expressions and control their temper. They value teachers who are energetic, respectful of national and religious values, optimistic and protective.

Kazakh students, on the other hand, want teachers who use different teaching methods and give less homework. They prefer a modern and pleasant classroom environment. They value peer learning and correct language use. They also appreciate teachers who observe students well, are creative, self-confident, demanding when necessary, and act as leaders.

Table 7.
Similarities and Differences in Undesirable Teacher Characteristics According to the Perceptions of 8th- Grade Students in Türkiye and Kazakhstan

Türkiye-Specific	**Shared Characteristics**	**Kazakhstan-Specific**
fails to re-teach when necessary	does not provide the nature of knowledge	does not know students' rights
uses only one teaching method	makes unfair assessments	teaches with Soviet-style sociological education
excludes students from lessons	unfair / discriminating	explains incorrectly
becomes angry when asked questions	who has one-dimensional thought	does not conduct entertaining lessons
restricting freedom of though	does not explain the lesson	comparing students
talks about irrelevant topics	does activities unrelated to the lesson	not speaking proper language (Kazakh)
does not act like a friend	only asks students to write	not improving oneself
ignores students' requests	does not teach effectively	prejudicial
uses slang	does not answer to questions	stubborn
uses phone during class	does not support the student	
his/her face is sullen	humiliates students	
overly relaxed	scolding students	
hurtful	undisciplined	
does not make jokes	not getting along well with students	
lacks empathy	nervous	
	does not like students	
	dislikes teaching	
	insensitive	
	strict and oppressive	
	indifferent to students	
	rude	
	breaks promise	
	not fun	
	tend to violence	

As shown in Table 7, when looking at the shared perceptions of 8th-grade students in Türkiye and Kazakhstan, we see many common traits they associate with undesirable teacher characteristics. Students from both countries do not want teachers who fail to explain the nature of knowledge, are unfair or discriminatory, have a narrow mindset, fail to lecture properly, or do unrelated activities during lessons. They dislike teachers who only make them write, do not teach effectively, or ignore student questions. Students also reject teachers who humiliate or scold them, lack discipline, have poor relationships with students, are not fun, are often angry, dislike their profession, are difficult to understand, display violent behavior, are overly strict or indifferent, and those who are rude or harsh. Teachers who break promises or do not like students are also seen negatively.

Some differences also emerged. Turkish students said they do not want teachers who restrict freedom of thought, become angry when asked questions, kick students out of class, use a one-size-fits-all teaching method, refuse to re-explain lessons, speak in slang, avoid humor, lack empathy, frown often, say hurtful things, or are distracted by their phones during class. Kazakh students, on the other hand, criticized teachers who follow outdated Soviet-style education, are unaware of student rights, fail to make lessons enjoyable, speak improperly, or do not engage in self-improvement.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

The findings of this study show that eighth-grade students in Türkiye and Kazakhstan have remarkably similar perceptions of the characteristics of desirable teachers. Students emphasize the importance of teachers having a broad general culture, deep intellectual and subject knowledge, pedagogical skills, and a positive attitude toward students. It is particularly noteworthy that students insist that effective teaching goes beyond simply presenting material; it includes linking lesson objectives to practical applications, adapting explanations to individual student levels, and reinforcing understanding through repeated explanations when necessary. This approach is consistent with contemporary educational theories that advocate student-centered learning and differentiated instruction.

Students also value teachers who encourage inquiry by answering questions in detail and encouraging them to ask more questions. The desire for individual attention and support reflects an understanding of diverse learning needs, consistent with Strikwerda-Brown et al.'s (2008) findings on student's appreciation for teachers who recognize different learning speeds and styles. Effective teaching, including fun elements such as games and activities, along with tolerant yet consistent maintenance of classroom discipline, was also emphasized.

Teachers' affective characteristics such as patience, kindness, friendliness, sincerity, enthusiasm, empathy and professionalism have been consistently emphasized, underlining the vital role of teacher personality in creating a supportive learning environment. The expectation that teachers understand students' moods and respond with protective, parent-like concern further emphasizes the emotional dimension of teaching, which has long been recognized as essential for student well-being and motivation. This reflects the understanding that effective teaching extends beyond content delivery to the nurturing of positive relationships that enhance learning.

The emphasis by students in both countries on knowledgeable and intellectual teachers who both transmit culture and encourage creative and critical thinking is consistent with Senemoğlu's (1990) perception that teachers serve as cultural transmitters and innovators. The preference for individualized instruction and adaptation to student levels is in line with contemporary educational practices advocating differentiation. Turkish and Kazakh students' insistence on re-explanation and question answering shows that they are aware of the importance of feedback and formative assessment in the learning process. This finding supports Senemoğlu's (2001) emphasis on the use of effective tools to maintain motivation, discipline and attention and to facilitate learning.

Students' emphasis on fairness, non-discrimination and positive classroom interaction echoes the findings of Azer (2005), Stronge (2007) and Szűcs Ida (2017) who emphasize respectful and equitable teacher-student relationships as the cornerstones of effective education. Students' appreciation of humor, empathy and kindness (Gürcan, 2020) highlights the role of emotional intelligence in teaching, which helps to create a positive classroom environment conducive to learning. Students' desire for teachers who are role models and behave with parental care can be interpreted as an expression of the need for psychological trust, which is a prerequisite for effective learning. This supportive stance is in line with the findings of Strikwerda-Brown et al. (2008) that students value teachers who respect and treat them as individuals.

In the literature, there are studies with similar results. For example, Raufelder et al. (2016), who conducted research on good and bad teacher characteristics, stated that being competent in one's subjects area is one of the good teacher characteristics. In addition, Shulman (1986, 1987) argued that content knowledge is the main element of teacher characteristics, because if the teacher does not know what to teach, he/she cannot know how to teach. It is also important that teachers ask students whether they understand the subject matter, because as Coulter (1979) states in his study, if students leave the class without understanding the subject matter, they will have more difficulties in doing homework.

In the study conducted by Senemoğlu (2001) students stated that the characteristics of good teacher are helping them solve their questions, motivating them to learn, providing discipline in the classroom, drawing attention to the subject, ensuring that attention is maintained throughout the lesson, being planned, using effective tools and materials in the lesson, providing examples from life, approaching them with respect and love, being fair and non-discriminatory, dealing with the student as a whole and establishing positive communication and gaining desired behaviors. In Toraman's (2019) study, students stated the characteristics of effective teachers as explaining the lesson clearly, repeating the incomprehensible subjects, explaining the lesson according to the student level, using instructional technologies in the lesson, making the lesson fun, using appropriate teaching materials, ensuring student participation in the lesson, using various methods and techniques in the lesson, taking into account the individual differences of the students, and possessing sincere qualities. According to the findings of Sarıtaş's (2013) study, the qualities that should be present in the ideal teacher in student opinions are clarity in speech and expression, the ability to warn/advise students, careful lesson preparation, choosing appropriate and effective methods, creating an emotional

atmosphere that will lead to efficiency in the classroom, understanding the nature and needs of the child, the ability to enrich the subject, asking easy questions in exams, being fair, open-minded, understanding, patient, tolerant. Similarly, Gürcan (2020) found that secondary school students wanted to see characteristics such as not getting angry, being fair, tolerant, smiling, humorous, empathizing and loving from their teachers. Strikwerda-Brown et al. (2008) stated that since students' study in different ways and at different speeds, they want teachers to find an approach that takes this into account and that they want to have teachers who treat them well, respect them, treat them as individuals and they value teachers who communicate well with them. In addition, Azer (2005) stated that one of the twelve characteristics of a good teacher is that teachers interact well with students and respect them. Stronge (2007) argued that teachers' ability to establish positive connections and good communication with students is an important factor in student achievement and creates a pleasant classroom atmosphere. In addition, according to the results of the study conducted by Szűcs Ida (2017) it is seen that the characteristics of being fair to students, dealing with student problems, communicating well with students and being respectful to students are at the forefront. Based on the above research results, it is seen that the findings of our research also support the studies conducted in the literature to a great extent.

According to the views of 8th grade students in Türkiye and Kazakhstan, undesirable teacher characteristics were interpreted under four categories in a consistent manner. When the research findings are analyzed, it is seen that "lack of professional knowledge" and "negative personal traits" categories stand out in terms of the number of codes related to undesirable teacher characteristics. In this context, it can be said that the majority of students' undesirable teacher characteristics were related to the teacher's negative personality traits and lack of professional knowledge. Similarly, Valcarcel et al. (2021) examined students' negative evaluations of their teachers posted on the RateMyTeacher.com website. According to the results of the study, it was found that the students' evaluations were relatively evenly divided between criticisms of teachers' teaching skills and criticisms of their personalities.

The differences between Turkish and Kazakh students' preferences are striking and probably reflect the different educational and socio-cultural contexts in which these students are situated. Turkish students' preference for teachers who provide additional learning materials, clear behavioral targets, frequent testing and exam motivation may be related to the high-stakes nature of the 8th grade high school transition exam in Türkiye. This exam-centered culture shapes students' expectations towards a more structured and goal-oriented pedagogy aimed at exam success. On the other hand, Kazakh students' preferences for modern teaching methods, peer learning, less homework and creativity reflect recent educational reforms in Kazakhstan aimed at modernization. The emphasis on proper language use and responsibility also points to cultural values related to language identity and teacher professionalism.

The harsh condemnation of teachers who humiliate or scold students and behave in an undisciplined or indifferent manner, shows students' sensitivity to emotional safety and positive relationship climates in the classroom. Turkish students' concern for freedom of thought points to a value placed on intellectual openness and professional courtesy. Meanwhile, Kazakh students' objections to outdated Soviet pedagogical approaches and a lack of personal development emphasize the importance of continuous professional development and culturally appropriate pedagogy. There are studies with similar results in the literature. For example, Wang et al. (2007)found that the teacher characteristics that students defined as bad teachers were rude, shouting, not paying attention to what they say, not taking their job seriously, not communicating with students, and not motivating.

In general, the widespread consensus among students about desirable and undesirable teacher characteristics suggests that students are not passive consumers of education but have well-formed expectations based on their learning experiences. Their emphasis on intellectual rigor, pedagogical effectiveness, emotional warmth and fairness suggests a holistic model of teaching that balances cognitive and affective domains. The parent metaphor used by students to describe desired teacher behavior points to a basic human need for care and support in educational settings, supporting Senemoğlu's (1990) perspective on the holistic nature of teacher roles. The tension between disciplinary requirements and the need for warmth and empathy reflects the complexity of the teaching profession, which requires a balance between authority and approachability. The differences between Turkish and Kazakh students' expectations also highlight the influence of systemic factors such as national curricula, assessment systems and cultural norms in shaping student perceptions. Understanding these contextual differences is essential for developing teacher education programs tailored to local needs while maintaining universal standards of effective teaching.

The present study contributes to the literature by not only confirming several well-established characteristics of desirable and undesirable teachers but also revealing how these are expressed in culturally related yet structurally distinct educational contexts. By analyzing the perceptions of 8th-grade students in Türkiye and Kazakhstan, this research offers a nuanced understanding of both universal expectations and context-specific preferences shaped by systemic and cultural factors.

In this research, according to the views of 8th-grade students in Türkiye and Kazakhstan desirable and undesirable teacher characteristics were revealed. The findings of this research are very similar to the findings of other studies conducted on this subject in various countries. In this case, the following suggestions can be made regarding the development of both pre-service and in-service teacher education programs for the training/development of teachers with desirable teacher characteristics in both countries:

Given students' demand for teachers with broad general knowledge, teacher education programs should include comprehensive cultural and intellectual development components.

Students demand teachers who have complete and accurate field knowledge and who can effectively impart this knowledge to students in a wide variety of ways and materials. In this case, the nature of knowledge should be effectively taught to prospective teachers and teachers in teacher training programs, and information on how to impart this knowledge to students should be given in multidimensional brain-friendly educational environments within the integrity of theory and practice.

Students want teachers who make accurate and fair measurement and evaluation to ensure their development. In this case, in teacher training programs, meaningful brain-friendly education should be provided for students and teachers in order to provide the functions and qualities of measurement and evaluation to teacher candidates and teachers in a meaningful way.

Students demand teachers with healthy personality traits in all aspects. In this case, it is important to select prospective teachers from among socially and mentally healthy individuals and to protect the social and mental health of teachers in service. For this purpose, the Ministry of National Education and the Ministry of Health should co-operate to ensure that teachers and students can live their lives as fully healthy individuals.

In teacher education programs, effective training should be provided with virtual reality teaching materials with direct real examples to gain desired teacher characteristics.
Moreover, the present study could be replicated by including the perspectives of teachers, parents and students, which would provide a more comprehensive understanding of the phenomenon under study. Such an approach also makes it possible to compare the perceptions of these different stakeholders, providing a richer and more multidimensional picture. Furthermore, the study can be extended to include examples from other countries, allowing for cross-cultural comparisons and contributing to a broader understanding of the topic in different educational contexts.

Research and Publication Ethics Statement

Ethics committee approval for the research was obtained with the decision of the Hacettepe University Senate Ethics Commission dated May 9, 2023.

Contribution Rates of Authors to the Article

This research is derived from the first author's ongoing doctoral thesis conducted under the supervision of the second author. Accordingly, the first author participated in all stages of the research. The second author, as the supervisor, provided guidance and feedback throughout the research process.

Statement of Interest

There is no conflict of interest between the authors.

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Adaptation Study of the Problematic ChatGPT Use Scale into Turkish*

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ABSTRACT

The purpose of this study is to examine the validity and reliability of the Turkish form of the Problematic ChatGPT Use Scale developed by Yu et al. (2024). Unconscious and excessive use of technology may lead to negative psychological, social, and academic outcomes, and the scale was designed to identify whether individuals engage in unhealthy or maladaptive patterns of ChatGPT use. Following the linguistic and conceptual adaptation procedures, the scale was administered to adult participants aged 18–60. A total of 301 adults participated in the study (204 women, 97 men). Exploratory and confirmatory factor analyses indicated that the scale has a single-factor structure consisting of 11 items rated on a five-point Likert format. Factor loadings ranged from 0.52 to 0.87. In the confirmatory factor analysis, the chi-square value was significant (χ^2 = 2319.736, df = 55, p = .00), and the fit indices were CFI = 0.819, TLI = 0.774, RMSEA = 0.178, and SRMR = 0.107. Internal consistency analysis yielded a Cronbach's alpha coefficient of 0.91. Criterion validity was supported by a significant correlation with the Artificial Intelligence Dependence Scale, indicating conceptual overlap between the two constructs. Overall, the findings show that the Turkish version of the Problematic ChatGPT Use Scale is a valid and reliable instrument for assessing problematic ChatGPT use among adults.

Keywords: Problematic ChatGPT Use, Artificial Intelligence Addiction Scale, Validity, Reliability.

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1. INTRODUCTION

Developing artificial intelligence technologies are significantly contributing to how people interact with digital environments. This transformation is part of a broader shift in Industry 4.0, which has introduced new approaches across various sectors, including production management and marketing (Tehci & Ersoy, 2018). This process can lead to the development of problematic use habits in some individuals. Digital addiction and problematic technology use are defined as excessive and uncontrolled attachment to tools such as digital games, AI-powered chatbots, social media, and the internet (Meng et al., 2022). These types of habits can negatively affect people socially, psychologically, and academically, and can impair their functioning (Griffiths et al., 2014; Young, 1998). The impact of digital technologies is not just an external change; it has become a factor that directly affects the quality of life for individuals.

Today, the rapid proliferation of AI-powered chatbots has brought the issue of technology addiction back to the forefront. Developed by Open AI, ChatGPT has rapidly gained popularity in daily and academic life due to its ability to generate human-like responses and provide information on a wide range of topics (Feuerriegel et al., 2024). However, this rapid proliferation can lead some individuals to become overly reliant on AI-based systems like ChatGPT. This situation can negatively impact individuals' social and cognitive abilities and weaken their real-world interaction and thinking skills (Xie et al., 2023). A life intertwined with artificial intelligence can actually reinforce individuals' dependence on technology, disrupting the balance in their relationship with the digital world.

The purpose of this study is to adapt the "Problematic ChatGPT Use Scale" developed by Yu et al. (2024) into Turkish and to test its linguistic equivalence, validity, and reliability. The adaptation process was carried out in accordance with international scale adaptation standards, considering both linguistic and cultural requirements to ensure psychometric appropriateness for

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individuals in Turkey. This study aims to determine individuals' levels of problematic ChatGPT use and contribute to future research on digital addiction.
The focus of the study has been shaped around the following questions.
RQ1: Is the Turkish version of the Problematic ChatGPT Use Scale linguistically and conceptually equivalent to the original scale?
RQ2: Does the Turkish form demonstrate an adequate factor structure consistent with the original instrument?
RQ3: Are the reliability coefficients of the Turkish version (e.g., Cronbach's alpha, CR) within acceptable ranges?
RQ4: Does the scale demonstrate sufficient convergent, discriminant, and criterion validity in the Turkish sample?
These research questions directly guided the methodological process and were addressed through the analyses presented in the findings section.

Problematic digital technology use can be defined as individuals becoming uncontrollably and excessively dependent on technology, and this can be divided into different subcategories. These categories include areas such as problematic internet use (PIU), problematic social media use (PSMU), internet gaming disorder (IGD), and problematic chatbot use. The increasing prevalence of advanced chatbots like ChatGPT has led to the emergence of a new form of problematic technology use, increasing the risk of dependence on these systems (Ramadan, 2021; Xie et al., 2023). This new type of addiction can negatively impact individuals' daily lives, mental health, and social relationships. This evolving technology can also change human interactions and social bonds, making it difficult to understand and prevent new types of addiction.

Problematic Internet Use (PIU) is defined as individuals using the internet in an uncontrolled and overly dependent manner, which can negatively impact a person's academic, social life, and work (Chou et al., 2005; Young, 1998). Similarly, problematic social media use (PSMU) is a condition where individuals can impair their mental health by excessively using social media platforms (Andreassen, 2015). AI-powered chatbots, on the other hand, have the potential to replace social interactions because they offer customized responses to users. This can also lead individuals to withdraw from social relationships and even experience social isolation (Kim et al., 2022). These AI-based systems, by replacing human interactions, can lead individuals to experience emotional states such as loneliness and depression more frequently. Excessive use of such technologies can weaken individuals' real-life social connections and increase their sense of loneliness.

Chatbot addiction is characterized by people replacing human interaction with digital tools (Skjuve et al., 2021). It is possible for individuals to form emotional attachments to advanced AI-powered chatbots like ChatGPT because they make users feel understood (Pentina et al., 2023). These chatbots can encourage users to use them more by making them feel like a personal touch. According to Xie et al. (2023) study, people form safer and less anxious relationships with chatbots. Therefore, people can communicate with chatbots more easily and become more dependent on these technologies over time. However, preferring ChatGPT over social interaction can harm individuals' real-world interpersonal relationships.

The psychological effects of using ChatGPT on individuals should be comprehensively examined. Excessive interaction with AI-powered chatbots can lead to depression and anxiety (Huang et al., 2024). The 24/7 accessibility of platforms like ChatGPT could lead individuals to turn to these platforms exclusively during stressful and difficult moments. This situation can lead to social isolation and detachment from real human relationships over time (Ramadan, 2021). When individuals turn to digital chatbots for emotional support and comfort, they may lack genuine human interaction, which could jeopardize their psychological well-being. Using ChatGPT can reinforce cognitive biases and weaken critical thinking skills (Feuerriegel et al., 2024). ChatGPT can help acquire information with less cognitive effort, especially in academic and professional settings. Individuals who rely on ChatGPT's responses may experience a decline in their decision-making skills and problem-solving abilities (Khan, 2025; Zhou et al., 2024). When people constantly rely on external information, they can lose their critical thinking and analytical skills. Over-reliance on ChatGPT, especially in academic settings, can passive students' learning process and lead to cognitive laziness (Marriott & Pitardi, 2024).

The aim of this study is to adapt the Problematic ChatGPT Use Scale into Turkish and examine its psychometric properties. As AI-powered chatbots become increasingly integrated into daily life, concerns about excessive or maladaptive use have grown, given its potential negative effects on individuals' social, academic, and psychological functioning. Accordingly, this study evaluates the scale's factor structure, reliability, validity, and linguistic–cultural compatibility within the Turkish context. In addition, the relationships between problematic ChatGPT use and relevant psychological variables are explored to provide a clearer understanding of how AI-supported chatbots may influence individuals. This research is expected to contribute to the literature and offer a solid foundation for future studies in this emerging field.

2. LITERATURE REVIEW

2.1. Problematic ChatGPT Use

The rapid expansion of generative artificial intelligence tools such as ChatGPT has introduced new patterns of digital behavior, including the potential for excessive or maladaptive use. Unlike traditional digital platforms, ChatGPT provides continuous, personalized, and human-like conversational interaction, which may increase the risk of psychological dependence (Xie et al., 2023). Studies indicate that frequent and emotionally charged interactions with AI systems can reduce real-world social

engagement, reinforce avoidance-based coping strategies, and increase psychological reliance (Huang et al., 2024; Pentina et al., 2023).

Problematic ChatGPT use refers to excessive, uncontrolled, and maladaptive engagement with ChatGPT that disrupts individuals' social, academic, and psychological functioning (Yu et al., 2024). This includes symptoms such as preoccupation, loss of control, withdrawal-like reactions, and interference with daily activities. Given that this form of AI-specific behavior is relatively new, measurement tools are needed to systematically examine its psychological correlates.

2.2. Related Constructs: Digital Addiction and AI Dependence

Problematic ChatGPT use shares certain features with established forms of digital addiction—such as problematic internet use (Young, 1998), problematic social media use (Andreassen, 2015), and AI dependence (Morales-Garcia et al., 2024)—including loss of control, excessive engagement, tolerance, and functional impairment. However, ChatGPT differs due to its interactive depth and generative capacity, which enable users to receive instant information, emotional support, and personalized responses.
Research shows that overreliance on AI-based chatbots can increase loneliness, social withdrawal, and reductions in decision-making and critical thinking (Duong et al., 2024; Ramadan, 2021). These findings demonstrate the importance of developing tools capable of assessing AI-specific maladaptive behaviors rather than relying solely on general internet-related measures.

2.3. Need for a Valid and Culturally Appropriate Measurement Tool

Yu et al. (2024) developed the Problematic ChatGPT Use Scale to assess psychological dependence and loss of control specifically associated with ChatGPT. However, no validated Turkish instrument existed. Considering the rapid adoption of AI tools in Türkiye across academic, professional, and personal contexts, there is a need for a culturally adapted, psychometrically sound scale.

Adapting the scale into Turkish provides researchers with a standardized tool for investigating problematic ChatGPT use and examining its associations with cognitive, emotional, and behavioral variables.

3. METHOD

The study primarily focused on the linguistic and cultural adaptation of the scale and followed internationally recognized guidelines for test adaptation (e.g., ITC and Hambleton-based procedures). In the first stage, a forward–backward translation process was implemented. Five independent bilingual translators, all fluent in both Turkish and English and familiar with psychological terminology, translated the original items into Turkish. These versions were compared and synthesized into a single preliminary Turkish form by a small reconciliation team. Next, this preliminary form was back-translated into English by another five bilingual translators who were blinded to the original scale.

All forward and backward translations were then reviewed by a panel of three field experts (academics in psychological counseling and educational sciences with experience in scale development and digital addiction research). The expert panel evaluated each item in terms of semantic equivalence, conceptual consistency, and cultural appropriateness for adults in Türkiye and suggested minor wording changes where necessary. Following this expert review, cognitive interviews were conducted with a small group of participants (n = 20) to check item clarity, interpretability, and perceived relevance. Based on their feedback, minor linguistic refinements were made.

Subsequently, a pilot study was carried out with a separate group of participants to examine the functioning of the items (e.g., response distributions, initial internal consistency). After confirming that the Turkish items operated adequately, the main data collection was conducted. For the main study, data were obtained from 301 adult volunteers residing in Türkiye, and the psychometric analyses of the Turkish version of the Problematic ChatGPT Use Scale were performed. After data collection, a construct validity study was conducted (EFA and CFA), criterion validity was examined using the Turkish version of the Artificial Intelligence Dependence Scale (Savaş, 2024), and reliability analyses (e.g., Cronbach's alpha, CR) were carried out. In addition to exploratory and confirmatory factor analyses, internal consistency coefficients were calculated to evaluate the reliability of the adapted scale.

3.1. Scales Used in the Study

Artificial Intelligence Dependence Scale (Morales-Garcia et al., 2024; Turkish adaptation by Savaş, 2024) is a five-item scale. Participants can score from 1 to 5, meaning they strongly disagree or strongly agree. High scores indicate an increasing dependence on artificial intelligence. In the study conducted by Morales-Garcia et al. (2024), the internal consistency coefficient of the scale created by 528 university students is a Cronbach Alpha value of 0.87. In a study conducted by Savaş (2024), there were 584 students, and the internal consistency coefficient, Cronbach's Alpha value, was 0.82. The method was applied to participants voluntarily, and the response time varied between three and four minutes.

The Problematic ChatGPT Use Scale was first developed in a study by Yu et al. (2024). Participants can answer this scale with 11 questions, ranging from 1 to 4. High scores indicate problematic ChatGPT usage.

This study examined the relationship between the widely used and validated Artificial Intelligence Addiction Scale and the Problematic ChatGPT Use Scale. The analysis focused on how the new scale related to the AI Addiction Scale, indicating that both instruments measured conceptually similar constructs. The reliability and validity of the scale were tested using several statistical techniques. First, Cronbach's alpha was calculated to assess internal consistency. This coefficient served as an indicator of the scale's reliability. In addition, the compatibility of the factor structure with the theoretical model was evaluated through confirmatory factor analysis (CFA) to test construct validity. These analyses assessed the psychometric properties of the Problematic ChatGPT Use Scale and demonstrated whether it functioned as a reliable and valid measurement tool.

3.2. Data Collection Process

The survey design of the study was approved by the Scientific Research and Publication Ethics Committee of Nevşehir Hacı Bektaş Veli University. Before the final administration, the survey was pilot-tested with 310 adult participants, and the survey was revised based on their feedback. For the main study, data were collected from adult volunteers aged 18–60 residing in Türkiye. The Problematic ChatGPT Use Scale, developed by Yu et al. (2024), was included in the final survey form as an 11-item measure.

3.3. Data Analysis

Reliability and validity analyses were carried out based on established methodological guidelines in the literature. In addition to construct validity procedures, extensive validity steps were followed in accordance with recommendations by DeVellis (2017), Kline (2015), and Tabachnick & Fidell (2019). Expert opinions were obtained, and a detailed literature review was conducted as part of the content validity process (Lawshe, 1975). The suitability of the data for factor analysis was examined using the Kaiser–Meyer–Olkin (KMO) coefficient and Bartlett's Test of Sphericity (Kaiser, 1974). Following this, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted in line with the guidelines of Byrne (2016) and Worthington & Whittaker (2006). Item–total correlations and item discrimination indices were calculated. Internal consistency reliability was assessed using Cronbach's alpha (Cronbach, 1951). All analyses were performed using SPSS 22, R, and AMOS 24 software.

3.4. Sample Characteristics

Adults aged 18 to 60 constituted the study group. Participants were recruited through online announcements shared on social media platforms (Instagram, WhatsApp groups, and Telegram channels) and through university community networks. Individuals who volunteered to participate and confirmed that they were active ChatGPT users were included in the study. Inclusion criteria were: (a) being between 18 and 60 years old, (b) residing in Türkiye, and (c) voluntarily agreeing to participate. Exclusion criteria were incomplete responses and failure to provide informed consent. A total of 310 adults responded to the survey, but 9 forms were excluded because they did not meet the data-quality requirements; thus, 301 valid responses were used for analysis. Simple random sampling was applied among volunteers who met the inclusion criteria. Of the participants, 97 (32.2%) were male and 204 (67.8%) were female. Sample size was deemed sufficient based on the criterion that the number of participants should be at least five times the number of items (Tavşancıl, 2006). In the first application, all 301 adult participants were included in the exploratory factor analysis (EFA), and in the second application, the same participants were included in the confirmatory factor analysis (CFA). In addition to these guidelines, recent literature suggests that employing efficient estimation methods in sampling designs can further improve the reliability of statistical outcomes (Zaman, 2019).

Table 1.
Demographic characteristics of the study group

Gender		**Frequency**	**Percentage**	**Valid Percentage**	**Cumulative Percentage**
Gender	Woman	204	67,8	67,8	67,8
	Male	97	32,2	32,2	100,0
	Total	301	100,0	100,0	
Civil Status	Single	240	79,7	79,7	79,7
	Married	61	20,3	20,3	100,0
	Total	301	100,0	100,0	
Age	Between 18 and 28	220	73,1	73,1	79,1
	Between 29 and 39	58	19,3	19,3	92,4
	Between 40	18	6,0	6,0	98,3

	and 50				
	51 years and older	5	1,7	1,7	100,0
	Total	301	100,0	100,0	
ChatGPT Usage Hour	0	105	34,9	34,9	34,9
	1	137	45,5	45,5	80,4
	2	33	11,0	11,0	91,4
	3	11	3,7	3,7	95,0
	4	8	2,7	2,7	97,7
	5	4	1,3	1,3	99,0
	6	1	,3	,3	99,3
	7	2	,7	,7	100,0
	Total	301	100,0	100,0	

4. FINDINGS

4.1. RQ1: Assessment of the Linguistic and Conceptual Equivalence of the Turkish Version

The linguistic and cultural adaptation of the scale was carried out in accordance with internationally accepted guidelines for test adaptation (e.g., ITC and Hambleton procedures). First, a forward–backward translation approach was employed. Five independent bilingual experts translated the original items into Turkish, and these translations were synthesized into a unified preliminary version. This version was then back-translated into English by a different group of five bilingual translators who were not familiar with the original instrument. All translation forms were subsequently evaluated by a panel of three experts in psychological counseling and educational sciences who had experience in scale development and digital technology–related behavioral research. The panel reviewed each item for semantic and conceptual equivalence, clarity, and cultural appropriateness for adults in Türkiye. Minor wording adjustments were made in line with their recommendations. To further ensure linguistic and conceptual equivalence, cognitive interviews were conducted with a small group of participants (n = 20). These interviews examined item clarity, comprehensibility, and perceived relevance. Participants' feedback indicated that the items were understandable and contextually appropriate, requiring only minor refinements. Finally, a pilot study was conducted to evaluate item functioning in practice, including response patterns and initial reliability indicators. The results confirmed that the Turkish items were linguistically and conceptually equivalent to the original scale and suitable for use in the main study.

4.2. RQ2: Evaluation of the Factor Structure Exploratory factor analysis

Principal Component Analysis was used to verify the construct validity. The single-factor analysis was performed without rotation. For example, the KMO test value was found to be 0.914 and the Bartlett's test value was found to be 2319.736 (df=55, p=0.00). These results indicate that the scale data is suitable for factor analysis (Kalaycı, 2009; Sönmez & Alacapınar, 2014). Following these results, principal component analysis was performed to determine the elements of the scale. As a result of factor analysis, only one factor with an eigenvalue above 1 was found. This accounts for 56.14% of the total variance. All items are at an acceptable level in terms of factor loadings, and the factor loadings range from 0.521 to 0.875. The analysis reveals that the scale has a one-dimensional structure. Factor analysis linked all components of the scale to a single factor, which accounted for 56.14% of the total variance. This finding indicates that the scale is unidimensional. Additionally, the common variances of the items, i.e., the communalities, are generally at an acceptable level. Although I1 (0.271) and I2 (0.296) have relatively low common variance, they were deemed suitable for inclusion in the analysis due to sufficient factor loadings.

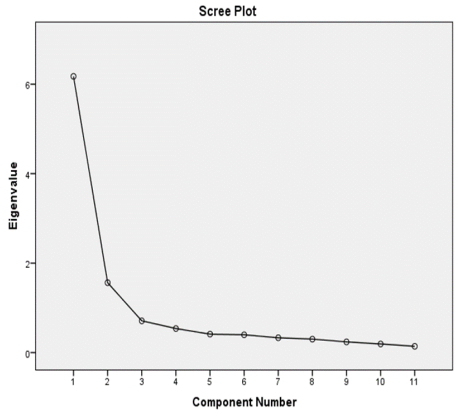


Figure 1. Factor line graph.

Table 2.
Factor loadings and common variances of scale items

Item	Factor Loading	Communality
I1	0,521	0,271
I2	0,544	0,296
I3	0,745	0,555
I4	0,707	0,500
I5	0,846	0,716
I6	0,804	0,647
I7	0,812	0,659
I8	0,875	0,765
I9	0,824	0,678
I10	0,809	0,655
I11	0,658	0,432

In factor analysis, common variances of items close to 1.00 or above 0.66 are considered a good model fit (Büyüköztürk, 2007). Table 3 shows the inter-item correlations. In this context, fundamental information regarding the use of R software is addressed in Bulut (2023).

Table 3.
Inter-item correlations

N=301	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
I1	1	0,534	0,444	0,474	0,373	0,348	0,315	0,332	0,238	0,258	0,29
I2		1	0,551	0,625	0,336	0,304	0,328	0,308	0,199	0,266	0,364
I3			1	0,649	0,563	0,472	0,507	0,578	0,478	0,449	0,508
I4				1	0,504	0,44	0,544	0,484	0,375	0,364	0,521
I5					1	0,706	0,67	0,751	0,694	0,732	0,447
I6						1	0,659	0,745	0,691	0,661	0,403
I7							1	0,728	0,704	0,617	0,431
I8								1	0,799	0,748	0,494
I9									1	0,823	0,5
I10										1	0,507
I11											1

Table 4.
Average, Standard Deviation, Corrected Item-Total Correlations, Cronbach's Alpha values if the item is deleted, and the total variance explained by the scale

N=301	Average	Standard Deviation	Skewness	Kurtosis	Corrected Item Total Correlation	When the item is deleted, Cronbach's Alpha	Total Variance Explained and Eigenvalue
I1	1,76	0,718	,554	-,316	,493	,911	56,137 (6,165)
I2	1,88	0,890	,637	-,573	,522	,914	
I3	1,54	0,655	,967	,443	,715	,899	
I4	1,71	0,778	,803	-,094	,690	,900	
I5	1,49	0,587	,844	,277	,766	,897	
I6	1,46	0,596	1,124	1,229	,712	,900	
I7	1,49	0,625	1,144	1,391	,728	,898	
I8	1,46	0,591	,978	,483	,788	,896	
I9	1,39	0,564	1,231	1,163	,712	,900	
I10	1,40	0,566	1,198	1,076	,706	,900	
I11	1,54	0,704	1,265	1,458	,594	,905	

Looking at the relevant data in Table 4, it can be seen that the corrected item-total correlation coefficients range from 0.493 to 0.788, and that 56.1% of the total variance on the scale is explained (eigenvalue = 6.165). Whether the preconditions for parametric tests were met was evaluated based on the skewness and kurtosis values of the data (measures of normal distribution) and the results of the Levene test (homogeneity of variances) (Büyüköztürk, 2010). The fact that the skewness and kurtosis values are within the specified limits indicates that the data is normally distributed.

4.3. Confirmatory factor analysis

Confirmatory Factor Analysis (CFA) was conducted to test the construct validity. In addition, covariance was defined between the errors of the observed values to achieve the recommended values for the fit indices (Şimşek, 2007). When the fit indices of the one-dimensional model were examined, they were found to be CFI = 0.819, TLI = 0.774, RMSEA = 0.178, and SRMR = 0.107. These values indicate that the model's fit is weak to moderate. The highest factor loadings were observed for items I5 (0.842), I8 (0.901), and I9 (0.862), while the loadings for items I1 and I2 were relatively low (0.405 and 0.400, respectively). Modification indices, particularly between I2–I4, I3–I4, and I1–I2, indicate that adding error covariances can improve the model's fit. Although Items I1 and I2 exhibited relatively lower factor loadings compared to the remaining items, they were retained based on theoretical relevance and psychometric acceptability. Importantly, the original study by Yu et al. (2024) also reported lower yet acceptable loadings for these items, emphasizing their conceptual contribution to the construct of problematic ChatGPT use. Furthermore, item–total correlations obtained in this study were above recommended thresholds, and removing these items did not improve the reliability coefficients (Cronbach's alpha, CR). Therefore, both items were preserved in order to maintain consistency with the original instrument and avoid compromising the conceptual integrity of the scale. Figure 1 shows the path analysis (path diagram) of the measurement model obtained from the data analyzes performed using the AMOS 24 program. The diagram shows standardized beta values on paths extending from dimensions to items. The error for each substance is shown next to the substances. The most important factor that makes structural equation modeling valuable is its ability to simultaneously perform confirmatory factor analysis and regression analysis, while also including and presenting the error terms for the items in the model (Ayyıldız & Cengiz, 2006). In addition, the correlation relationships between the dimensions can also be observed within the scope of the analysis.

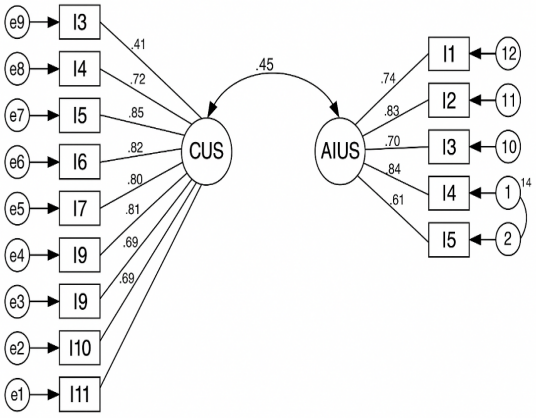


Figure 2. CFA correlation diagram (standardized).

When examining Figure 2, it is evident that the scale meets the fit indices frequently used in the literature. Based on the structural equation analysis and the findings obtained from the model, the structural validity of the measurement model consisting of 1 dimension and 11 items is at an acceptable level.

4.4. RQ3: Reliability and Validity Analyses

4.4.1. Item Validity

In the study, item mean scores were examined to test item validity and are shown in Table 5.

Table 5.
Item analysis results

Items	Average	Standard Deviation	t	p
Item 1	0.441	0.037	11.897	0.000
Item 2	0.654	0.055	11.892	0.000
Item 3	0.238	0.021	11.521	0.000
Item 4	0.402	0.034	11.682	0.000
Item 5	0.100	0.010	10.399	0.000
Item 6	0.121	0.011	10.699	0.000
Item 7	0.146	0.013	10.871	0.000
Item 8	0.065	0.007	8.988	0.000
Item 9	0.079	0.008	9.943	0.000
Item 10	0.095	0.009	10.454	0.000
Item 11	0.337	0.029	11.702	0.000

According to the analysis results, the fact that all z-values are above 4.392 indicates that the variances in the model are statistically significant.

4.4.2. Findings Regarding the Reliability of the Scale

Table 6.
Criterion validity

Correlations			
		ChatGPT Total	**Artificial Intelligence Total**
ChatGPT Total	Pearson Correlation	1	,517**
	Sig. (2-tailed)		,000
	N	301	301
Artificial Intelligence Total	Pearson Correlation	,517**	1
	Sig. (2-tailed)	,000	
	N	301	301
****. Correlation is significant at the 0.01 level (2-tailed).**			

There is a positive, moderate, and statistically significant relationship between the total score of ChatGPT and the total score of Artificial Intelligence ($r = 0.517$, $p < 0.001$). This result indicates a significant relationship between attitudes toward ChatGPT use and general attitudes toward artificial intelligence.

Table 7.
CKÖ Reliability Analysis Results (Cronbach's Alpha), Average Variance Explained (AVE), and Composite Reliability (CR)

Number of Items	**Cronbach's Alpha**	**AVE**	**CR**
Scale total (11 items)	0,910	0.561	0.932

When Table 7 is examined, it is seen that the Cronbach's Alpha internal consistency coefficient is .910, the AVE value is .561, and the CR value is .932. According to Fornell & Larcker (1981), an AVE value above .50 demonstrates adequate convergent validity, while a CR value above .70 indicates acceptable composite reliability. These results show that the scale meets the recommended psychometric criteria.

Table 8:
Fornell & Larcker Method

	CR	**AVE**	**MSV**	**MaxR(H)**	**CUS**	**AIUS**
CUS	0,925	0,586	0,196	0,944	0,765	
AIUS	0,862	0,558	0,196	0,879	0,442	0,747

In Table 8, the dark values represent the AVE, and the values with (***) indicate the correlation between variables. Since the AVE is greater than the inter-item correlations, the model's discriminant validity is established (Fornell & Larcker, 1981). A recent study stated that HTMT values should be examined for divergent validity (Henseler et al., 2015). According to the authors, if the variables in the model have a similar structure, the HTMT value should be below 0.80; otherwise, it should be below 0.90. Table 9 presents the HTMT coefficients.

Table 9.
HTMT Coefficients

	CUS	**AIUS**
CUS		
AIUS	0,509	

When Table 9 is examined, it is seen that all coefficients are below 0.90. According to Henseler et al. (2015), this indicates that the scale items successfully measure the constructs they are expected to measure. The VIF coefficients for the variables in the model were evaluated for multicollinearity. As a result of the analysis, it was determined that the VIF values for the sub-expressions of the variables ranged from 1.165 to 4.549. According to Hair et al. (2019), VIF values below 5 indicate that multicollinearity is not a problem in the model. In this context, the results obtained support the accuracy of the model.

5. CONCLUSION

The present study examined problematic ChatGPT use—a recently emerging construct in the field—and conducted comprehensive reliability and validity analyses to adapt the Problematic ChatGPT Use Scale (Yu et al., 2024) into Turkish. The findings demonstrated that the scale possesses acceptable psychometric properties, and the confirmatory factor analysis

confirmed the original single-factor structure. These results indicate that the Turkish version of the scale is a valid and reliable tool for assessing problematic ChatGPT use. Considering the rapidly increasing integration of AI-based systems into everyday life, the identification and measurement of problematic usage patterns have become increasingly important. This study contributes to the national literature by providing a standardized instrument that can help researchers and practitioners better understand the psychological, social, and cognitive effects associated with excessive reliance on AI-based tools.
Furthermore, the results align with previous research showing that excessive or emotionally charged interactions with AI systems can lead to dependence-like symptoms and reduced psychological well-being (Huang et al., 2024; Xie et al., 2023). The confirmation of a single-factor structure is also consistent with the initial validation study conducted by Yu et al. (2024). Given the rapid adoption of generative AI platforms such as ChatGPT, the measurement of problematic use remains a critical step for future studies exploring digital addiction, technology-induced cognitive load, and AI-mediated social withdrawal (Andreassen, 2015; Young, 1998).
While the current study provides strong initial evidence for the validity and reliability of the adapted scale, the findings are limited to the sample characteristics of the present research. Future studies may strengthen generalizability by applying the scale to broader and more diverse samples, including clinical, adolescent, or occupational groups. Alternative structural models, such as a two-factor structure, may also be tested. Additionally, items I1 and I2—identified as having relatively lower factor loadings—could be revised or reevaluated in future analyses. In the present study, these items were retained because their item–total correlations and overall reliability contributions were sufficient, and because the original scale developers also included them despite similar loading patterns. Thus, keeping I1 and I2 ensures conceptual alignment with the original scale and protects the theoretical breadth of the construct. Nevertheless, future studies using larger or different populations may consider revising these items to further enhance the model's fit. Model refinement using modification indices, including the addition of error covariances where theoretically justified, may further enhance model fit.
Overall, the validated Turkish form of the scale provides a solid foundation for future multidimensional research on AI-related behavioral tendencies. It is anticipated that the finalized version of the scale presented in the Appendix will serve as a useful instrument in future studies across diverse fields and contribute meaningfully to the expanding literature on problematic technology use.

Research and Publication Ethics Statement
The study has received ethical approval.

Contribution Rates of Authors to the Article
Author 1: %50 – Data analysis, methodology, writing
Author 2: %50 – Conceptualization, editing, review

Statement of Interest
The authors declare that there is no conflict of interest regarding the publication of this article.

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Analyzing Turkey's Education Strategies and Policy Documents in the Context of Digital Transformation, Development and Artificial Intelligence*

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ABSTRACT

This systematic analysis evaluates Turkey's education strategies and policy documents, focusing on their compatibility with digital transformation and artificial intelligence (AI). The study aims to provide a comprehensive overview of the country's current educational landscape and its preparedness for emerging technologies. Employing content analysis, documents were selected based on their direct relevance to national education policy, digital transformation, and AI integration, including recent publications like the Higher Education Council's (YÖK) guide on generative AI. Findings indicate a significant gap between policy aspirations for digitalization and the on-the-ground realities of educational inequality and infrastructure deficits. While policy documents acknowledge these challenges, they often lack concrete mechanisms for sustainable implementation, a concern also highlighted in global reports. AI presents significant opportunities for personalized learning, teacher support, and curriculum development; however, it also raises critical ethical concerns regarding data privacy and equity. In conclusion, a multi-faceted and sustainable strategy is proposed to accelerate Turkey's digital transformation in education. This strategy should focus on strengthening the digital infrastructure to ensure equity of opportunity, aligning teacher training with new pedagogical models, establishing robust ethical guidelines for artificial intelligence, digitizing educational materials, centering stakeholder involvement in the system, and continuously feeding this entire process with research and development studies.

Keywords: Turkish Education Policy, Digital Transformation, Artificial Intelligence in Education, Educational Technology, Policy Analysis

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1. INTRODUCTION

In recent years, the use of artificial intelligence (AI) in education has been increasingly recognized for its transformative potential in shaping the future of learning. As countries strive to keep pace with technological developments, AI has become a focal point due to its significant impact. AI applications are revolutionizing electronic environments and transforming our interactions with technology (Dwivedi et al., 2021). Among the most notable AI innovations is ChatGPT, which became publicly available in late 2022 (Sallam, 2023). Despite the benefits, the widespread use of AI in education has brought a number of concerns. From completing homework assignments to conducting academic research, there are growing fears that authenticity is threatened (Rudolph et al., 2023). This situation is similar to the protests by maths teachers in the United States in 1988 against the use of calculators in schools (Mijwil et al., 2023). Nowadays, similar debates have emerged regarding the restriction of AI technologies in education.

In order to understand the role of AI in education, it is considered important to analyze the strategy and policy documents of various countries. These documents provide a basis for discussions and insights into the use of AI in education systems. In Turkey, various strategic plans and policies have been developed to pursue digital transformation, economic growth and

* This article was conducted on document analysis and does not contain any studies with human or animal subjects. All data have been obtained and reported by ethical concerns, principles, and rules.

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innovation in education (Ministry of Industry and Technology & Presidential Digital Transformation Office, 2021; Ministry of Science, Industry and Technology, 2018; Presidential Presidency of Strategy and Budget, 2023; MoNE, 2019).

This study aims to provide a comprehensive overview of the country's education policy by systematically analyzing documents published in Turkey that are directly or indirectly related to digital transformation, development and AI. Among the documents analyzed in the study, the Twelfth Development Plan, which emphasizes the country's long-term vision for economic growth, education and digital transformation is particularly significant. Turkey's holistic approach integrates technology into various societal domains and positions education as a central pillar for future development. The Digital Turkey 2030 vision further elaborates policies and strategies for comprehensive digital transformation (Presidency of the Republic of Turkey Strategy and Budget Directorate, 2023).

Analyzing strategy and policy documents in the educational context is important for several reasons. Firstly, strategy and policy documents provide insights into how schools manage external demands, set goals and make decisions (Honig & Hatch, 2004). This alignment helps schools navigate their way through complex educational environments and achieve broader educational goals. Second, such analyses shed light on the interactions between governments' actions and policy changes, especially during critical times such as the COVID-19 pandemic (Liu, 2021). These analyses provide important perspectives on the impact on policy formulation, implementation and educational practices.

Stakeholders can gain insights into possible strategies and directions by analyzing key policy documents such as national strategic plans and education frameworks (Sulong, 2022). This information is vital in shaping educational practices, resource allocation and overall quality of education. By analyzing policy documents at the national and university level, researchers can identify patterns, gaps and opportunities for improvement. Qualitative document analysis techniques provide valuable data on policy goals, strategies and objectives in education (Ahmad et al., 2024). This analysis is crucial for identifying gaps, inconsistencies and areas for improvement in educational policies. Furthermore, evaluating the impact and effectiveness of policies through document analysis helps to assess the roles of teachers, students and technologies in the education sector (Melese et al., 2024). Critical analysis of these documents also reveals areas where definitions or strategies need to be improved to better achieve educational goals.

Consequently, analyzing strategy and policy documents in education is essential to guide decision-making processes, understand the actions of governments, shape educational practices and promote excellence in education. Through this analysis, researchers, policy makers and educators can gain valuable insights into the dynamics of education systems, identify areas for improvement and work towards creating more effective and inclusive educational environments.

1.1. Purpose of the Study

This study evaluates the digital transformation, development and AI compatibility of Turkey's education strategies and policy documents, which have been systematically analyzed, and aims to provide a comprehensive overview of the country's education policy in this direction. Three objectives were set to achieve this goal. Firstly, it was aimed to systematically review and categorize the main themes, objectives and scope of Turkey's education policy documents in order to understand the strategic priorities. Secondly, to assess the proposed strategies and the expected impact on educational outcomes to reveal how digital transformation, development and AI are integrated into education policies. Third and finally, it is aimed to document how stakeholders' views and concerns, if any, are reflected in policy documents. In line with these aims and objectives, answers to the following research questions were sought:

1. In relation to the policy documents in Turkey;
a) What is their purpose and scope?
b) What are the main themes?
2. What are the common themes/concepts in policy documents in Turkey?
3. In policy documents in Turkey;
a) Which targets and findings are reported?
b) In which ways are these objectives and findings similar?
c) What is the place of artificial intelligence?
d) Which educational success criteria are reported?
4. How are stakeholder views, challenges and concerns regarding the use of AI in education reflected in policy documents in Turkey?

2. METHODOLOGY

Content analysis method was used in this study. Content analysis is a scientific approach that allows verbal, written and other materials to be analyzed objectively and systematically (Tavşancıl & Aslan, 2001). In the domain of educational sciences, content analysis is a prevalent methodology, offering a systematic and replicable approach. This technique entails the condensation of textual elements, such as books, chapters, reports, and historical documents, into smaller categories through coding that

adheres to predefined criteria. Yıldırım and Şimşek (2006) explained the main purpose of content analysis as reaching concepts and relationships that can explain the collected data. For this purpose, the data collected must first be conceptualized and then organized in a meaningful way according to the emerging concepts and themes explaining the data must be determined accordingly. Accordingly, content analysis has four stages: processing the qualitative data obtained from the documents, coding the data, determining the themes, organizing the codes and themes, defining and interpreting the findings.

In this study, firstly, various categories were created with the criteria to be used in policy document selection. Then, a subject-based search strategy was preferred and the year range to be used in the selection of the policy documents were determined. The methods and techniques to be used in data analysis were selected in order to examine, interpret and synthesize the identified policy documents. Then, coding was done and various themes were reached in this context. After this stage, the data were organized, grouped according to the themes and, where appropriate, the data were quantified and presented. Finally, the findings were interpreted. In the following sections, the methodology of the research is explained in detail.

2.1. Creating Categories with Criteria

In this study, a systematic analysis of Turkey's education strategies and policy documents has been conducted, focusing on their compatibility with digital transformation, development and AI. The aim of this analysis is to provide a comprehensive overview of Turkey's approach to the use of AI in education, focusing on understanding the main themes, objectives, recommendations and the evolution of these policies over time. To achieve this, a set of criteria and categories were established to guide the analysis.

Criteria included relevance, date of publication, publishing institution/organization, purpose of the document, scope and depth. The authors and one expert held three iterative discussion sessions during the criteria setting process. These criteria were used to ensure the selection of policy documents that were directly related to the research objectives, to measure the reliability of the sources, and to assess the scope and depth of each document. Table 1 presents the criteria and the rationale for these criteria.

Table 1.
Criteria Used in Policy Document Selection

No	Criteria	Purpose/Justification for Use
1	Compliance	Relevance to research objectives.
2	Publication Date	Date of publication of the document to track changes in policies and strategies related to the use of AI in education.
3	Publishing Institution/Organization	Reliability and impact of the information. Is it an official policy document of a government agency, an academic report or a recommendation of an educational institution?
4	Objective	Objective for which the document was published.
5	Scope and Depth	The scope and depth of the document. Some of the documents provide a broad overview of AI in education, while others may delve into specific aspects.

In the study, the main aspects of the policy documents were categorized (See Table 2). The main categories identified within the scope of the study include the main theme of the document, the objectives set out in the policy and the recommendations for the use of AI in education. Furthermore, the perspectives of various stakeholders, including governmental organizations, educators, students and industry experts, if any, were also taken into account. Finally, the challenges and concerns raised in these documents are analyzed and categorized.

Table 2.
Categories Used in the Evaluation of Policy Documents

No	Criteria	Purpose/Justification for Use
1	Main Themes	Categorization of the main themes in the policy documents. Key themes may include concepts such as increasing digital literacy, personalized learning, teacher support, curriculum development or AI ethics. In documents, frequently used keywords can be related to the theme of the document or to the policies of the organization/institution that published the document.
2	Educational Objectives and Findings	Identification and categorization of the educational objectives stated in the documents. The objectives may be to improve student performance, improve access to education, promote innovation or increase the efficiency of the education system.

3	Place of AI	Identification and categorization of references to AI in documents.
4	Success Criteria	Classification of indicators or metrics to measure the success of the use of AI in education. Indicators can be focal points such as student outcomes, cost or technology adoption.
5	Educational Recommendations and Stakeholder Views	Classifying and analyzing the recommendations in the documents. Recommendations could be curriculum changes, teacher training, improvement of technological infrastructure, code of ethics and research funding.
6	Challenges and Concerns	Reporting the challenges and concerns expressed in the documents. Challenges and concerns can be categorized according to issues such as privacy, equity, barriers to implementation or ethics.

With the analysis approach presented in Table 2 within the scope of the study, it is thought that by providing a comprehensive and structured analysis, it can provide a common language in the process of obtaining valuable insights for policy makers, educators and researchers who want to understand and contribute to the use of AI in education in the Turkish context.

2.2. Selection of Policy Documents

The policy documents to be analyzed within the scope of the study were selected by a research group consisting of two researchers other than the authors of the study. The researchers collected the names of the documents or the institutions/organizations that published policy documents in the field of education in a search list. Based on this list, the year criteria for the documents to be included in the research were determined by *systematic mapping* method before starting the document searching. In this context, the Web of Science database was searched as it covers a wide range of high-quality educational journals. A subject-based search strategy was preferred for accessing the studies. This strategy is preferred to select articles from a pool of words labelled by their authors. In this context, two different keyword sets were created. One of these sets is related to AI, while the other is focused on education. Using the OR operator, synonymous and closely related terms in each set of keywords were combined and then linked using the AND operator to relate both sets. The search was conducted in November 2023 using the following English keywords.

- (ALL=(**artificial intelligence**) OR ALL=(**AI**) OR ALL=(**generative AI**)) AND
- (ALL=(**education**) OR ALL=(**education policy**) OR ALL=(**education strategy**))

The accessed studies were filtered and limited with the category of education and educational research considering the scope of the study. As a result, 1,676 studies were accessed in this review. The distribution of these studies according to publication years is presented in Figure 1.

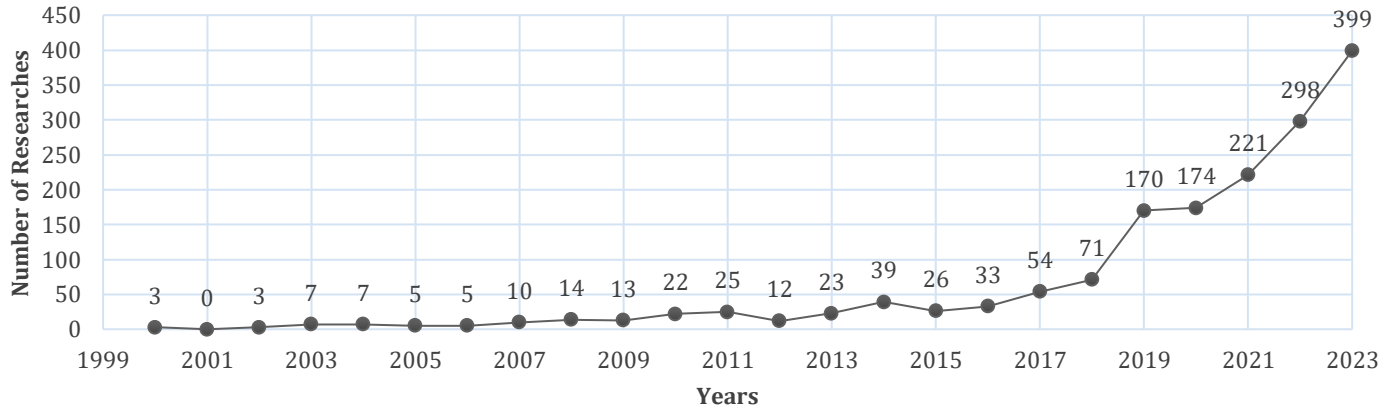


Figure 1. Distribution of studies in which education and AI are analyzed together by years.

As can be seen in Figure 1, the number of studies showed a steady distribution until 2018. While the number of studies was 71 in 2018, it increased significantly to 170 in 2019. When analyzing the total number of studies, it can be seen that while 301 studies were conducted until 2018, this number has reached 1.333 since 2018. As a result, the number of studies carried out in this field in the last five years is four times higher than the number of studies carried out in 18 years. In this context, documents published in 2018 and later were included in the review. The year 2018 was chosen as the starting point because, as shown in the data presented in Figure 1, it marks a turning point where the number of academic publications on artificial intelligence and education began to increase sharply. This suggests that policy documents from 2018 onwards are more likely to reflect the growing strategic focus on this topic.

The policy documents published with reference to the searching list were obtained from the websites of the relevant institutions and collected in a pool. Then, the working group came together again and analyzed the pool and possible document suggestions were put forward. The pool of policy documents is presented in Table 3 according to the criteria determined in the previous section.

Table 3.
Policy Documents Analyzed in the Scope of the Research and Their Compliance with the Determined Criteria

No	Document Title	Compliance	Publication Date	Publishing Organization	In-Text Citation
1	2022 Education Evaluation Report	Education Policies and Strategies	2023	TEDMEM (Turkish Education Association)	(TEDMEM, 2023a)
2	Digital Turkey 2030: Economic Impacts and Policy Framework	Digital Transformation and Technology Policies	2023	Vodafone & Policy Analysis Laboratory	(Vodafone & Policy Analysis Lab., 2023)
3	Twelfth Development Plan (2024 - 2028)	Development Plans and Strategic Documentation	2023	Presidency of the Republic of Turkey Presidency of Strategy and Budget	(Presidency Strategy and Budget Directorate, 2023)
4	TRAI Productive Artificial Intelligence Report	AI Policies and Strategies	2023	TR AI	(TR AI, 2023)
5	Call to Action for High Technology in Turkey's 2nd Century	Digital Transformation and Technology Policies	2023	TÜSİAD (Turkish Industry and Business Association) & TÜBİSAD (Informatics Industrialists' Association)	(TÜSİAD & TÜBİSAD, 2023)
6	A New Understanding of Education is Necessary	Education Policies and Strategies	2023	TEDMEM (Turkish Education Association)	(TEDMEM, 2023b)
7	2021 Education Evaluation Report	Education Policies and Strategies	2022	TEDMEM (Turkish Education Association)	(TEDMEM, 2022)
8	Education Monitoring Report 2022	Education Policies and Strategies	2022	ERG (Education Reform Initiative) & Education Observatory	(ERG & Education Observatory, 2022)
9	2020 Education Evaluation Report	Education Policies and Strategies	2021	TED (Turkish Education Association)	(TED, 2021)
10	Education in Turkey under COVID-19	Education Policies and Strategies	2021	ERG (Education Reform Initiative) & TÜSİAD	(ERG & Education Observatory, 2021a)
11	Education Monitoring Report 2021: Educational Environments	Education Policies and Strategies	2021	ERG (Education Reform Initiative) & Education Observatory	(ERG & Education Observatory, 2021b)
12	Future of Software Ecosystem in Turkey	Digital Transformation and Technology Policies	2021	Deloitte & TÜSİAD (Turkish Industry and Business Association)	(Deloitte & TÜSİAD, 2021)
13	National Artificial Intelligence Strategy Document 2021 - 2025	Digital Transformation and Technology Policies	2021	Republic of Turkey Ministry of Industry and Technology & Republic of Turkey Presidency Digital Transformation Office	(Ministry of Industry and Technology & Presidency Digital Transformation Office, 2021)
14	2019 Education Evaluation Report	Education Policies and Strategies	2020	TED (Turkish Education Association)	(TED, 2020a)
15	Education in the COVID-19 Process: Distance Learning,	Education Policies and Strategies	2020	TED (Turkish Education Association)	(TED, 2020b)

	Problems and Solutions				
16	Education Monitoring Report 2020: Educational Environments	Education Policies and Strategies	2020	ERG (Education Reform Initiative) & Education Observatory	(ERG & Education Observatory, 2020)
17	STEM Education for Industry 4.0 in Vocational and Technical High Schools	Education Policies and Strategies	2020	TÜSİAD (Turkish Industry and Business Association) & Istanbul Aydın University STEM Education Application and Research Centre	(TÜSİAD & Istanbul Aydın University, 2020)
18	Opinions and Suggestions for the Development of Artificial Intelligence in Turkey	AI Policies and Strategies	2020	TBD (Turkish Informatics Association)	(TBD, 2020)
19	2018 Education Evaluation Report	Education Policies and Strategies	2019	TED (Turkish Education Association)	(TED, 2019)
20	Education Monitoring Report 2019: Content of Education	Education Policies and Strategies	2019	ERG (Education Reform Initiative) & Education Observatory	(ERG & Education Observatory, 2019)
21	Eleventh Development Plan (2019 - 2023)	Development Plans and Strategic Documentation	2019	Strategy and Budget Directorate of the Presidency of the Republic of Turkey	(Presidency Strategy and Budget Directorate, 2019)
22	Republic of Turkey Ministry of National Education 2019-2023 Strategic Plan	Education Policies and Strategies	2019	Republic of Turkey Ministry of National Education (MoNE)	(MoNE, 2019)
23	Digital Technologies and Economic Growth	Digital Transformation and Technology Policies	2018	TÜSİAD (Turkish Industrialists' and Businessmen's Association)	(TÜSİAD, 2018)

As seen in Table 3, there are 23 policy documents accessed and analyzed within the scope of the research. The publication dates of these documents cover the years 2018-2023. During the document searching process, the backward search channel was also used to expand the scope of the study. The backward search involves considering the list of references cited by the documents analyzed as a result of the search (Xiao & Watson, 2019). In this context, the documents in Table 4 were also included in the study.

Table 4.
Documents Included in the Study within the Scope of Retrospective Research

No	Document Name	Compliance	Publication Date	Publishing Organization	In-Text Citation
1	Turkey's Industrial Revolution: Digital Turkey Roadmap	Digital Transformation and Technology Policies	2018	Republic of Turkey Ministry of Science, Industry and Technology	(Ministry of Science, Industry and Technology, 2018)

As seen in Table 4, 1 document was reached in the retrospective research and the relevant document was included in the study.

2.3. Analyzing Data

In this study, in which both qualitative and quantitative approaches were adopted, the reports examined and the data obtained were analyzed using methods appropriate to both approaches. Qualitative data analysis is a process in which the researcher organizes the data, divides them into units of analysis, synthesizes them, divides them into categories and themes, and decides which of them should be reflected in the report by considering them from an interpretive perspective (Bogdan & Biklen, 1997).

2.4. Reliability and Validity

One of the researchers conducted a document search using the research strategy. The reports were downloaded to the researcher's computer and the titles of the studies, the year and the publishing institution/organization were reported in a spreadsheet file.
The internal validity of the research can be expressed as whether the differences on the dependent variable are directly caused by the independent variable. External validity is related to the generalizability of the findings obtained at the end of the research (Fraenkel & Wallen, 2006). In the study, various measures were taken to ensure internal validity. Firstly, the selection of documents was unbiased and the relevant documents were selected by a working group including the authors according to the criteria determined before the research. The processes of document selection and data extraction in the selected documents are explained in detail. In order to ensure the external validity of the research, the process followed about the methodology of the research, such as how the documents and data were analyzed and how the results were reached, was reported in detail. In addition, during the analysis process, continuous and repeated revisions were made through discussion, doubt removal and consensus building (Boesch et al., 2013). This iterative approach ensured that any disagreements in coding were resolved and a shared understanding was maintained throughout the analysis.

3. POLICY DOCUMENTS

Within the scope of this study, the policy documents listed in Tables 3 and 4 were analyzed. Selected according to the criteria in Table 1, these documents, published between 2018 and 2023, collectively map the evolution of Turkey's policy discourse. Rather than being standalone publications, they form a dynamic dialogue between government bodies, industry associations, and civil society organizations. This section presents these documents sequentially to trace this conversation, highlighting how early diagnostic reports prompted official strategies, which in turn were scrutinized by independent evaluations, leading to a more nuanced and mature policy landscape. The analysis below aims to illuminate the interplay between these different voices, focusing on the converging and diverging perspectives on Turkey's digital and educational transformation.

3.1. Digital Technologies and Economic Growth: Turkey's Position, Opportunities and Options in Digital Technology Sectors

The policy dialogue of this period was significantly shaped by an early diagnostic from the private sector. TÜSİAD's 2018 paper functions as a foundational text, framing digital transformation not merely as a technological shift but as a critical economic imperative. By analyzing Turkey’s position and identifying threats and opportunities, the document effectively set the agenda for subsequent government action. It articulated the private sector's perspective on the urgency of developing a national strategy, thereby creating a benchmark against which future official policies could be compared.

3.2. Turkey's Industrial Revolution ‘’Digital Turkey‘’ Road Map

Responding to the same global pressures identified by industry actors like TÜSİAD, the Ministry of Science, Industry and Technology released its official strategy in the same year. This 2018 roadmap represents the government's formal acceptance of the challenge. In contrast to the diagnostic nature of the TÜSİAD report, this document is a prescriptive framework, conceptualizing the digital transformation of manufacturing as a long-term journey. Its formulation around six core components—people, technology, infrastructure, suppliers, users, and governance—demonstrates a comprehensive, state-led ambition to orchestrate a complex ecosystem.

3.3. Republic of Turkey Ministry of National Education 2019 - 2023 Strategic Plan

Concurrent with the push for industrial digitalization, a parallel and equally critical effort was underway to reform the human capital pipeline. The Ministry of National Education’s 2019-2023 Strategic Plan represents the official reform agenda in this domain. Aiming for a "quality revolution," this plan serves as the primary government narrative on education, outlining a top-down vision for systemic improvement. Its reliance on analytical tools like PESTLE and SWOT signals an intent to create a data-informed policy, establishing an official set of objectives and strategies for the nation's educational future.

3.4. Eleventh Development Plan (2019 - 2023)

The Eleventh Development Plan serves as a high-level strategic umbrella, integrating the distinct goals of industrial transformation and human capital development into a single national vision. As the first development plan of the Presidential Government System, it elevates themes like the "national technology move" to the highest level of state policy. This document is crucial because it codifies the ambitions outlined in more specific roadmaps (like the "Digital Turkey" roadmap) and educational plans, framing them as integral components of Turkey's long-term quest for global competitiveness and public welfare.

3.5. Education Monitoring Report 2019: Content of Education

While the Development Plan outlined the national vision, the Education Reform Initiative (ERI) provided a granular, independent analysis of the education system's realities. Published in the same year, this report introduces a critical counter-narrative from civil society. By focusing on specific issues like secondary education design, vocational training, and gender equality, ERI's work provides a necessary on-the-ground assessment of the policies promoted by the Ministry. It marks the entry of a consistent, evidence-based monitoring voice into the policy conversation.

3.6. 2018 Education Evaluation Report

Similarly, the Turkish Education Association's (TED) 2019 report on the preceding year offers another critical perspective, reinforcing the role of non-governmental organizations in policy evaluation. Complementing the ERI's focus, TEDMEM's report provides a comprehensive, nine-part analysis of the entire education system, from governance to teacher training. The existence of multiple, data-rich evaluation reports from both ERI and TEDMEM demonstrates a robust civil society ecosystem dedicated to holding public policy accountable and enriching the debate with independent data.

3.7. Opinions and Suggestions for the Development of Artificial Intelligence in Turkey

As the general discussion on digital transformation matured, the focus began to narrow onto specific disruptive technologies. The Turkish Informatics Association's (TBD) 2020 report represents a pivotal conceptual step in this direction. Defined as a "conceptual document" rather than a formal strategy, it served to socialize ideas and build consensus around the necessary steps for developing a national AI ecosystem. This report can be seen as the intellectual groundwork that paved the way for the more formal, state-led strategy that would follow.

3.8. STEM Education for Industry 4.0 in Vocational and Technical High Schools

This 2020 report provides a critical link between the ambitions for a high-tech economy (as discussed in documents 3.1, 3.2, and 3.7) and the educational reforms needed to support it (as outlined in document 3.3). By investigating the implementation of STEM and Industry 4.0 concepts within vocational high schools, this TÜSİAD and Istanbul Aydın University study tests the practical feasibility of national strategy at the classroom level. It highlights the potential gap between high-level policy goals and the actual capacity of the education system to produce the required skilled workforce.

3.9. Education Monitoring Report 2020: Educational Environments

The established policy trajectory was abruptly disrupted by the onset of global and national crises. ERI's 2020 report reflects this shift, as its analysis of "Educational Environments" is inevitably framed by the impacts of the COVID-19 pandemic and earthquakes. This document shows how external shocks forced a re-evaluation of educational priorities, moving beyond curriculum to fundamental issues of physical, social, and emotional safety. It marks a point where crisis response began to intersect with long-term reform efforts.

3.10. Education in the COVID-19 Process: Distance Learning, Problems and Solutions

TED's 2020 report directly confronts the primary educational challenge of the year. It provides an immediate and focused analysis of the emergency transition to distance learning, documenting the problems encountered and proposing solutions. In dialogue with ERI's broader report on educational environments, this document offers a specific critique of the pandemic response, examining the effectiveness of tools and strategies deployed under crisis conditions and contributing to a real-time policy feedback loop.

3.11. 2019 Education Evaluation Report

Published in 2020, TED's evaluation of the pre-pandemic year of 2019 serves as an important baseline. By analyzing the state of the education system just before the COVID-19 crisis, this report provides a crucial "before" picture. When read alongside the pandemic-focused reports of the same year, it allows for a clearer understanding of which challenges were chronic and which were acutely triggered by the emergency, enriching the overall analysis of the system's resilience.

3.12. National Artificial Intelligence Strategy 2021 – 2025

This official strategy document represents the culmination of the earlier, more conceptual discussions on AI (e.g., TBD's 2020 report). Published by the Ministry of Industry and Technology and the Digital Transformation Office, it marks the transition from ideas to a concrete, actionable state policy. With its 24 objectives and 119 measures, the strategy institutionalizes Turkey's

AI ambitions, providing a formal framework for public and private sector action and signaling a new level of maturity in the country's technology policy.

3.13. Future of Software Ecosystem in Turkey

Just as the government was formalizing its AI strategy, this 2021 report from Deloitte and TÜSİAD introduced a sobering reality check from the industry. It argues that despite strategic planning and a growing startup ecosystem, Turkey has failed to capture its deserved share of the global software market. This document creates a productive tension with the optimistic tone of official strategies, highlighting a persistent gap between policy ambition and economic outcomes and suggesting that the existing support mechanisms were insufficient.

3.14. Education Monitoring Report 2021: Educational Environments

ERI's 2021 report continues the analysis of education under crisis, deepening the themes from its 2020 predecessor. The focus on home environments, digital media, and the "school as the third teacher" reflects a more profound understanding of the pandemic's impact. Significantly, this report expands the definition of "crisis" to include climate change, arguing for a "holistic resilience approach." This represents an evolution in the thinking of civil society, pushing the policy debate beyond immediate emergencies toward long-term systemic preparedness.

3.15. Education in Turkey under COVID-19

This joint ERI and TÜSİAD report from 2021 synthesizes the lessons learned from over a year of pandemic-affected education. Drawing on a webinar series, it consolidates expert opinions and official data to provide a comprehensive assessment. It functions as a capstone analysis of the initial crisis period, formalizing the challenges and opportunities for transformation that were first identified in the more immediate response reports of 2020.

3.16. 2020 Education Evaluation Report

TEDMEM's 2021 evaluation of the first pandemic year provides a structured historical record of the educational system's response. It methodically analyzes the challenges, setbacks, and coping mechanisms across all major sub-domains of education. This report complements the more thematic analyses from ERI by offering a comprehensive, almanac-style review, solidifying the data-based understanding of the pandemic's profound impact.

3.17. Education Monitoring Report 2022

In its 2022 report, ERI shifts its focus to systemic issues that persisted through the crisis: preschool education, vocational training, and teacher policies. The use of content analysis to map the Ministry of National Education’s own public communications is a novel methodological approach, allowing ERI to critically evaluate the Ministry’s stated priorities against its actual public messaging. This demonstrates a growing sophistication in the monitoring techniques used by civil society organizations.

3.18. 2021 Education Evaluation Report

TEDMEM's 2022 report examines the "return to school" year of 2021. The central theme is the need to build a system resilient against "unknown crises," reflecting the key lesson learned from the pandemic. This document moves the conversation from reactive crisis management to proactive resilience-building. By providing data-based contributions, it aims to influence future policy to be more durable and adaptive.

3.19. A New Understanding of Education is Necessary

Published in 2023, this TEDMEM document elevates the policy discussion to a higher conceptual level. It argues that the cumulative weight of recent crises necessitates a fundamental paradigm shift in education. By categorizing the core problems of the Turkish system—from rote learning to a lack of crisis resilience—and offering solutions, it serves as a manifesto for deep-seated change, synthesizing the findings of its previous annual reports into an urgent call for a new educational philosophy.

3.20. Call to Action for High Technology in Turkey's 2nd Century

This 2023 report from TÜSİAD and TÜBİSAD represents a renewed and more forceful push from the industry. It directly addresses the persistent implementation gaps identified in earlier reports (like the 2021 software ecosystem analysis). Its concrete, ambitious proposals—such as a "Technology Development Bank" and restructuring incentives—are not just

recommendations but a clear "call to action," signaling the private sector's view that the current pace and direction of digital transformation are inadequate to meet Turkey's long-term goals.

3.21. TRAI Productive Artificial Intelligence Report

Reflecting the hyper-accelerated pace of technological change, this 2023 report brings the policy conversation to the cutting edge of AI. Its focus on Generative AI—a topic not central to the 2021 National AI Strategy—demonstrates how quickly official strategies can be outpaced. The report serves as an urgent update for all stakeholders, mapping the new landscape and highlighting the transformative impact on businesses, implicitly arguing that any national strategy must now account for this new paradigm.

3.22. Twelfth Development Plan (2024 - 2028)

The Twelfth Development Plan is the government's latest comprehensive vision, and it clearly reflects the policy dialogues of the preceding five years. Its explicit central axis of "green and digital transformation" shows that the themes championed by industry and civil society have been fully integrated into the highest level of national strategy. This plan can be read as a response to the entire body of literature that precedes it, attempting to provide a stable, long-term roadmap that incorporates lessons learned from past challenges and crises.

3.23. Digital Turkey 2030: Economic Impacts and Policy Framework

This 2023 report from Vodafone and Policy Analysis Laboratory acts as a forward-looking policy brief, designed to directly inform strategy documents like the Twelfth Development Plan. By comparatively analyzing Turkey's digitalization across society, companies, and government, it synthesizes the challenges and offers a consolidated set of recommendations. It represents a constructive effort to bridge analysis and action, providing a ready-made framework for policymakers aiming to accelerate digital transformation.

3.24. 2022 Education Evaluation Report

As one of the final documents in this period, TEDMEM's 2023 evaluation of the 2022 school year serves as a comprehensive stocktaking. It functions as an "almanac of education," providing a data-rich summary of the system's state after the most acute phase of the pandemic had passed. By encompassing the evolution of TEDMEM's own monitoring efforts, the report not only evaluates the education system but also reflects on the practice of policy monitoring itself, closing the loop on a five-year cycle of intense scrutiny and debate.

A collective analysis of these policy documents reveals a recurring pattern in Turkey's approach to strategic transformation: a strong capacity for ambitious, centralized vision-setting that often struggles with cohesive and consistent on-the-ground implementation. This dynamic is not new; it reflects the legacy of large-scale initiatives like the FATİH Project, where the distribution of technological hardware took precedence over pedagogical integration and teacher preparedness, leaving a significant gap between investment and educational outcomes. Similarly, the rapid scaling of the EBA platform during the COVID-19 pandemic showcased the state's impressive reactive capabilities, yet it also laid bare the chronic digital divide and the challenges of ensuring equitable access—issues consistently highlighted in the monitoring reports by civil society organizations such as ERI and TEDMEM. Ultimately, the policy landscape of the 2018-2023 period suggests a system adept at generating forward-looking strategies for the digital economy and education, but less proficient at ensuring the two domains evolve in genuine synergy. The critical challenge for the coming period, therefore, lies not in the formulation of new plans but in creating resilient, flexible, and equitable implementation mechanisms that ensure technological advancements translate into tangible and widespread societal progress.

4. FINDINGS AND DISCUSSION

The findings are presented in such a way that the sub-problems identified in accordance with the purpose of this research are answered separately. In this context, headings were created for each research question.

4.1. Purpose, Scope and Main Themes of Policy Documents Published in Turkey

The reports analyzed in this study provide a general framework for the future of Turkey's education system. The 2023 Education Vision and the Eleventh Development Plan focus on increasing the quality and access to education, building the capacity of teachers and improving educational infrastructure. The TÜSİAD report provides recommendations on how digital transformation can be integrated into the education system. ERG and TEDMEM reports focus on monitoring and evaluating the performance of the education system in Turkey.

The reports reveal persistent inequalities in education, a shortage of teachers, and inadequate educational infrastructure. The negative impact of the COVID-19 pandemic on education is also highlighted in reports. Some reports focus on specific issues such as special education, the education of migrant and refugee children, and vocational education. These reports present the problems and solutions in these areas. A significant number of reports include content related to digital transformation in education. These reports provide information and recommendations on different aspects of the education system. The reports show that there are still many problems in education, but important steps have been taken to improve the education system. It is emphasized that all stakeholders (public, private sector, NGOs, academics, etc.) need to work together for a successful digital transformation of education in Turkey.

Analysis of the reports reveals several commonalities. Almost all reports emphasize that there are inequalities in education and teacher shortages in Turkey. The reports show that inadequate educational infrastructure is also an important problem. All reports emphasize the importance of digital transformation in education and argue that developments in this field will contribute to improving the education system. There are also points where the reports differ from each other. For example, while some reports focus on general education policies, others focus on specific issues such as “special education, education of migrant and refugee children, vocational education, etc.”. For example, the TEDMEM (2019) report focuses on inequalities in education in general, while the ERG & Education Observatory (2021b) report focuses on inequalities in migrant and refugee children's access to education.

Different approaches are also evident in the reports. While some reports adopt a more theoretical approach, others take a more practical approach. While the TÜSİAD (2018) report provides a theoretical framework on how digital transformation can be integrated into the education system, the National Artificial Intelligence Strategy prepared by the Ministry of Industry and Technology & Presidential Digital Transformation Office (2021) sets out concrete practices and targets in this area. Therefore, while some of the reports provide general recommendations, others offer more concrete and applicable suggestions. While the MoNE (2019) 2023 Education Vision offers general recommendations to eliminate inequalities in education, the ERG & Education Observatory (2021b) report offers concrete recommendations to increase access to education for migrant and refugee children.

As a result of the thematic analysis conducted within the scope of this study, the common themes that stand out in the reports examined are presented in Figure 2.

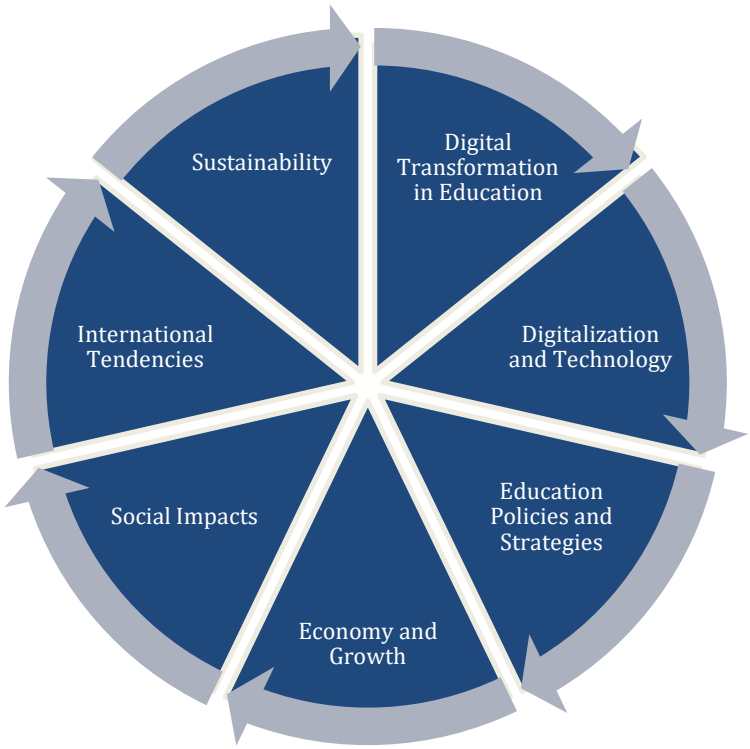


Figure 2. Themes emerging in the analyzed policy documents.

Figure 2 visualizes the themes as components of a single, interconnected system. Its circular design, where each theme is an equal segment, is deliberate. It argues that no single theme can be understood in isolation. For instance, "Digital Transformation in Education" is influenced by "International Tendencies" and has direct "Social Impacts." The arrows suggest a dynamic, continuous relationship, where all themes mutually influence one another. While this model posits a balanced interrelationship,

Table 5 provides the empirical data that quantifies the actual prevalence of these themes in the analyzed reports. The frequency counts (f) in the table reveal a distinct hierarchy among the themes, demonstrating which topics in fact dominate the current discourse.

Table 5.
Frequency Analysis and Explanation According to the Themes of the Analyzed Reports

Themes	f	Description	Sample Reports
Digital Transformation in Education	12	New technologies used in education, distance education, online learning, use of AI in education and educational technology trends.	TED, TEDMEM, ERG & Education Observatory, TÜSİAD & Istanbul Aydın University
Digitalization and Technology	10	The effects of digital transformation in different sectors, e-commerce, use of mobile technology, AI and automation, data security and privacy.	TÜSİAD, Ministry of Science, Industry and Technology, TBD, Deloitte & TÜSİAD, Vodafone & Policy Analysis Lab.
Education Policies and Strategies	8	Ministry of National Education's education policies and strategies, curriculum reforms, teaching profession, assessment and evaluation system, special education and vocational education.	MoNE, TED, ERG & Education Observatory, TEDMEM
Economy and Growth	7	Contributions of digital transformation to the economy, e-government applications, entrepreneurship and innovation, research and development (R&D) investments, employment and unemployment.	Presidential Strategy and Budget Directorate, TÜSİAD & TÜBİSAD
Social Impacts	5	The effects of digital transformation on society, social inequalities, digital literacy, cyberbullying, changing roles in family and society.	Vodafone & Policy Analysis Lab, ERG & Education Observatory
International Trends	4	Education and technology trends in the world, education policies of OECD countries, international exams, good practices in education.	TED, ERG & Education Observatory, Presidency Strategy and Budget Directorate
Sustainability	2	Environmental impacts of digital transformation, sustainable development goals, green technologies, energy efficiency.	Presidential Strategy and Budget Directorate

An analytical interpretation of the data presented in Table 5 reveals a distinct hierarchy of priorities within the discourse on digital transformation. The analysis of thematic frequencies indicates a predominant focus on the instrumental aspects of technology, with "Digital Transformation in Education" (f=12) and "Digitalization and Technology" (f=10) emerging as the most salient themes. This techno-centric orientation is followed by a secondary, yet significant, concern for the structural implications of these changes, as evidenced by the frequencies of "Education Policies and Strategies" (f=8) and "Economy and Growth" (f=7). In stark contrast, themes addressing the broader societal and ethical ramifications are notably marginalized. The relatively low frequencies for "Social Impacts" (f=5) and the minimal attention given to "Sustainability" (f=2) suggest that critical issues such as digital inequality, societal well-being, and environmental consequences are treated as peripheral concerns in the reports analyzed. This thematic distribution implies that the prevailing discourse prioritizes the implementation, governance, and economic leveraging of digital technologies over a more holistic examination of their long-term human and ecological impacts. While the involvement of diverse stakeholders—spanning government, private industry, and civil society—indicates a broad-based conversation, the data suggests this dialogue is currently weighted heavily towards technological and economic imperatives rather than social or environmental stewardship.

4.2. Themes/Concepts Commonly Used in Policy Documents Published in Turkey

The concepts in 24 policy documents published between 2018 and 2023, which were examined within the scope of this study, were analyzed using frequency analysis. For this purpose, a Python program was prepared by the researchers. In the program, firstly, the pdf format files of the policy documents were converted into text using the PyPDF2 library. Then, the words to be excluded from the document, which was brought to a single text format, were determined. Accordingly, words such as “but”, “wonder”, “yet” and “from” in the documents that would not be taken into consideration within the scope of the research were identified. Without including these words in the frequency analysis, the 100 most repeated words for each document were counted using the Counter library of the Python programming language and the result was saved in an excel file. The related words were then reviewed by the researchers and the word frequency table was finalized. Accordingly, 90 words with more than 100 occurrences and their frequencies are grouped and presented in Table 6.

Table 6.
Frequency Distribution of Words and Word Groups Used in Policy Documents

Words and Word Groups	Frequency
Education (10103); MoNE (3975); Turkey (3339); School (3108); Digital (3077); Student (3013); Vocational Education (2830); Teaching (2797); Teacher (1916); Technology (1555); Distance Education (1489); Assessment (1416); Social (1398); Learning (1393); Technical (1253); Artificial Intelligence (1134)	1000+
Data (959); COVID (891); Public (879); OECD (787); Secondary Education (752); Class (742); Exam (700); Industry (688); Anatolia (675); International (668); Knowledge (656); Global (577); Epidemic (559); Transformation (557); Lesson (542); Business (535); Production (512)	500-1000
Service (479); Economic (474); Face to Face (402); Policy (392); Project (380); Guidance (378); Health (371); Development (365); Private (336); National (330); Solution (327); Basic Education (327); Software (323); Application (318); Child (302); Sector (300); Problem (293); STEM (289); Effective (261); Research (256); Incentive (251); Science (250); Basic (244); Employment (240); News (232); Higher Education (231); Informatics (225); TEDMEM (224); Product (221); Energy (217); Manufacturing (213); Digitalization (196); Development (193); Internet (193); Teaching (191); Investment (188); Disaster (182); Productive Artificial Intelligence (180); R&D (171); Action (163); Imam Hatip (154); Infrastructure (148); Undergraduate (146); Project High School (146); Placement (144); Sustainable (139); Human (131); Economy (129); Security (129); Domestic (124); Dollar (121); EBA (121); Online (111); Mixed (110); Communication (109); Monitoring (109); EU (104)	100-500

A word cloud was created to visualize the data presented in Table 6. Accordingly, the commonly used words in the analyzed policy documents are presented in Figure 3.



Figure 3. Representation of commonly used words in the analyzed policy documents using word cloud.

As seen in Table 6 and Figure 3, the words education, MoNE, Turkey, school and digital were frequently used in policy documents. This was followed by words such as student, vocational education, teaching, teacher, technology, distance education and evaluation. Notably, the word cloud reveals that 'Artificial Intelligence' is also among the commonly used words. However, the concept of productive AI, which is the application area of AI especially in educational settings, was used relatively less.

4.3. Objectives and Findings of Policy Documents Published in Turkey

The objectives and findings of the policy documents analyzed in this study were categorized. However, since nine documents did not report educational objectives and findings, they were not included in this analysis. The relevant categories of findings are presented in the following sections. These findings provide important insights into the current state and future strategies of the education system in Turkey. This can provide guidance in the formulation and implementation of education policies.

4.3.1. Improvement of Education Infrastructure and Training of Qualified Labor Force

Policy documents focus on making the education infrastructure suitable for the digitalization process and training a qualified workforce (Ministry of Science, Industry and Technology, 2018). The proposed measures prioritize steps such as establishing continuous education centers and thematic vocational high schools training digital technology users and increasing the number

of programs that train digital technology developers at universities stand out (TBD, 2020). In addition, activities such as updating curricula, providing teachers with digital competencies, and raising awareness of digital transformation can also be considered in this category.

The digital divide in education has deepened, and the difficulties in accessing digital infrastructure, especially during the pandemic, have increased injustices in education (ERG & Education Observatory, 2022). This situation reveals serious limitations in students' and teachers' access to digital content and communication tools (ERG & Education Observatory, 2021a). The resulting learning loss and learning poverty have become a critical topic of discussion, emphasizing the importance of compensating for the stagnation or regression of students' academic gains (ERG & Education Observatory, 2021a). Furthermore, it is noted that school-age children in Turkey from poor households have low rates of access to devices and the internet, which prevents the distance education process from being carried out effectively and leads to a deepening of unequal opportunities (ERG & Education Observatory, 2021a). This not only hinders individual student progress but also challenges the overall development of an ICT-based education system, which is crucial for fostering innovative ideas, developing digital skills, and minimizing the negative effects of inequality (Gupta & Hayath, 2022).

This situation in Turkey directly aligns with the global warning issued by UNESCO (2023), which cautions that artificial intelligence and digital technologies, without appropriate guidance and regulation, can exacerbate existing educational inequalities. The challenges observed—from disparate access to digital tools to the varying quality of online learning experiences—underscore UNESCO's concern that the benefits of technological advancements in education will not be shared equally, potentially leaving the most vulnerable students even further behind. Similarly, a report by the OECD (2023) emphasizes that a successful digital transformation in education requires more than just the provision of technology. It calls for the development of a strategic vision that ensures equitable access and usage opportunities for all students. The report suggests that without such a vision, simply introducing new technologies may fail to close, and could even widen, the educational gap.

While Turkish policy documents, such as the "Education Vision 2023" and the ambitious FATİH project, indicate the existence of a forward-looking vision for a digitally integrated education system, the practical realities highlight a significant disconnect. The persistent disparities in infrastructure and access, particularly affecting students in rural areas and from low-income families, underscore the gap between these national goals and the on-the-ground reality. This discrepancy reveals that despite a clear policy direction, the effective implementation and the equitable distribution of resources remain critical challenges, confirming that a strategic vision must be accompanied by concrete and equitable action to prevent the deepening of educational injustices in the digital age.

4.3.2. Enhancing Technology and Innovation Capacity

Policy documents emphasize the development of technology and innovation capacity (Ministry of Science, Industry and Technology, 2018). In this context, goals such as developing trainings and infrastructure for new technologies such as AI, cloud computing and big data, and preparing technology roadmaps for sectors stand out (TBD, 2020). The development of innovative delivery systems such as online training options is becoming increasingly important in workforce skills training (Robertson, 2018). In this context, initiatives such as Massive Open Online Courses, microloans and nano-certificates aim to provide high-quality, timely and affordable education and workforce training (Börner et al., 2018). Reforms in technical and vocational education and training systems are necessary to increase skills, competitiveness and productivity (Khan et al., 2022).

4.3.3. Improvement of Data Communication Infrastructure

Policy documents emphasize the strengthening of data communication infrastructure (Ministry of Science, Industry and Technology, 2018). Under this category, targets such as improving internet infrastructure and establishing a national big data infrastructure have been identified. Increasing investments in the education sector, especially in data communication infrastructure, can increase productivity, support skills development, and promote economic development by increasing labor productivity (Mukui, Awiti & Onjala, 2019).

4.3.4. Strengthening Corporate Governance

Policy documents include targets for strengthening institutional governance (MoNE, 2019). Effective governance is a necessity for meeting the instructional and other needs of stakeholders in educational institutions (Abdelaziz, 2022). This category includes goals such as improving management processes and organizational structures in line with contemporary norms and increasing public-private sector cooperation.

4.3.5. Supporting and Mainstreaming Digital Transformation

Policy documents emphasize the support and dissemination of digital transformation (Ministry of Science, Industry and Technology, 2018). Under this category, there are goals such as increasing awareness of digital transformation and supporting

the digital transformation of users. The support and diffusion of digital technologies leads to the development of sustainable curricula, digitalization of educational processes, and improvement of student performance (Shenkoya & Kim, 2023). As this study has found, the COVID-19 pandemic has further emphasized the importance of digital technologies in education, leading to a paradigm shift towards their institutionalization and highlighting their role in ensuring continuity in learning (Parveen & Ramzan, 2024).

4.3.6. Learning Objectives and Findings

Targets and findings for the education system in policy documents also constitute an important category (TÜSİAD & İstanbul Aydın University, 2020). Under this category, goals such as increasing STEM education competency levels and ensuring that students receive education in line with their interests and abilities are included. The Malaysian Ministry of Education has recognized the importance of aligning teachers' and students' competencies in STEM disciplines with the requirements of STEM careers (Rasid et al., 2020). Moreover, the integration of STEM education into the curriculum helps to develop core competencies such as critical thinking, problem solving, and innovation (Margot & Kettler, 2019).

4.3.7. Education Policies Regarding the Pandemic

Education policies and measures taken during the pandemic were also mentioned in policy documents (TED, 2020b). This category includes objectives and findings on how education infrastructure and processes were managed during the pandemic. The pandemic led to radical changes in the governance and management of educational institutions, affecting planning, implementation and evaluation processes (Laksono, 2021). In this context, crisis management strategies were implemented in education policies in various countries to ensure the continuity of education during the pandemic (Karsantik, 2021).

4.3.8. The Need for a Resilient and Flexible Structure

Policy documents emphasize the need to make the education system more resilient and flexible in the face of emergencies (Presidential Strategy and Budget Directorate, 2023). Flexibility and adaptability in education are essential for education systems to effectively address the changing needs, challenges and different learning contexts (Chand, 2024). Moreover, the incorporation of digital technologies into education requires flexibility to adapt to different pedagogical approaches and individual student characteristics (Berrocoso et al., 2021). In this framework, it is necessary to ensure the proper use of technology in education, increase technological literacy and reduce inequalities arising from the use of technology. In addition, the documents also emphasize steps such as supporting the professional development of teachers, structuring the learning process to adapt to different needs, and improving the quality of educational spaces. In this context, principles such as equality, flexibility and teacher professionalism are essential for the implementation of a successful education policy (Demboh & Susanti, 2021).

4.4. Artificial Intelligence in Policy Documents Published in Turkey

There is no clear definition and scope of AI in policy documents. Some documents define AI as the ability to solve problems and learn in a similar way to human intelligence, while others focus on specific technologies (e.g. deep learning, machine learning) using a narrower definition. The documents indicate that AI can play an important role in various policy areas. Accordingly, AI is expected to boost economic growth and productivity, create new jobs and reduce unemployment. AI can be used to diagnose and treat diseases, develop medicines and make healthcare more efficient. The documents emphasize that AI can be used to personalize education, make learning more effective, and provide a unique learning experience for each student. AI can also be used to fight crime, improve cyber security and ensure public safety.

TÜSİAD (2018) provides an example of how the APAS robot, an important element of the industry 4.0 transformation, is used in the quality control process thanks to AI. This example emphasizes the role of AI in production processes. Furthermore, the report of the Ministry of Science, Industry and Technology (2018) underlines the importance of AI in the digital transformation process of the manufacturing industry. AI is seen as a pioneering technology to ensure high levels of productivity, profitability and quality in combination with other technologies. The MoNE (2019) report emphasizes the importance of digital content and skills-based transformation to support learning processes. It is stated that AI is included in the innovations brought about by changes such as the development of information technologies, digitalization and industry 4.0. The Presidential Strategy and Budget Presidency (2019) report states that development roadmaps have been prepared in a number of technology areas, including AI, within the framework of the national technology move. It is stated that national policies for the production and widespread use of AI technologies will be determined and efforts will be made to develop domestic technology production capabilities.

Some of the documents include findings on the use of AI in education. AI offers various opportunities such as personalizing education, making learning more effective and providing a unique learning experience for each student. AI is used to support student learning, assist teachers and provide personalized educational experiences (Alkan, 2024). Research shows that AI can

enhance learning in various fields and emphasizes its potential to improve educational outcomes (Lillehaug & Lajoie, 1998). However, there are ethical concerns about the use of AI in education, such as data privacy, bias and inequality (See Figure 4). There are studies reporting similar findings in the literature. While educators acknowledge the necessity of using AI in classrooms, they also voice concerns about privacy, ethics and accessibility (Alam et al., 2024). Another striking finding is that success criteria were included in only one report. In the strategic plan published by the Ministry of National Education (MoNE, 2019), the increase in student success rates, increase in literacy rates and increase in the efficiency of the education system are shown.

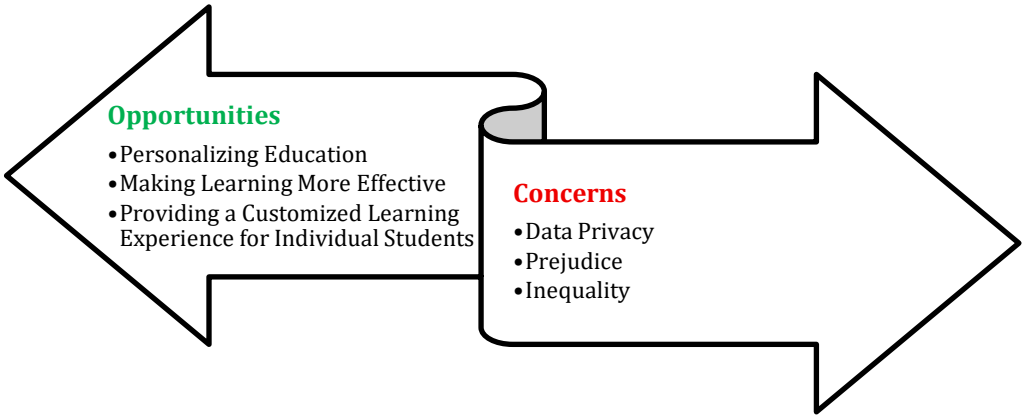


Figure 4. Opportunities and concerns emphasized for AI in the analyzed policy documents.

Policy documents also offer various recommendations to increase the use of AI in education. Accordingly, ethical concerns about the use of AI in education should be addressed first. Success criteria for the use of AI in education should be determined and monitoring and evaluation should be carried out according to these criteria. Teachers and students should be trained in using AI. In this context, there are studies emphasizing the necessity of AI education in the literature (Alenezi, 2023; Wu et al., 2024). Research and development studies on the use of AI in education should be supported.

4.5. The Use of Artificial Intelligence in Education in Policy Documents Published in Turkey and Stakeholder Views

When the policy documents identified within the scope of this research are examined, it is seen that stakeholder views, challenges and concerns about the use of AI in education are clearly revealed in various documents. This situation is explained under the following headings.

4.5.1. Digital Technologies and Education Policies

TÜSİAD (2018) report emphasizes that Turkey lags behind Europe in the use of digital technologies in education. Despite its young population, the rate of internet use for educational purposes is low. This shows that more effort is needed for digital transformation.

4.5.2. Digital Skills Development

The Ministry of Science, Industry and Technology (2018) report emphasizes that digitalization has changed workforce expectations and the importance of training a qualified workforce. For this, it is stated that the education system should focus on developing digital skills. In this direction, the importance of digital skills acquisition in education for the development of the digital economy is emphasized and it is stated that the education curriculum should be updated.

4.5.3. Updating Training Content and Teacher Training

The MoNE (2019) report emphasizes the need to digitalize educational materials, increase teachers' digital skills and develop digital platforms such as education portals. In addition, it is important to provide students with skills and develop their cognitive thinking abilities, especially in the field of STEM (Presidency Strategy and Budget Presidency, 2019). It is also stated that teachers should be supported in areas such as defining administrative competencies and measuring the skills required for educational leadership (TED, 2019). Supporting teachers in the use of technology, providing students with digital skills, including digital skills modules in curricula, and promoting digital literacy skills throughout society are common views expressed in the documents.

While policy documents emphasize teacher training, there are uncertainties regarding the sustainability and effectiveness of these training programs. The OECD (2023) states that the continuous professional development of teachers in digital pedagogy is the cornerstone of digital transformation. UNESCO (2023) states that in the age of artificial intelligence, the role of teachers has evolved from being mere technology users to becoming guides who equip students with critical thinking and ethical reasoning skills. The current situation in Turkey shows how far behind these global trends are and that teacher training policies urgently need to be redesigned according to these new roles.

4.5.4. Science and Technology Focused Education

The Presidential Strategy and Budget Presidency (2019) report emphasizes the importance of equipping students with analytical and critical thinking skills in science, technology, engineering and mathematics. It is stated in various documents that it is important to integrate 21st century skills such as analytical thinking, creative thinking and technological literacy into the education system and to revise curricula to develop these skills.

4.5.5. Software and Technology Competence

TED (2019) report states that online training programs will be implemented to increase the quality and number of software developers. It is also recommended to establish scholarship programs for graduate students in the field of software. Deloitte & TÜSİAD (2021) report emphasizes the importance of application-oriented education models for training competent manpower in the software sector. This shows that flexible and short-term training programs should be developed in accordance with the needs of the sector.

4.5.6. Artificial Intelligence and Education

The TBD (2020) report emphasizes the use of AI technologies in education and the development of a domestic AI industry. For this purpose, it is recommended to create an R&D culture and infrastructure. At the same time, policy documents emphasize the importance of training a qualified workforce suitable for AI and other advanced technologies (TBD, 2020).

4.5.7. Strengthening Education Infrastructure

TÜSİAD & İstanbul Aydın University (2020) report points to the need to establish laboratories in educational institutions where Industry 4.0 components will be implemented. In this context, it is stated that vocational education programs should be updated and students should be provided with skills in line with sectoral needs (Ministry of Industry and Technology & Presidential Digital Transformation Office, 2021; TED, 2019).

4.5.8. Online and Distance Education

Especially in pandemic conditions, the importance of the distance education model has emerged. In this context, policy documents emphasized the need to develop distance education infrastructure and increase the online accessibility of educational materials (MoNE, 2019; TED, 2020B). Among the steps to be taken in education in the post-pandemic period, issues such as supporting the psychological resilience of students, conducting quantitative and qualitative evaluations in distance education, and providing support according to the different needs of teachers were shown.

4.5.9. Stakeholder Concerns

Stakeholders also expressed their concerns in the policy documents reviewed. Accordingly, stakeholders' concerns are compiled in Figure 5.

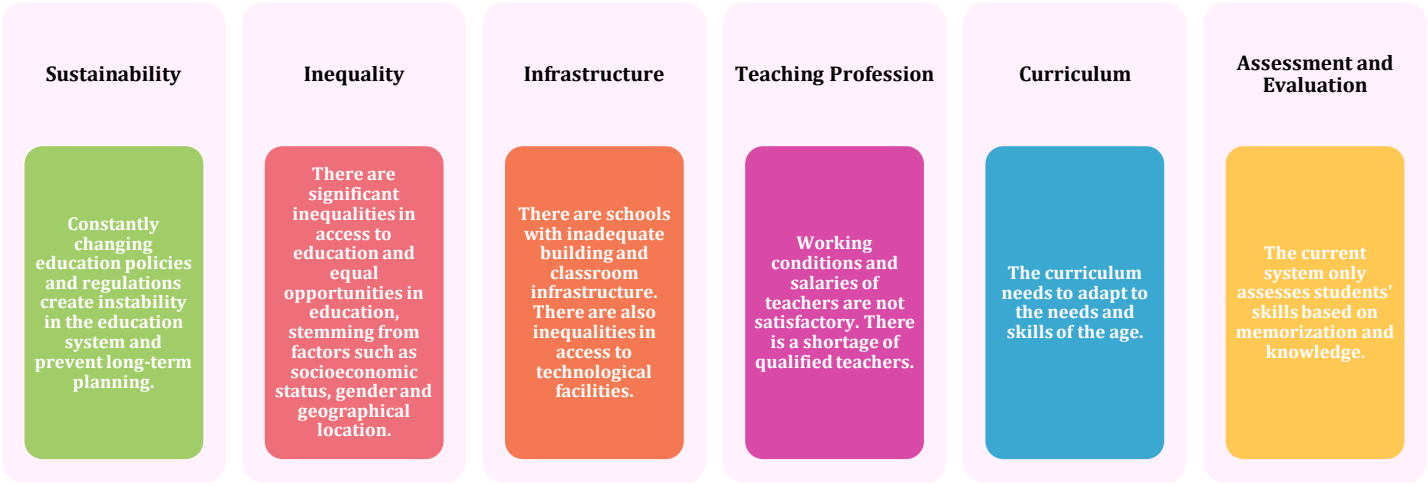


Figure 5. Stakeholder concerns highlighted in policy documents.

As can be seen in Figure 5, stakeholder concerns primarily focus on sustainability, inequality, infrastructure, the teaching profession, curriculum, and assessment and evaluation. In addition, various problems that emerged especially during the pandemic were also reflected in the documents. Inequalities in access to the internet and technological devices have led to inequalities in the utilization of distance education. Inadequate digital skills of teachers and students reduced the effectiveness of distance education. The pandemic and distance education negatively affected students' social and emotional development. Estimates that students suffered significant learning losses during the pandemic were also mentioned in the documents.

In the literature, there are studies in which stakeholder views on the use of AI in education are discussed. Accordingly, stakeholders have shown great interest in the use of AI in education, which presents both opportunities and challenges. Different views are expressed by stakeholders, with some emphasizing how AI can enhance educational opportunities and change the way people learn and teach (Chukwubueze & Vinella, 2024; Gligorea et al., 2023; Roshanaei et al., 2023). However, challenges related to data privacy, algorithmic bias and the need for teacher training, as well as the accuracy and reliability of AI-supported educational content have also been raised (Bobrytska et al., 2024; Uygun, 2024). In the educational context, stakeholders emphasize the importance of addressing ethical issues and guaranteeing fair access to AI resources (Arvin et al., 2023; Karimi & Khawaja, 2023; Roshanaei et al., 2023).

5. CONCLUSION AND RECOMMENDATIONS

The aim of this study is to comprehensively analyze Turkey's educational strategies and policy documents related to digital transformation, development and AI and to provide a comprehensive overview of the country's education policy. Using content analysis methodology, strategy and policy documents were selected, coded and analyzed in line with certain criteria. The results of the study indicate that the importance of digital transformation in education in Turkey is emphasized, but various challenges are encountered in this process. Structural problems such as inequalities in education, teacher shortages and inadequate digital infrastructure prevent the digital transformation process from taking place effectively. In particular, the negative repercussions of the COVID-19 pandemic on education have led to a deepening of the digital divide and increased learning losses. Difficulties in accessing digital infrastructure during the pandemic further increased inequalities in education and reduced the effectiveness of the distance education process.

The analysis reveals that foundational initiatives like the FATİH Project were crucial first steps in building the nation's digital education infrastructure, providing hardware such as interactive whiteboards and tablets, and creating rich e-content through platforms like the Education Information Network (EBA) (YEĞİTEK, 2015). However, the persistent challenges identified in this study—such as the digital divide, the need for sustainable teacher training, and ensuring equal access—demonstrate that the projections and goals of the FATİH Project are still highly relevant to current technology integration policies. The project highlighted the necessity of a multi-faceted approach that includes not only technology provision but also continuous professional development for teachers and the creation of high-quality digital pedagogical resources.

In response to the evolving demands for new competencies, recent policy shifts, most notably the "Century of Türkiye Education Model" ("Yeni Maarif Modeli"), aim to move the education system beyond knowledge transfer towards a holistic, skills-based framework (EPAM, 2025). This model's emphasis on integrating 21st-century skills—such as critical thinking, digital literacy, and problem-solving—with a strong foundation of national and moral values directly addresses the findings of this study. The model represents a strategic effort to cultivate well-rounded individuals who are not only competent but also virtuous, aligning with the need to prepare students for a complex, technology-driven world while preserving societal values.

Policy documents reveal that AI offers significant opportunities in education in areas such as personalized learning, teacher support and curriculum development. However, there are ethical concerns about the use of AI in education, such as data privacy, bias and inequality. The guide published by the Higher Education Council on the use of generative AI reinforces these concerns and provides a foundational ethical framework (YÖK, 2024). The guide stresses the importance of transparency, accountability, honesty, and fairness in the deployment of AI technologies in academic research and publishing. It warns against the risks of factual errors, bias in AI-generated content, and the potential for ethical violations like plagiarism if AI usage is not properly disclosed. This requires careful planning and implementation of AI-supported education applications.

In general, it is recommended that the steps outlined in Figure 6 be taken to successfully implement digital transformation in Turkey and utilize artificial intelligence in education policies.

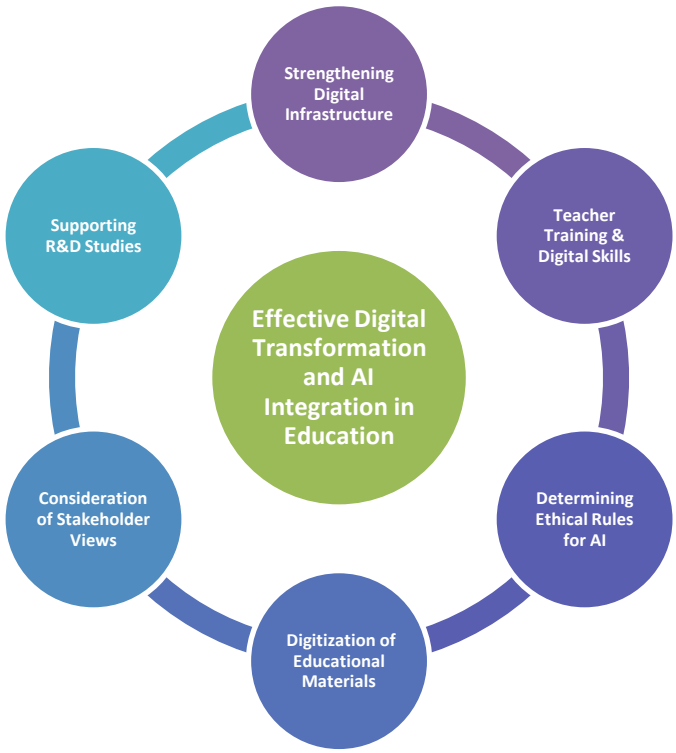


Figure 6. Effective digital transformation and AI integration in education.

For the successful realization of digital transformation and the use of AI in Turkey's education policies, a multi-faceted approach is recommended. This process should begin by strengthening the digital infrastructure in educational institutions and increasing internet access, building on the lessons from the FATİH Project; it is especially important to include schools in disadvantaged regions in this transformation process to mitigate educational inequalities. Alongside infrastructure, continuous training programs should be organized to improve the digital skills of teachers, enabling them to use digital technologies effectively and preparing them to foster 21st-century skills and integrate AI tools into their teaching practices responsibly, in alignment with the goals of the "Century of Türkiye Education Model." Furthermore, as AI-supported education applications are developed and implemented, they must adhere to robust ethical rules, as outlined in the YÖK's ethics guide, paying close attention to issues such as data privacy, transparency in AI usage, accountability for AI-generated outputs, and preventing bias and inequality. This technological and ethical framework must be supported by the digitization of educational materials, providing online access to students and aligning the content with the interdisciplinary and skills-focused structure of the new curriculum models to make learning processes more effective. For the sustainability and success of all these initiatives, the views of stakeholders, including teachers, students, and parents, must be taken into account. Their active participation should be ensured in the implementation of new policies like the "Century of Türkiye Education Model." Finally, to continuously advance this dynamic field, R&D studies on the use of AI in education should be supported. The dissemination of innovative practices should also be encouraged.

These recommendations will contribute to the realization of AI and digital transformation processes in education in Turkey in a more effective and sustainable manner. Future research should examine the long-term effects of AI on education. However, in this direction, the opinions of stakeholders should be addressed more comprehensively and the effectiveness of AI-supported educational practices should be evaluated. Because these studies will accelerate the digital transformation of Turkey's education system and increase equality of opportunity in education.

Research and Publication Ethics Statement

This study complies with research and publication ethics.

Contribution Rates of Authors to the Article

The authors declare that they have contributed equally to the article.

Statement of Interest

The authors declare that there is no conflict of interest between them.

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A Reliability Generalization Meta-Analysis of Mathematics Self Efficacy- Revised (MSES-R) Scale*

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ABSTRACT

The Mathematics Self-Efficacy-Revised (MSES-R) scale (Kranzler & Pajares, 1997) has been widely used to measure students' mathematics self-efficacy. This study aims to determine the common reliability coefficient using reliability generalization, a type of meta-analysis. The research process was organized using PRISMA guidelines. The average consistency reliability was calculated as 0.901 with a 95% CI [0.864; 0.939] using a random effect model. The studies showed heterogeneity [Q (6) = 219.788; p < .01; I2 = 96.99%]. The meta-analysis predicts that certain moderator variables significantly affect the scale's reliability. The reliability generalization analysis of the MSES-R scale reveals the different properties of the MSES-R inventory using a mixed effects model. It was found that sample type and department context significantly affect the Cronbach's alpha coefficient of the MSES-R scale (p < 0.01), while the study location variable does not significantly affect the common coefficient (p > 0.01).

Keywords: Cronbach's alpha coefficient, mathematics self-efficacy, meta-analysis, reliability generalization

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1. INTRODUCTION

Educational psychologists and mathematics educators have long sought variables that can enhance students' cognitive and affective outcomes in mathematics learning, particularly those that foster academic achievement (Chief Examiner Report, 2005, 2006, 2007). Among these variables, self-efficacy beliefs have received increasing attention. Self-efficacy is defined as individuals' evaluations of their competence, skills, and capacities and their ability to translate these into behaviors (Schunk, 2009). According to Bandura (1986), self-efficacy reflects individuals' judgments about their capacity to perform a specific task, and it is considered a key determinant of motivation and behavior (Pajares, 1992). Individuals with strong self-efficacy beliefs are more motivated to cope with difficulties and exert greater effort to overcome challenges (Bandura, 1994), whereas those with weak self-efficacy beliefs tend to give up quickly when facing obstacles (Pajares, 1996).

In mathematics education, affective factors are as important as cognitive skills (McLeod, 1992). One of the most influential affective factors associated with mathematics achievement is mathematics self-efficacy (Usher, 2009). It is generally defined as students' judgments about their ability to successfully complete mathematical tasks (Hackett & Betz, 1989; Pajares & Kranzler, 1995). Students' confidence in their mathematical abilities enables them to engage actively in learning by applying different strategies, methods, and techniques (Alderman, 1999). Pajares and Kranzler (1995) even argued that the predictive power of self-efficacy beliefs for mathematics performance is as strong as that of general mental ability. Indeed, numerous studies have consistently reported a significant relationship between mathematics self-efficacy and achievement (Hackett & Betz, 1989; Moore, 2005; Pajares & Graham, 1999; Pajares & Miller, 1995; Usher, 2009). Collectively, these findings emphasize the necessity of developing students' mathematics self-efficacy beliefs to improve their achievement.

Accurate measurement of affective constructs such as mathematics self-efficacy is therefore crucial for evaluating students' motivation in learning mathematics. The reliability of measurement instruments directly affects educational interventions and instructional decisions. Among the available instruments, the Mathematics Self-Efficacy Scale-Revised (MSES-R; Kranzler & Pajares, 1997) stands out as one of the most frequently validated and widely applied tools to assess mathematics self-efficacy.

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It consists of three subscales—tasks, courses, and problems—that capture students' confidence in applying mathematics to real-life tasks, succeeding in mathematics courses, and solving novel problems. Specifically, the tasks subscale measures students' confidence in applying mathematics to everyday situations such as calculating recipe quantities; the courses subscale reflects their beliefs about succeeding in mathematics subjects like geometry or algebra; and the problems subscale evaluates their confidence in solving novel mathematical problems.

Compared to other instruments such as the Mathematics Self-Efficacy Questionnaire (MSEQ; Betz & Hackett, 1983) or the Self-Efficacy for Learning Mathematics Scale (SELM; Bandura, 1997), the MSES-R provides a broader and more differentiated measurement framework that captures both academic and applied aspects of mathematical competence (Pajares & Kranzler, 1995). Its tripartite structure allows researchers to distinguish between students' perceived competence in formal coursework and their confidence in problem-solving or real-life applications, offering a more holistic view of mathematics self-efficacy. Furthermore, the MSES-R has been extensively validated and adapted across diverse populations and cultural contexts, resulting in a relatively large and methodologically diverse body of literature (e.g., Finney & Schraw, 2003; Guardia-Olmos et al., 2012; Blake & Masten, 2015). This makes it particularly suitable for a reliability generalization (RG) meta-analysis, as the accumulation of independent reliability coefficients provides a strong empirical basis for evaluating its internal consistency across contexts. Therefore, the MSES-R was selected for examination in this study.

Despite its widespread application, no RG meta-analysis has yet synthesized this evidence. Therefore, this study not only addresses the lack of RG research on MSES-R but also establishes its theoretical and empirical superiority over other mathematics self-efficacy instruments. By synthesizing reliability coefficients from diverse studies, it aims to provide a comprehensive understanding of the MSES-R's measurement precision and to strengthen its role as a benchmark tool in mathematics self-efficacy research.

Prior RG studies in mathematics education have addressed constructs including motivation (Taylor, 2012; Holland et al., 2018), learning (Mji & Alkhateeb, 2005; Henson & Hwang, 2002; Ross, Blackburn & Forbes, 2005), self-efficacy (Henson, Kogan & Vacha-Haase, 2001; Nilsson, Schmidt & Meek, 2002), thinking (Mahapoonyanont, Krahomwong, Kockhakornjarupong & Rachasong, 2010), self-esteem (Lane, White & Henson, 2002), anxiety (Capraro, Capraro & Henson, 2001; Barnes, Harp & Jung, 2002), self-awareness (Leach, Henson, Odom & Cagle, 2006), personality (Caruso, Witkiewitz, Belcourt-Ditloff & Gotlieb, 2001; Vacha-Haase, Kogan, Tan & Woodall, 2001; Capraro & Capraro, 2002), well-being (Crouch, 2016), and behavior (Hess, McNab & Basoğlu, 2014; Kilgus, Eklund, Maggin, Taylor & Allen, 2018). In addition, the Career Decision Self-Efficacy Scale (CDSE) has been the subject of an RG study focusing on career decision-making (Nilsson, Schmidt & Meek, 2002). Reliability studies have also been conducted on self-efficacy as a sub-dimension of motivational learning strategies (Taylor, 2012; Holland et al., 2018). However, no RG study has focused exclusively on a scale designed to measure mathematics self-efficacy. Addressing this gap, the present study conducts a RG of the widely used problem dimension of the Mathematics Self-Efficacy Scale-Revised (MSES-R).

2. METHODOLOGY

In this section, the type of the study, the data collection process, the process of determining the criteria, the validity and reliability of the measurement results related to the coding form, and the data analysis are mentioned.

2.1. Research Type

To achieve this goal, we conducted a systematic review and analysis following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PRISMA is preferred for managing and reporting literature reviews. The four steps of PRISMA are as follows:

1. Identifying research literature from database searches
2. Screening articles using inclusion and exclusion criteria
3. Assessing full-text articles for eligibility
4. Analyzing and reporting the final articles included in the review.

In the initial stage, studies were identified through searches in Web of Science, Scopus, and Google Scholar databases to ensure comprehensive coverage of the literature. However, after applying the inclusion and exclusion criteria, only the studies indexed in the Web of Science database met all requirements, and thus the final analysis was conducted on these seven studies. The study publication period for this review was from 1997 to December 2023 since Kranzler & Pajares published MSES-R in 1997, with no study conducted in 2024. First, studies that cited the relevant article (Kranzler & Pajares, 1997) were identified in the specified databases. The study was limited to quantitative methods

2.2. Meta-Analysis of Reliability and Reliability

Reliability is related to the consistency and reproducibility of the scores of a measurement tool administered at a certain time and under specific conditions (Onwuegbuzie & Larry, 2000; Taylor, 2012). Therefore, the reliability of a measurement tool is affected by the sample size and sample characteristics (Ashley, Williams & Young, 2021). Vacha-Hasse and Thompson (2011)

stated that reporting reliability coefficients is essential. If the reliability coefficient is not reported, this omission jeopardizes the study's reproducibility under similar conditions (Cousin & Henson, 2000).

As a result of the importance and incentives for reporting reliability coefficients, a new method was developed to investigate reliability coefficients and reach a common reliability coefficient (Ashley, Williams & Young, 2021). This new approach, described by Vacha-Hasse (1998) and known as RG or RG meta-analysis, is a tool developed to identify the source of differences among coefficients and present reliability coefficients holistically. RG aims to identify the source of measurement error in studies using the same instrument. It provides researchers with a method to assess score reliability in previous administrations of an instrument and investigate possible sources of variability in reliability estimates. Additionally, RG enables researchers to estimate expected reliability levels in their studies and provides options regarding different research designs concerning statistical significance and effect size (Henson & Thompson, 2002). Studies using the relevant measurement tool are data sources, and reliability coefficients are coded as dependent variables, while sample characteristics are coded as independent variables (possible predictors) (Cousin & Henson, 2000).

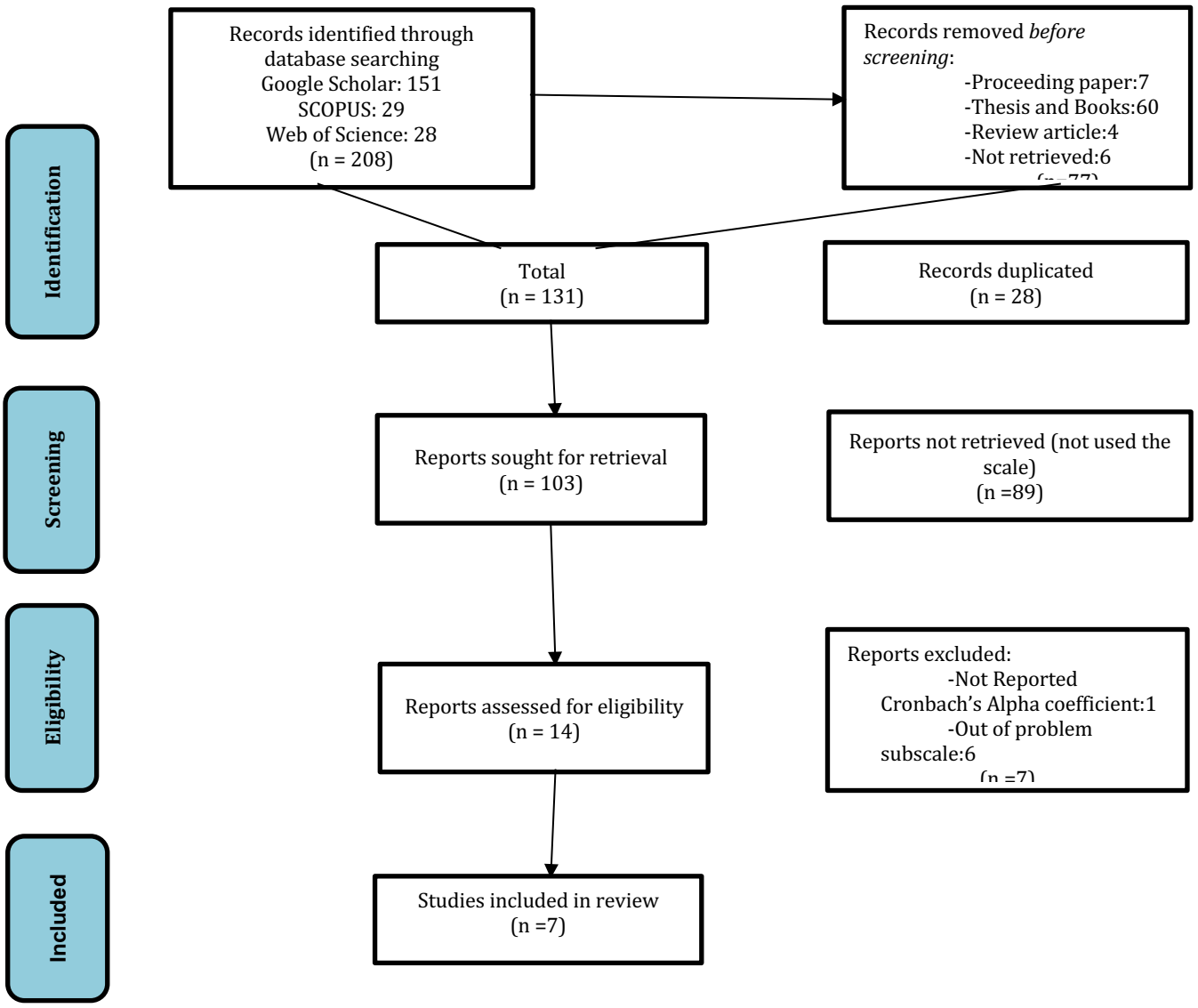


Figure 1. Study selection flow diagram

2.3. Data Collection Process

This study was initiated to identifying and reviewing research articles that cited the Mathematical Self-Efficacy Scale – Revised (MSES-R) developed by Kranzler and Pajares (1997), in order to systematically examine the empirical studies employing this scale and to include them in a RG meta-analysis.

As shown in Figure 1, electronic database searches were conducted using Google Scholar, Scopus, and Web of Science, yielding a total of 208 records, including 151 from Google Scholar, 29 from Scopus, and 28 from Web of Science. After removing proceeding

s (n = 7), theses and books (n = 60), review articles (n = 4), and studies that could not be retrieved (n = 6), seventy-seven records were excluded prior to screening. An additional twenty-eight duplicate records were also removed. The remaining studies were screened based on the predetermined inclusion and exclusion criteria.

The inclusion criteria required that studies had employed the Mathematical Self-Efficacy Scale (MSES-R) had reported Cronbach's alpha coefficient or another internal consistency reliability coefficient for the overall scale or its subscales, been published in peer-reviewed journals, and had provided sufficient statistical data for RG analysis. In contrast, studies were excluded if they were review papers, theses, books, or conference proceedings, did not employ the MSES-R, failed to report a Cronbach's alpha coefficient, or contained duplicated data.

Following this process, eighty-nine studies were excluded for not using the relevant scale, leaving fourteen studies for full-text review. Among these, one study was excluded for not reporting Cronbach's alpha coefficient, and six were excluded for reporting reliability estimates related to subscales outside the problem-solving dimension. Consequently, seven studies met all inclusion criteria and were retained for the final RG meta-analysis. Figure 1 presents the PRISMA flow diagram summarizing the overall study selection process.

2.4. Mathematics Self-Efficacy-Revised Scale

In mathematics education literature, numerous scales have been developed to measure mathematics self-efficacy. MSES-R is the most preferred instrument in mathematics education studies. MSES-R was initially developed by Kranzler & Pajares (1997) with 52 items. They later revised the scale, and calculated Cronbach's alpha coefficient of 0.901 during the original study. The scale, measured on a 5-point Likert scale, consists of three dimensions: tasks, courses, problems. Table 1 shows the items in the MSES-R.

Table 1.
Scale Items in the MSES-R Scale

Subscale	Item (example)
Tasks	Calculate recipe quantities for a dinner for 41 when the original recipe is for 12
Courses	Geometry
Problems	A baseball player got two hits in three at bats. This could be represented by 2/3. Which decimal would most closely represent this?

2.5. Data Analysis

The 14 full-text articles were re-evaluated to confirm the presence of information about the reliability coefficients. One study that did not report Cronbach's alpha coefficient was excluded. Only studies with full-text availability in English were included. Finally, seven studies met all inclusion criteria and were analyzed using the RG meta-analytic approach.

A random-effects model was applied because variability in Cronbach's alpha coefficients was expected across studies due to differences in sample characteristics, populations, and research contexts (Borenstein et al., 2019; Hedges & Vevea, 1998). The between-study variance (τ^2) was estimated using the Restricted Maximum Likelihood (REML) method, which yields more stable and unbiased estimates compared to other estimators such as DerSimonian–Laird (Viechtbauer, 2005). Common heterogeneity statistics (Cochran's Q and I^2) were calculated to quantify the variability across studies.

Publication bias was assessed using Rosenthal's Fail-Safe N, supplemented by Egger's regression and Kendall's tau tests to ensure robustness. Additionally, a mixed-effects model was employed to examine whether categorical moderators (e.g., sample type, discipline, study location) significantly influenced the overall reliability estimates. All analyses were performed using Jamovi software (Version 2.3.13).

3. RESULTS

In this section of the study, a meta-analysis was conducted to calculate the overall effect size concerning the reliability of the Mathematics Self-Efficacy Scale, as measured by Cronbcah's alpha coefficient. Additionally, moderator analyses were used to identify the sources of variation in the average Cronbach's alpha coefficients.

3.1. Reliability Findings and Sample Distribution

This section first presents the findings on publication bias, followed by the results of heterogeneity, effect size, and moderator analyses. The characteristics of the included articles are summarized in Table 2.

Table 2.
Mean of Cronbach' Alpha Coefficients, 95% Confidence Intervals, and Heterogeneity Tests for the Problem Dimension of MSES-R

Authors	Country-Continent	Sample Type	Discipline	n	Alpha
Guardia-Olmos et al. (2012)	Spain-Europe	University	Psychology	96	0.916
Cebollero et al. (2012)	Spain-Europe	University	Psychology	95	0.916
Finney & Schraw (2002)	USA-America	University	Psychology	138	0.92
Dobarro (2007)	Brazil-Europe	High School	General	213	0.9
Blake & Masten (2015)	Jamaica-USA	High School	General	780	0.97
Ayotola & Adedeji (2009)	Nigeria-Africa	High School	General	352	0.87
Briley (2012)	USA-America	Adults	Primary School Teachers	95	0.78

Table 2 shows the features of the analyzed studies regarding country-continent, sample type, discipline, number of participants, and Cronbach's alpha coefficient. The studies were distributed as follows: three studies from Europe, three from the USA, and one from Africa. Most studies were conducted in high schools (n=1345), three studies were conducted with university students in psychology (n=329), and one study was conducted with adults (primary school teachers, n=95). The cumulative sample size consisted of 1769 participants. The "problem" dimension was included in the scale as part of the developed MSES-R scale. Cronbach's alpha coefficients varied between 0.78 and 0.97.

3.2. Reliability and Heterogeneity

The Cronbach's alpha coefficients reported for the overall scale across seven studies were determined to assess reliability. The total number of participants was 1769 (range n = 95 to n = 780) with M = 1196 and sd = 924. The statistics of the RG of the MSES-R scale are presented in Table 3.

Table 3.
Mean of Cronbach's Alpha Coefficients, 95% Confidence Intervals, and Heterogeneity Tests for the Problem Dimension of MSES-R

Scale	N	M	sd	CA	LL	UL	Q	I2
Problem	7	1196	924	0.901	0.864	0.939	219.788	96.99%

Note: n = Number of Studies; CA= Cronbach's Alpha Coefficient *LL = Lower Limit; UL = Upper Limit; Q = Cochran's Heterogeneity Q Statistic; I2 = Heterogeneity Index; p < 0.01.*

According to the RG of the random-effects meta-analysis, the cumulative Cronbach's alpha coefficient is 0.901 (95% CI [0.864; 0.939]). This value was calculated using the Cronbach's alpha coefficients reported in the studies. Heterogeneity was assessed using Cochran's Q and I2 tests on the Cronbach's alpha coefficients. The Cochran's Q test yielded a significant result (df(6) = 219.788; p < .01), while the I2 test indicated a high level of heterogeneity (96.99%). This substantial heterogeneity suggests the need for further analysis. Heterogeneity among the calculated coefficients was analyzed by constructing a forest plot. Figure 2 presents a forest plot of Cronbach's alpha coefficient for the problem dimension of the MSES-R scale.

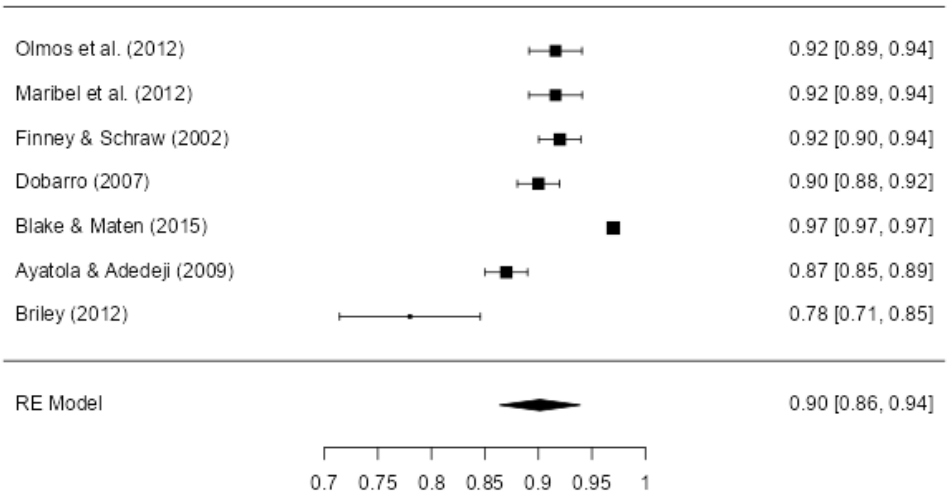


Figure 2. Forest plot for the RG of MSES-R Scale

3.3. Results Regarding Publication Bias

Within the scope of the study, before calculating the mean effect size for the meta-analysis, researchers attempted to detect any signs of publication bias in the studies reviewed during the analysis. The Fail-Safe N test, Egger's Regression test, and Kendall's Tau test were used to reveal any possible publication bias.

Table 4.
Publication Bias Assessment

Test	Value	P Value
Fail-Safe N	411857.000	< .001
Egger's Regression Intercept	-4.126	< .001
Kendall's Tau (τ)	-0.143	0.773

The Fail-Safe N test yielded a value of 411857.000 (p< .001). The intercept in Egger's Regression was calculated to be -4.126 (p <.001). An examination of the results of Kendall's Tau test (τ = -0.143; p = .773) using the funnel plot concluded that there is no publication bias. Figure 2 presents the funnel plot based on the transformed Cronbach's alpha coefficient for publication bias. The results show that there is no publication bias.

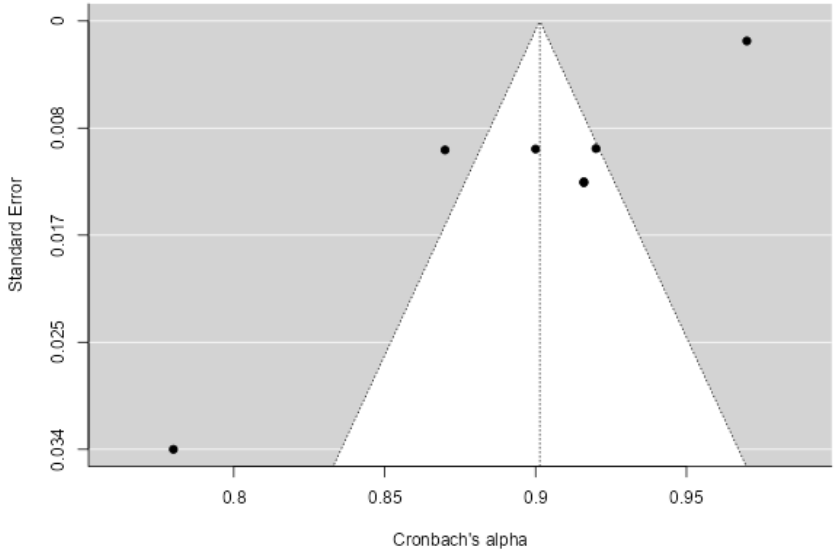


Figure 2. Funnel plot of Cronbach's coefficient for the MSES-R Scale

To address potential publication bias, a funnel plot was produced followed by Egger's test. Funnel plot asymmetry was suggested by Egger test, producing a p-value less than 0.001.

3.4. Results Related to Moderator Analyses

In RG research, there are different approaches to evaluate moderator variables and explain the variability of reliability coefficients. Some researchers propose various descriptive and inferential statistical strategies to explain the variability of reliability coefficients. Strategies for investigating variability include methods suggested by researchers like such as Vacha-Haase, Tani, and others (2001).

Moderator analyses were conducted using the mixed-effects model to investigate the reliability values of categorical variables. The categorical variables considered were sample type (university, high school, adults), study location (Europe, America, Africa), and department (psychology, high school, primary school teaching). The analysis found that school level significantly affects the discipline (z = -0.0861; p < 0.01; 95% CI [-0.063; 0.058]; R2 = 43.81%), as does the discipline (z = -2.53; p < 0.01; 95% CI [-0.244; -0.0031]; R2 = 43.81%). No significant effect was seen with the country-continent (z = -2.25; p > 0.01; 95% CI [−0.113; 0.089]; R2 = 0%).

This study examined the reliability of the Mathematics Self-Efficacy Scale-Revised (MSES-R) using the RG meta-analysis method. The primary aim was to determine the common reliability coefficient of the MSES-R scale. The findings contribute significantly to understanding the different effects on the reliability of this scale to and synthesizing various results in the literature.

The results indicate that the overall reliability of the MSES-R scale, calculated using the random effect model, is 0.901 (95% CI [0.864; 0.939]). However, these results showed substantial heterogeneity [Q(6) = 219.788; p < 0.01; I2 = 96.99%]. This high

level of heterogeneity underscores the importance of investigating the sources of measurement error in studies using the same instrument (Henson & Thompson, 2002).
The meta-analysis results predict that certain moderator variables significantly impact the reliability of the MSES-R scale. Specifically, sample type (university, high school, adults) and discipline (psychology, high school, primary school teaching) had significant effects on the overall estimate. This finding suggests that different sampling groups can influence the reliability of the scale, particularly given the high heterogeneity observed. Additionally, the results indicate that the country-continent variable does not significantly affect the overall reliability estimate. This suggests that the MSES-R scale may yield consistent reliability results across different geographical regions, supporting its global applicability.

These findings imply that factors such as sample type and discipline should be considered when interpreting results using the MSES-R scale. The reliability of a measurement tool is influenced by the type and number of the sample (Ashley, 2021). Therefore, reporting the common reliability coefficient of studies is recommended (Cousin & Henson, 2000).

This study provides further insight into the reliability of the MSES-R scale and emphasizes the importance of accurately measuring mathematics self-efficacy. Future research should explore the factors influencing the reliability of the MSES-R scale in greater detail and offer additional insights into the use of this scale. These findings can enhance the understanding of the tools used to assess and develop students' mathematics self-efficacy. Therefore, it is crucial to consider differences in student groups and disciplines when using the MSES-R scale.

3.5. Strengths and Limitations

This study provides a comprehensive and methodologically robust synthesis of the reliability of the Mathematics Self-Efficacy Scale-Revised (MSES-R) through a RG meta-analysis. By integrating results from seven studies conducted across three continents (Europe, America, and Africa) and diverse educational levels, the research offers valuable evidence of the scale's high internal consistency ($\alpha = 0.901$). The use of a random-effects model strengthens the reliability and accuracy of the findings. Moreover, the inclusion of moderator analyses, covering variables such as sample type, department, and geographical region adds explanatory depth by identifying contextual factors that influence reliability estimates. The results demonstrating the MSES-R's consistent reliability across different regions underscore the global applicability and psychometric robustness of the scale. Furthermore, the study followed PRISMA guidelines, ensuring transparency and replicability in the research process. Collectively, these strengths position the present study as a significant contribution to the literature on mathematics self-efficacy measurement and meta-analytic reliability research.

The cumulative Cronbach's alpha coefficient indicates a high level of internal consistency for the MSES-R scale across studies. However, the heterogeneity was substantial, suggesting that reliability estimates varied considerably depending on study characteristics. Moderator analyses (sample type and department) showed some differences but given the small number of studies (k=7), these findings should be interpreted with caution. Notably, the gender variable, commonly examined in RG studies, could not be included, as none of the available studies reported gender-specific coefficients.

4. DISCUSSION, CONCLUSION AND SUGGESTIONS

The MSES-R scale has been widely used at all levels of education across various countries, demonstrating good reliability. This study utilized the RG meta-analysis method to examine the reliability of the Mathematics Self-Efficacy Scale-Revised (MSES-R). The primary objective was to identify the common effect on the reliability that the MSES-R scale may have. The findings significantly contribute to analyzing various factors affecting the reliability of this scale and synthesizing various results from the literature.

The overall reliability of the MSES-R scale was calculated as 0.901 (95% CI [0.864; 0.939]) using the random effect model. However, these results showed significant heterogeneity [$Q(6) = 219.788$; $p < 0.01$; $I2 = 96.99\%$], emphasizing the importance of investigating the sources of measurement error in studies using the same instrument (Henson & Thompson, 2002).

The study predicts that certain moderator variables significantly impact the reliability of the MSES-R scale. Specifically, sample type (university, high school, adults) and discipline (psychology, high school, primary school teaching) significantly affect the overall estimate. Different sampling groups can influence the reliability of the scale. Additionally, the continent variable does not significantly affect the overall reliability estimate, suggesting that the MSES-R scale may yield consistent reliability results across different geographical regions.

The high reliability of the MSES-R across diverse populations and cultural contexts reinforces its value as a benchmark instrument in both research and educational practice. Its consistent psychometric performance supports its use for diagnosing students' self-efficacy beliefs, designing interventions to strengthen mathematics confidence, and enabling valid cross-cultural and cross-level comparisons. These findings also highlight the importance of considering sample type and academic discipline when interpreting results obtained through the MSES-R scale, as variations in participant characteristics may influence reliability outcomes. Reporting the common reliability coefficient of studies using this instrument is therefore recommended to enhance comparability across research (Cousin & Henson, 2000).

Overall, this study not only contributes methodologically by synthesizing reliability evidence for the MSES-R but also reinforces its theoretical and practical significance as a key tool in understanding how students develop, experience, and apply mathematics self-efficacy. Future research should examine additional factors influencing the reliability of the MSES-R, such as cultural context, gender, and instructional environment, to further clarify its robustness. By doing so, researchers and educators can gain deeper insights into how mathematics self-efficacy can be more accurately assessed and effectively enhanced across diverse educational settings.

Research and Publication Ethics Statement

This study is a systematic literature review examining the reliability coefficients of the Mathematics Self-Efficacy Scale. Data were not collected from any group of students or teachers; data were obtained solely by accessing studies in the literature. Therefore, no application was made to the Ethics Commission for this study.

Contribution Rates of Authors to the Article

Researchers contributed equally at all stages of the research.

Statement of Interest

The authors have not declared any potential conflicts of interest regarding the research, authorship, or publication of this article.

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ABSTRACT

The primary purpose of this study is to investigate preservice science teachers' competencies related to AI-TPACK and their perceptions regarding the use of artificial intelligence in education. By examining these constructs, the study aims to provide insights into how preservice teachers integrate AI into their pedagogical and content knowledge and how their perceptions influence this process. This study adopted a quantitative survey research design. Specifically, two standardized instruments, the AI-TPACK and Perceptions of Artificial Intelligence in Education (PAI) scales, were administered simultaneously to preservice science teachers. The participants of this study consisted of 122 undergraduate students enrolled in the science education program at the faculty of education of a public university. The findings indicate that preservice science teachers' overall performance on the AI-TPACK scale reflected moderate competency in integrating AI into pedagogical practices. The highest mean scores highlighted willingness to integrate AI technologies into self directed learning, self-efficacy in enhancing conceptual understanding, and competence in using AI-based simulations. The findings revealed that preservice science teachers' overall results on the PAI indicated generally positive perceptions toward AI integration in education. Preservice science teachers particularly valued AI's contribution to efficiency, rapid assessment, and ease of access to information while noting potential drawbacks such as reduced student engagement and dependency. The analysis revealed a statistically significant positive correlation between preservice teachers' AI-TPACK competencies and their perceptions of AI. Results also indicated that male preservice teachers scored significantly higher in several AI-TPACK subscales. At the same time, prior AI training enhanced technological knowledge but did not necessarily improve pedagogical or content-related competencies. Overall, the findings highlight the need for targeted training opportunities emphasizing hands-on, pedagogically integrated use of AI to foster more comprehensive AI-TPACK competencies.

Keywords: Preservice Science Teachers, Artificial Intelligence in Education, AI-TPACK, Perceptions of AI.

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1. INTRODUCTION

The rapid integration of artificial intelligence (AI) technologies into educational settings today necessitates that teachers and pre-service teachers become familiar with these technologies and integrate them effectively with pedagogical and content knowledge. Two key concepts have emerged in this context: Perceptions of Artificial Intelligence in Education (PAI) and AI-Technological Pedagogical Content Knowledge (AI-TPACK) competencies. Studies examining teachers' perceptions of AI highlight the dimensions of attitude and acceptance (Alejandro et al. 2024; Liu et al. 2024). Perceived usefulness, ease of use, and pedagogical beliefs are critical factors influencing teachers' intentions to adopt AI tools (Velli et al. 2024). Moreover, in line with technology acceptance models, the dimensions of perceived usefulness, ease of use, and behavioral intention can also be considered as relevant constructs in understanding teachers' perceptions and intentions toward AI integration in education. Teachers' perception of the meaningfulness of technology within educational contexts is regarded as a key element in increasing their acceptance levels (Choi et al., 2023; Zhang et al., 2023). Furthermore, teachers note AI's significant opportunities in areas

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such as lesson planning, personalized instruction, and real time student feedback. However, risks related to privacy, transparency, bias, and academic integrity are also strongly present in teachers' perceptions; in particular, the element of trust emerges as a crucial variable that reinforces intentions to use AI (Nazaretsky et al., 2025; Viberg et al., 2025). International policy documents similarly underscore the importance of equipping teachers not only from a technical standpoint but also with an ethical perspective (EU Commission, 2022; Holmes & Miao, 2023). The pedagogical uses of AI vary across disciplines. While teachers generally hold positive views about the role of AI in supporting instructional processes and material development, they express concerns regarding errors and ethical issues in assessment and evaluation processes (Alm & Ohashi, 2024). This reflects the contextual nature of how AI's role in education is perceived.

These discussions point to the need for a holistic consideration of teacher competencies. The Technological Pedagogical Content Knowledge (TPACK) theoretical framework (Mishra & Koehler, 2006) has long been employed to explain technology integration with pedagogical and content knowledge. However, recent literature emphasizes the necessity of incorporating AI specific dimensions into this model. The expanded model, referred to as AI-TPACK, defines the unique competencies required for integrating AI into educational settings.

AI-TPACK maintains the core components of the original TPACK framework, while also encompassing sub-dimensions such as AI Technological Knowledge (AI-TK), AI Pedagogical Knowledge (AI-TPK), and AI Content–Technological Knowledge (AI-TCK) (Ning et al., 2024). Some studies have additionally incorporated ethical considerations into this model. For instance, in science education, a teacher may understand machine learning based data analysis tools within the AI-TK dimension, provide individualized feedback using ChatGPT within the AI-TPK dimension, and concretize abstract chemistry concepts using molecular simulations within the AI-TCK dimension. These components collectively represent the AI-TPACK framework, which simultaneously integrates pedagogical strategies, subject matter knowledge, and technology. This framework provides a critical roadmap for teachers' effective and ethical use of AI in educational environments (Celik, 2023).

The literature highlights the transformative potential of AI-TPACK in instructional practices (Bautista et al., 2024; Choudhury et al., 2024; Karataş & Ataç, 2024; Dogan et al, 2025; Lan et al., 2025; Oved & Alt, 2025; Runge, Hebibi & Lazarides, 2025). Findings indicate that teachers are more confident in integrating AI tools into lesson design when they balance technological, pedagogical, and content knowledge (Hava & Babayiğit, 2025). However, research using assessment instruments shows that while teachers tend to be stronger in technological dimensions, they are more limited in pedagogical and ethical dimensions (Ning et al., 2024; Celik, 2023; Chiu et al., 2025).

Moreover, studies demonstrate that teachers' AI competencies are not only associated with technical knowledge but also closely related to factors such as self-efficacy, experience, institutional support, and infrastructural resources (Cabero-Almenara et al., 2024). While the influence of demographic variables is relatively limited, institutional culture and support from professional communities play a facilitating role in adopting AI. Finally, interdisciplinary and cultural differences significantly influence teachers' perceptions of AI. Teachers in STEM tend to adopt technologies more quickly, whereas ethical concerns are more prominent among language and social sciences teachers. Additionally, cultural context strongly impacts trust, risk perception, and intention to adopt (Viberg et al., 2025; Alm & Ohashi, 2024).

1.1. Statement of the Problem

Despite the growing recognition of AI's role in transforming education, limited attention has been given to how preservice teachers' competencies and perceptions influence their readiness for AI integrated pedagogy. A significant limitation in the existing literature is the relative neglect of studies that examine AI-TPACK competencies and perceptions of AI together, particularly in the context of preservice science teachers. Most studies address teachers' technical competencies or perceptions separately, without focusing on the interaction between these two dimensions. However, both the AI-TPACK levels and AI-related perceptions of preservice teachers can potentially shape future classroom practices directly. Therefore, this study aims to comprehensively examine preservice science teachers' AI-TPACK competencies and perceptions of AI.

1.2. Purpose of the Study

The primary purpose of this study is to investigate preservice science teachers' competencies related to AI-TPACK and their perceptions regarding the use of artificial intelligence in education. By examining these constructs, the study aims to provide insights into how preservice teachers integrate AI into their pedagogical and content knowledge and how their perceptions influence this process. The results are expected to contribute to the literature on teacher education by identifying the factors that affect the development of AI-related competencies.

1.3. Problem of the Study

The increasing integration of AI in education requires teachers to develop not only technological skills but also the pedagogical capacity to incorporate AI into their teaching practices meaningfully. However, there is limited empirical evidence on preservice teachers' AI-TPACK competencies and their perceptions of AI use in educational contexts. Understanding these dimensions is

crucial for designing effective teacher education programs that prepare future teachers for AI-supported learning environments.

1.3.1. Sub-problems of the study

In line with the overall purpose of the research, the study was guided by several sub-problems that aimed to explore preservice science teachers' competencies in integrating AI, their perceptions of AI use in education, and the factors influencing these constructs.

1. What are the preservice science teachers' levels of AI-TPACK competencies?
2. What are the preservice science teachers' perceptions regarding the use of AI in education?
3. Is there a significant relationship between preservice science teachers' AI-TPACK competencies and their perceptions of AI in education?
4. Do preservice science teachers' AI-TPACK competencies differ significantly according to demographic variables such as gender, class level, type of secondary school graduate, urbanicity of upbringing, daily technology use, daily internet use, and prior training/experience with AI or programming?
5. Do preservice science teachers' perceptions of AI use in education, as measured by the PAI scale, differ significantly according to demographic variables?

2. METHODOLOGY

This study adopted a quantitative survey research design, which is widely used in educational research to obtain standardized data that allows for statistical analysis and generalization of findings (Creswell, 2014; Cohen et al., 2002). In this approach, numerical data are collected at a single point in time through structured instruments to describe participants' attitudes, perceptions, or competencies. Specifically, two standardized instruments, the AI-TPACK scale and the PAI scale, were administered simultaneously to preservice science teachers. This enabled the collection of comprehensive data regarding both their competencies in integrating AI into pedagogical practices and their perceptions of AI in educational contexts. Furthermore, the study employed a descriptive and correlational survey design, as the aim was not only to describe the current levels of participants' competencies and perceptions but also to examine potential relationships between these constructs. Descriptive statistics were used to summarize preservice science teachers' responses, providing an overview of their AI related competencies and perceptions. Correlational analysis, on the other hand, was conducted to determine the extent to which AI-TPACK competencies were associated with perceptions of AI use in education. This design is considered particularly suitable for research seeking to identify patterns and associations without manipulating variables (Fraenkel & Wallen, 2009). In line with this methodological framework, the following section presents detailed information regarding the study participants, including their demographic characteristics and data collection tools.

2.1. Participants

The participants of this study consisted of 122 undergraduate students enrolled in the science education program at the faculty of education of a public university. A convenience sampling strategy was employed, involving preservice science teachers from different grade levels at a public university, who were accessible and voluntarily participated in the study. The demographic characteristics presented in Table 1 highlight the diversity of preservice science teachers in terms of gender, class level, educational background, and prior experience with technology and AI. These variables were considered important for examining potential differences in AI-TPACK competencies and perceptions of AI in education. As participants represent diverse secondary school backgrounds and varying levels of prior AI or programming training, the study aims to explore whether these background differences influence preservice teachers' overall AI-TPACK competencies and perceptions of AI in education, or whether such competencies and perceptions develop independently of prior experience.

Table 1.
Demographic Information of the Participants

			Frequency (N)	Percentage (%)
Gender	Female		90	74
	Male		32	26
Classe	1		18	15
	2		41	34
	3		43	35
	4		20	16
Urbanicity of Upbringing	City		58	48
	District		49	40
	Village		15	12
Type of Secondary School Graduated	Science School	High	17	14

	Anatolian High School	88	72
	Imam Hatip High School	17	14
Daily Use of Technology (e.g., Computers, etc.)	0-3 h	32	26
	3-5 h	55	45
	More than 5 h	35	29
Daily Internet Usage (including via mobile phone)	0-3 h	29	24
	3-5 h	56	46
	More than 5 h	37	30
Prior Experience with Technology-Assisted Teaching	Yes	52	43
	No	70	57
Prior Training in Artificial Intelligence	Yes	20	16
	No	102	84
Prior Training in Software/Programming	Yes	7	6
	No	115	94
Total		122	100

2.2. Data Collection Tools

2.2.1. Perception Scale Regarding Artificial Intelligence Use in Education (PAI)

The teachers' perception scale regarding artificial intelligence use in education (PAI), developed by Üzüm et al. (2025), consists of 15 items and three sub dimensions: Teaching Perception (TP), Learning Perception (LP), and Ethical Perception (EP). In the PAI scale, participants responded using a 5-point Likert scale ranging from strongly agree (5) to strongly disagree (1). This scale enabled respondents to express the extent of their agreement with each item, thereby capturing varying levels of perception and attitude. To examine construct validity, a confirmatory factor analysis (CFA) was conducted, and the fit indices were found to be within acceptable thresholds ($\chi^2/df < 3$; CFI and TLI > .90; RMSEA < .08). These results indicate that the theoretical model of the scale is statistically supported, and the factor structure demonstrates adequate construct validity. The reliability of the scale was assessed using Cronbach's alpha coefficients. The internal consistency for the total scale was found to be $\alpha = .87$. At the same time, the subdimensions ranged between .79 and .82: TP ($\alpha = .79$), LP ($\alpha = .82$), and EP ($\alpha = .80$). These findings demonstrate that the scale has high internal consistency at both the overall and subscale levels. Furthermore, the significant item total correlations provide additional evidence that the instrument is a reliable tool for research on teachers' perceptions regarding using AI in education. Since the original version of this scale was developed in Turkish, it was used as is.

2.2.2. Artificial Intelligence – Technological Pedagogical Content Knowledge (AI-TPACK) Scale

The AI-TPACK scale developed by Ning et al. (2024) is structured around seven subdimensions, each reflecting a specific intersection of AI knowledge with pedagogical, technological, and content domains. These dimensions include Content Knowledge (CK; $\alpha = .809$), Pedagogical Knowledge (PK; $\alpha = .837$), AI Technological Knowledge (AI-TK; $\alpha = .912$), Pedagogical Content Knowledge (PCK; $\alpha = .806$), AI Technological Content Knowledge (AI-TCK; $\alpha = .945$), AI Technological Pedagogical Knowledge (AI-TPK; $\alpha = .942$), and AI Technological Pedagogical Content Knowledge (AI-TPACK; $\alpha = .931$). The reliability analysis for the overall scale yielded a Cronbach's alpha coefficient of .957. This multidimensional framework comprehensively assesses teachers' competencies and perceptions regarding integrating AI into educational practice. In the AI-TPACK scale, participants responded using a 5 point Likert format ranging from strongly conformant (1) to strongly non-conformant (5). This format allowed respondents to indicate the degree of conformity of each item to their personal experiences and circumstances. The AI-TPACK scale, originally developed by Ning et al. (2024), was adapted into Turkish by Canbazoğlu Bilici, Tanrısevdi, Yıldız Durak, and Çakıroğlu (2024). The adaptation study was conducted on the 39 items, five point Likert-type scale, and administered to science teachers. A CFA was performed to examine the structural validity of the Turkish version, and the results confirmed that the scale preserved its original seven factors structure. The reliability analyses demonstrated that the Turkish scale has high internal consistency. The Cronbach's alpha coefficient for the total scale was reported as .980. The reliability coefficients for the sub-dimensions were as follows: CK ($\alpha = .873$), PK ($\alpha = .888$), AI-TK ($\alpha = .954$), PCK ($\alpha = .928$), AI-TCK ($\alpha = .973$), AI-TPK ($\alpha = .970$), and AI-TPACK ($\alpha = .946$). These findings provide evidence that the Turkish version of the scale is a valid and reliable instrument for assessing teachers' technological pedagogical content knowledge in the context of artificial intelligence.

In the present study, we deliberately focused on four subdimensions of the AI-TPACK scale (AI-TK, AI-TCK, AI-TPK, and AI-TPACK), as these domains are directly related to the integration of AI into teaching and learning practices. While the original

scale encompasses seven factors, the subdimensions of CK, PK, and PCK reflect more general aspects of teachers' knowledge that are not necessarily AI specific. In contrast, the selected four factors explicitly address how preservice science teachers perceive and operationalize AI within technological, pedagogical, and content related contexts. The Cronbach's alpha coefficients for these dimensions (AI-TK, AI-TCK, AI-TPK, and AI-TPACK) demonstrated high internal consistency, confirming that the adapted instrument was psychometrically sound for this research. The details of these reliability analyses are presented in the data analysis section.

2.3. Data Analysis

Before conducting the primary analyses, the distribution characteristics of the data obtained from the PAI scale and the AI-TPACK scale were examined to determine whether they met the assumptions of normality. The results of the normality tests are presented in Table 2, which indicates that the distributions of both scales were within acceptable thresholds for normality. Furthermore, the visual inspection of the Normal Q–Q Plots (Figure 1) confirmed that the data points closely followed the expected diagonal line. Based on these findings, it was concluded that the scale scores exhibited a normal distribution. Therefore, subsequent statistical analyses were conducted using parametric tests.

Table 2.
Normality Test Results for PAI and AI-TPACK Scale

Scale	Skewness	Skewness Std. Error	Kurtosis	Kurtosis Std. Error	Shapiro-Wilk (p)	Normality
PAI	0.220	0,219	0.171	0,435	0.979 (p = .055)	Normal
AI-TPACK	-0.136	0,219	-0.163	0,435	0.987 (p = .296)	Normal

The normality of the data was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Results indicated that both the PAI and AI-TPACK scales followed a normal distribution, as the test statistics were non-significant ($p > .05$). In addition, skewness and kurtosis values fell within the acceptable range of -1 to +1 (Tabachnick & Fidell, 2013). Therefore, parametric statistical tests were employed in subsequent analyses.

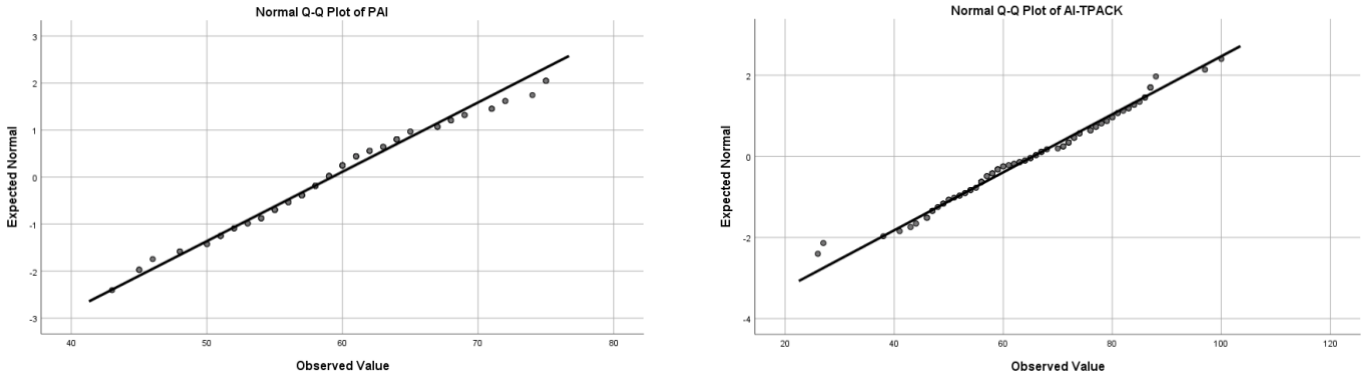


Figure 1. Normal Q-Q plots of PAI and AI-TPACK scale scores

A series of statistical analyses was conducted to examine the relationships between the demographic variables and the main study scales (PAI and AI-TPACK). Independent samples t-tests were employed for binary demographic variables such as gender, prior experience with technology assisted teaching, and prior training in AI. Since the sample sizes across groups were highly unequal for prior training in software/programming, and normality assumptions could not be ensured for the smaller group, a non-parametric Mann Whitney U test was conducted to provide a more robust comparison. For demographic variables with more than two categories, including class level, urbanicity of upbringing, type of secondary school graduated from, daily use of technology, and daily internet usage, one-way ANOVA tests were performed to compare group means. All analyses were conducted using a significance level of $\alpha = .05$. Along with p values, we reported effect size for each independent-samples t test using Cohen's d based on the pooled standard deviation. In accordance with the general guidelines for sample adequacy in factor analysis, a minimum participant to item ratio of 5:1 is considered the lower acceptable limit (Gorsuch, 1983; Kline, 2016). Moreover, a total sample size between 100 and 200 participants is regarded as acceptable for confirmatory factor analysis when the model structure is relatively simple and factor loadings are strong (Kline, 2016).

Table 3.
Reliability and Descriptive Statistics of Scales

Scales and Subscales	N	Number of items	Cronbach's Alpha
PAI Scale	122	15	.804
Teaching perception	122	7	.839
Learning perception	122	4	.806

Ethical perception	122	4	.710
AI-TPACK Scale	122	22	.952
AI-TPACK-TK	122	5	.839
AI-TPACK-TCK	122	6	.873
AI-TPACK-TPK	122	6	.889
AI-TPACK-TPACK	122	5	.843

Cronbach's alpha analyses were conducted for both the PAI and AI-TPACK scales to examine the reliability of the instruments (Table 3). The overall reliability coefficient of the PAI scale was found to be .804. In addition, the reliability coefficients of its three subfactors, TP, LP, and EP, were .839, .806, and .710, respectively. These results indicate that the PAI scale, including its subdimensions, can be considered a reliable measurement instrument, since Cronbach's alpha values above .70 are generally accepted as evidence of sufficient reliability for psychometric tools. Similarly, the overall reliability of the AI-TPACK scale was calculated as .952. The reliability coefficients of its four subfactors, AI-TPACK-TK, AI-TPACK-CK, AI-TPACK-PK, and AI-TPACK-TPCK, were .839, .873, .889, and .843, respectively. Based on these results, the AI-TPACK scale and its subdimensions also demonstrate high internal consistency, further confirming the reliability of this instrument.

3. FINDINGS

The findings are structured according to the study's five subproblems, addressing AI-TPACK competency levels, perceptions of AI in education, the correlation between the two scales, and differences across demographic variables.

3.1. Preservice Science Teachers' AI-TPACK Competency Levels

The findings indicate that preservice science teachers' overall mean score on the AI-TPACK scale was 2.96 (SD = 0.90), which suggests a moderate level of competency in integrating AI into pedagogical practices (Table 4). This finding implies that while preservice science teachers display a certain level of confidence in utilizing AI technologies for educational purposes, their competencies remain developing rather than advanced. Among the items, the highest mean scores were observed in item 22 (M = 3.43, SD = 0.96), item 11 (M = 3.36, SD = 0.94), and item 20 (M = 3.25, SD = 0.94). The high score for item 22 indicates that preservice science teachers show a strong willingness to integrate AI technologies into their own learning processes, emphasizing its role in self directed learning and professional growth. The second highest score, item 11, highlights their strong sense of self efficacy in employing AI to enhance students' conceptual understanding, which is a critical component of effective science instruction. Furthermore, the relatively high mean score of item 20 reveals that preservice teachers perceive themselves as competent in using AI based simulations to support teaching practices, reflecting their recognition of AI's potential to enrich the instructional process in science education.

Table 4.
Descriptive Statistics of Preservice Science Teachers' AI-TPACK Competency Items

No	Items	Mean	sd
1	I am familiar with commonly encountered AI technologies in the educational environment.	2,84	,79
2	I possess the capability to easily acquire AI technologies necessary for teaching.	3,02	,90
3	I frequently incorporate AI technologies in the pedagogical context.	2,53	,88
4	I am proficient in using AI technologies to enhance the instructional process.	2,72	,87
5	I am knowledgeable about using AI technologies for interactive teaching purposes.	2,70	,89
6	I am familiar with AI in specific academic domains, such as mathematical intelligent tutoring systems.	2,92	,84
7	I am capable of effortlessly using AI in specific academic domains.	2,74	,88
8	I am proficient in using AI to update my knowledge base within the academic discipline.	2,71	,88
9	I can select appropriate AI tools based on the subject matter I am teaching.	3,23	,98
10	I am adept at using AI to effectively enhance students' comprehension of the material.	2,92	,88
11	I can use AI to broaden the knowledge horizons of students.	3,36	,95
12	I am capable of using AI to enhance my pedagogical perspectives.	2,84	,83
13	I am able to apply appropriate AI in various teaching activities.	3,16	,82
14	I have the capacity to select AI to sustain students' motivation and interest.	3,06	,90
15	I can apply AI to assess the learning outcomes of students.	3,27	,89

16	I am proficient in using AI to optimize classroom instructional management.	2,93	,98
17	I possess the ability to explain information derived from AI to provide real-time feedback.	2,85	,96
18	I am knowledgeable in integrating AI with educational content and teaching methods to improve classroom teaching efficiency and effectiveness.	2,85	,84
19	I am capable of selecting appropriate teaching methods and AI based on the educational content for instruction.	3,11	,98
20	I can use AI to create, simulate, and adapt scenarios that are in line with the educational content.	3,25	,94
21	I can use personalized AI to select suitable teaching methods as well as guide students in practical learning.	3,03	,94
22	I will use AI for self-directed learning, further deepening my subject knowledge and understanding of educational pedagogical theories.	3,43	,96
	Total	2,96	0,90

3.2. Preservice Science Teachers' Perceptions Regarding the Use of Artificial Intelligence in Education

The findings revealed that preservice science teachers' overall mean score on the PAI was 3.95 (SD = 0.86), indicating generally positive perceptions toward AI integration in education (Table 5). The highest rated items (12, 7, 14) were "It gets people used to effortlessness" (M = 4.34, SD = 0.76), "It provides rapid evaluation" (M = 4.34, SD = 0.75), and "It gets people used to ready-made information" (M = 4.31, SD = 0.75). These results suggest that teacher candidates particularly value AI's contribution to efficiency, rapid assessment, and ease of access to information.

Table 5.
Descriptive Statistics of Preservice Science Teachers' PAI Items

No	Items	Mean	sd
1	Artificial intelligence makes planning easier in teaching.	4,07	,72
2	It supports the monitoring of the teaching process.	3,98	,77
3	It offers contextual richness.	4,28	,73
4	It supports individualized instruction.	3,85	,90
5	It facilitates teaching difficult and complex subjects.	3,97	,83
6	It provides continuity in feedback.	3,70	,93
7	It provides rapid evaluation.	4,34	,75
8	It brings in reasoning ability.	3,43	,99
9	It increases motivation.	3,68	1,00
10	It encourages self-learning.	3,58	1,14
11	It increases curiosity in learning.	3,60	1,14
12	It gets people used to effortlessness.	4,34	,76
13	It bears ethical threats.	3,93	,74
14	It gets people used to ready-made information.	4,31	,75
15	It trivializes information.	4,17	,74
	Total	3,95	,86

3.3. Correlation Between AI-TPACK and PAI Scores

The relationship between preservice science teachers' AI-TPACK competencies and their perceptions of AI in education was examined to determine the degree of association between these two constructs (Table 6). Analyzing this correlation is important for understanding how preservice science teachers' competencies in integrating AI into pedagogical practices align with their overall perceptions of AI use in education. The analysis revealed a statistically significant positive correlation between preservice science teachers' AI-TPACK competencies and their perceptions of AI ($r=.194$, $p<.05$). Although the correlation coefficient indicates a low level of association, the findings suggest that higher levels of AI-TPACK competencies are modestly related to more positive perceptions of AI in education.

Table 6.
Correlation Analysis of AI-TPACK and PAI Scales

		PAI
AI-TPACK	Pearson r	.194*
	p	.032
	n	122

* Correlation is significant at 0.05.

3.4. Differences in AI-TPACK Scores Across Demographic Variables

The results of the study are presented according to preservice science teachers' AI-TPACK competencies across various demographic variables. Investigating demographic differences in AI-TPACK competencies is essential, as prior research indicates that variables such as gender, experience, and educational background may influence teachers' technology related self-efficacy and integration practices (Cabero-Almenara et al., 2024; Hava & Babayiğit, 2025). Each subsection reports the statistical outcomes for the related variable along with brief interpretations.

Table 7.
t-Test Results of Preservice Science Teachers' AI-TPACK Scale Scores by Gender

PAI Scale	Gender	N	$\bar{X}$	sd	t	p	Cohen's d
AITPACK-TK	Female	90	13,59	3,12	-1.313	.192	0.27
	Male	32	14,50	4,01			
AITPACK-TCK	Female	90	17,37	3,89	-2.278	.025	0.47
	Male	32	19,31	4,82			
AITPACK-TPK	Female	90	17,58	4,08	-2.301	.023	0.47
	Male	32	19,59	4,72			
AITPACK-TPACK	Female	90	15,23	3,42	-2.305	.023	0.47
	Male	32	16,94	4,06			
Total Scale (AI-TPACK)	Female	90	63,77	13,12	-2.326	.022	0.48
	Male	32	70,34	15,37			

Statistical significance α = .05 level.

Table 7 presents the results of an independent samples t-test conducted to examine whether preservice science teachers' AI-TPACK scale scores differed significantly by gender. The findings reveal that while there was no statistically significant difference between female (M = 13.59, SD = 3.12) and male (M = 14.50, SD = 4.01) preservice teachers on the AI-TPACK-TK subscale (t = -1.313, p = .192), significant gender differences emerged in several other subscales. Specifically, male preservice science teachers scored significantly higher than females in AI-TPACK-TCK (t = -2.278, p = .025), AI-TPACK-TPK (t = -2.301, p = .023), and AI-TPACK-TPACK (t = -2.305, p = .023). Furthermore, when considering the total AI-TPACK scale score, male preservice teachers (M = 70.34, SD = 15.374) demonstrated significantly higher levels compared to their female counterparts (M = 63.77, SD = 13.12), (t = -2.326, p = .022). Effect size values were calculated using Cohen's d, which indicated small to moderate effects across the subscales (ranging from d = 0.27 to d = 0.48).

Table 8.
t-Test Results of Preservice Science Teachers' AI-TPACK Scale Scores by Prior Experience with Technology Assisted Teaching

Scale Factor	Prior Experience with Technology Assisted Teaching	N	$\bar{X}$	sd	t	p	Cohen's d
AITPACK-TK	Yes	52	14,12	3,14	.808	.420	0.15
	No	70	13,61	3,56			
AITPACK-TCK	Yes	52	17,92	3,98	.103	.918	0.02
	No	70	17,84	4,43			
AITPACK-TPK	Yes	52	18,21	4,22	.230	.819	0.04
	No	70	18,03	4,44			
AITPACK-TPACK	Yes	52	15,75	3,58	.181	.857	0.03
	No	70	15,63	3,74			
Total Scale (AI-TPACK)	Yes	52	66,00	13,29	.345	.731	0.06
	No	70	65,11	14,57			

Table 8 presents the independent samples t-test results examining whether preservice teachers' AI-TPACK scores differ according to their prior experience with technology-assisted teaching. The findings indicate that there were no statistically significant differences across any of the AI-TPACK subscales or the total scale. For the AI-TPACK-TK subscale, preservice teachers with prior experience (M = 14.12, SD = 3.14) and those without experience (M = 13.61, SD = 3.56) did not differ significantly (t = .808, p = .420). Similarly, no meaningful differences were found in AI-TPACK-TCK (t = .103, p = .918), AI-TPACK-TPK (t = .230, p = .819), or AI-TPACK-TPACK (t = .181, p = .857). When considering the overall AI-TPACK scale, preservice teachers with prior experience in technology-assisted teaching (M = 66.00, SD = 13.29) scored slightly higher than those without

such experience (M = 65.11, SD = 14.57), yet this difference was not statistically significant (t = .345, p = .731). Across all comparisons, effect sizes were trivial to small (d = .02–.15), indicating negligible practical differences between groups with and without prior technology-assisted teaching experience.

Table 9.
t-Test Results of Preservice Science Teachers' AI-TPACK Scale Scores by Prior Training in AI

Scale Factor	Prior Training in Artificial Intelligence	N	$\bar{X}$	sd	t	p	Cohen's d
AITPACK-TK	Yes	20	15,90	2,65	3.102	.002	0.76
	No	102	13,42	3,37			
AITPACK-CK	Yes	20	18,80	3,11	1.070	.287	0.26
	No	102	17,70	4,40			
AITPACK-PK	Yes	20	18,50	3,86	.443	.659	0.11
	No	102	18,03	4,43			
AITPACK-TPCK	Yes	20	15,55	3,20	-.174	.862	0.04
	No	102	15,71	3,75			
Total Scale (AI-TPACK)	Yes	20	68,75	11,00	1.141	.256	0.28
	No	102	64,85	14,46			

The independent samples t-test results presented in the table 9 examine whether preservice teachers' AI-TPACK scores differ significantly based on their prior training in AI. The findings reveal that a statistically significant difference emerged only in the AI-TPACK Technological Knowledge (AITPACK-TK) subscale (t = 3.102, p = .002). Specifically, preservice teachers who had received prior AI training (M = 15.90, SD = 2.65) scored significantly higher than those without such training (M = 13.42, SD = 3.37). For the other subscales AITPACK-TCK, AITPACK-TPK, and AITPACK-TPACK as well as the overall AI-TPACK scale, no statistically significant differences were observed (p > .05), although participants with AI training consistently showed slightly higher mean scores than their counterparts. Effect size values indicated that the difference in AI-TPACK-TK was large (d = 0.76), whereas other subscales and the total score showed small or negligible effects (ranging from d = 0.04 to d = 0.28).

Table 10.
Mann–Whitney U Test Results of Preservice Teachers' AI-TPACK Scale Scores by Prior Training in Software/Programming

Scale Factor	Prior Training in Software/Programming	N	Mean Rank	U	z	p
AITPACK-TK	Yes	7	79,43	277	-1.389	.165
	No	115	60,43			
AITPACK-TCK	Yes	7	81,86	260	-1.574	.116
	No	115	60,26			
AITPACK-TPK	Yes	7	70,71	338	-.712	.476
	No	115	60,94			
AITPACK-TPACK	Yes	7	65,07	377,5	-.277	.782
	No	115	61,28			
Total Scale (AI-TPACK)	Yes	7	77,07	293,5	-1.201	.230
	No	115	60,65			

Table 10 presents the results of the Mann Whitney U test conducted to examine whether preservice teachers' AI-TPACK scale scores differed significantly according to their prior training in software or programming. The table includes the mean ranks, U values, and corresponding p values for each AI-TPACK subscale (AI-TPACK-TK, AI-TPACK-TCK, AI-TPACK-TPK, AI-TPACK-TPACK) as well as the total AI-TPACK score. The mean ranks indicate that preservice teachers with prior training in software or programming (n=7) consistently achieved higher average ranks than those without such training (n=115) across all subscales. Across all dimensions of the AI-TPACK scale, AITPACK-TK, AITPACK-CK, AITPACK-PK, and AITPACK-TPCK no statistically significant differences were found between participants with prior training and those without (p > .05 for all comparisons).

Table 11.
ANOVA Results of Preservice Science Teachers' AI-TPACK Scale Scores by Class Level

Class	N	$\bar{X}$	sd	F	p
1st	18	70,11	12,461	1,831	.145
2nd	41	64,73	13,274		
3rd	43	62,56	14,290		
4th	20	69,20	15,137		
Total	122	65,49	13,987		

The ANOVA results presented in Table 11 examine the differences in preservice teachers' AI-TPACK scale scores across class levels. The mean scores range from 62.56 (3rd year) to 70.11 (1st year), with standard deviations varying between 12.461 and 15.137. Despite these variations in average scores, the ANOVA test revealed no statistically significant differences across the four class levels (F = 1.831, p = .145).

Table 12.
ANOVA Results of Preservice Science Teachers' AI-TPACK Scale Scores by Urbanicity of Upbringing

Urbanicity of Upbringing	N	$\bar{X}$	sd	F	p
City	58	67,05	12,348	.822	.442
District	49	63,57	15,193		
Village	15	65,73	15,984		
Total	122	65,49	13,987		

Table 12 presents the ANOVA results of preservice teachers' AI-TPACK scale scores by urbanicity of upbringing. The mean scores were 67.05 for participants raised in cities, 63.57 for those from districts, and 65.73 for those from villages. Although minor variations are observed across the groups, the ANOVA test indicated no statistically significant differences among them (F = 0.822, p = .442).

Table 13.
Descriptive Statistics of Preservice Science Teachers' AI-TPACK Scores by Type of Secondary School Graduated

Type of Secondary School Graduated	N	$\bar{X}$	sd	F	p
Science High School	17	61,59	13,067	1.074	.345
Anatolian High School	88	66,59	13,838		
İmam Hatip High School	17	63,71	15,531		
Total	122	65,49	13,987		

The table 13 the descriptive statistics of preservice teachers' AI-TPACK scores based on the type of secondary school they graduated from (Science High School, Anatolian High School, and Imam Hatip High School). The results show that preservice teachers from Anatolian High Schools obtained the highest mean score (M = 66.59, SD = 13.838), followed by those from Imam Hatip High Schools (M = 63.71, SD = 15.531), and Science High Schools (M = 61.59, SD = 13.067). Despite these variations in mean scores, the ANOVA results (F = 1.074, p = .345) indicate that the differences across groups are not statistically significant. This suggests that the type of secondary school graduated does not exert a meaningful effect on preservice teachers' AI-TPACK competencies.

Table 14.
Descriptive Statistics of Preservice Teachers' AI-TPACK Scale Scores by Daily Use of Technology

Daily Use of Technology (e.g., Computers, etc.)	N	$\bar{X}$	sd	F	p
0-3 h	32	66,28	11,846	1.539	.219
3-5 h	55	67,22	15,369		
More than 5 h	35	62,06	13,249		
Total	122	65,49	13,987		

Table 14 presents the descriptive statistics and ANOVA results of preservice teachers' AI-TPACK scores according to their daily use of technology (e.g., computers). The mean scores indicate that preservice science teachers who reported using technology for 3–5 hours per day (M = 67.22) demonstrated slightly higher AI-TPACK competencies compared to those who used it for 0–

3 hours (M = 66.28) and those who used it for more than 5 hours daily (M = 62.06). Despite these numerical differences, the ANOVA results (F = 1.539, p = .219) show that the differences were not statistically significant.

Table 15.
Descriptive Statistics of Preservice Science Teachers' AI-TPACK Scale Scores by Daily Internet Usage

Daily Internet Usage (including via mobile phone)	N	$\bar{X}$	sd	F	p
0-3 h	29	64,83	12,151	1.011	.367
3-5 h	56	67,34	14,529		
More than 5 h	37	63,22	14,463		
Total	122	65,49	13,987		

The results in Table 15 present the ANOVA findings regarding preservice teachers' AI-TPACK scores based on their daily internet usage (including via mobile phones). The mean scores show slight variations among the groups: preservice teachers using the internet for 3-5 hours daily reported the highest mean score (M = 67.34), compared to those with 0-3 hours (M = 64.83) and those with more than 5 hours (M = 63.22). Despite these differences, the ANOVA test indicated that the differences were not statistically significant (F = 1.011, p = .367).

3.5. Differences in PAI Scores Across Demographic Variables

The analysis of preservice science teachers' PAI scores was conducted with respect to various demographic characteristics. The results for each variable are presented separately, accompanied by interpretations highlighting potential differences or similarities.

Table 16.
t-Test Results of Preservice Science Teachers' PAI Scale Scores by Gender

PAI Scale	Gender	N	$\bar{X}$	sd	t	p	Cohen's d
Teaching perception	Female	90	28,19	3,94	-.036	.972	0.01
	Male	32	28,22	4,38			
Learning perception	Female	90	14,42	3,26	-.734	.464	0.15
	Male	32	13,91	3,83			
Ethical perception	Female	90	16,51	2,24	-1.981	.050	0.41
	Male	32	17,41	2,06			
Total Scale	Female	90	59,12	6,70	-.292	.771	0.06
	Male	32	59,53	7,12			

The results of the independent samples t-test revealed that preservice science teachers' scores on the PAI scale did not significantly differ by gender (Table 16). For the TP subscale, the mean scores of females (M = 28.19, SD = 3.94) and male participants (M = 28.22, SD = 4.38) were nearly identical, with no significant difference (t = -0.036, p = .972). Similarly, for the LP subscale, although female participants (M = 14.42, SD = 3.26) scored slightly higher than their male counterparts (M = 13.91, SD = 3.83), this difference was not statistically significant (t = -0.734, p = .464). On the EP subscale, female participants (M = 16.51, SD = 2.24) scored marginally lower than male participants (M = 17.41, SD = 2.06). This difference approached the threshold of statistical significance (t = -1.981, p = .050), suggesting a potential tendency for male participants to report higher ethical perceptions regarding AI use. However, it still falls at the borderline of conventional significance levels. Finally, for the Total Scale, no significant gender difference was found (female: M = 59.12, SD = 6.70; male: M = 59.53, SD = 7.12; t = -0.292, p = .771). The effect size analysis (Cohen's d) indicated negligible to small differences across all subscales, except for the ethical perception dimension (d = 0.41), which demonstrated a small-to-moderate effect favoring male participants. Overall, these findings indicate that gender does not play a significant role in preservice teachers' perceptions of AI in education as measured by the PAI scale, though a near-significant trend was observed in the EP dimension.

Table 17.
t-Test Results of Preservice Science Teachers' PAI Scale Scores by Prior Experience with Technology Assisted Teaching

PAI Scale	Prior Experience with Technology Assisted Teaching	N	$\bar{X}$	sd	t	p	Cohen's d
Teaching perception	Yes	52	28,46	4,50	.623	.534	0.11

	No	70	28,00	3,68			
Learning perception	Yes	52	14,79	3,10	1.407	.162	0.26
	No	70	13,91	3,59			
Ethical perception	Yes	52	16,54	2,49	-.888	.376	-0.16
	No	70	16,90	2,00			
Total Scale	Yes	52	59,79	7,28	.783	.435	0.14
	No	70	58,81	6,41			

The independent samples t-test results demonstrated that preservice science teachers' prior experience with technology-assisted teaching did not significantly influence their scores on the PAI scale or its subdimensions (Table 17). For the TP subscale, participants with prior experience (M = 28.46, SD = 4.50) and those without experience (M = 28.00, SD = 3.68) did not differ significantly (t = 0.623, p = .534). Similarly, in the LP subscale, preservice teachers with prior experience (M = 14.79, SD = 3.10) reported slightly higher scores compared to those without such experience (M = 13.91, SD = 3.59), yet this difference was not statistically significant (t = 1.407, p = .162). In terms of EP, participants with prior experience (M = 16.54, SD = 2.49) and those without (M = 16.90, SD = 2.00) also showed no significant difference (t = -0.888, p = .376). Finally, for the total scale scores, preservice teachers with prior experience (M = 59.79, SD = 7.28) did not significantly differ from their counterparts without experience (M = 58.81, SD = 6.41; t = 0.783, p = .435). Effect sizes indicated small differences across dimensions (TP d = 0.11; LP d = 0.26; EP d = −0.16; Total d = 0.14), suggesting that prior experience with technology-assisted teaching had only a limited practical impact on PAI scores. Overall, these findings suggest that having prior experience with technology-assisted teaching does not exert a statistically significant impact on preservice teachers' perceptions of AI in education across the teaching, learning, and ethical dimensions of the PAI scale.

Table 18.
t-Test Results of Preservice Science Teachers' PAI Scale Scores by Prior Training in AI

PAI Scale	Prior Training in Artificial Intelligence	N	$\bar{X}$	sd	t	p	Cohen's d
Teaching perception	Yes	20	29,00	4,89	.973	.332	0.24
	No	102	28,04	3,86			
Learning perception	Yes	20	15,55	3,28	1.831	.070	0.45
	No	102	14,04	3,39			
Ethical perception	Yes	20	16,40	2,60	-.760	.449	0.18
	No	102	16,81	2,15			
Total Scale	Yes	20	60,95	8,67	1.243	.216	0.31
	No	102	58,89	6,35			

The independent samples t-test was conducted to examine whether preservice teachers' scores on the PAI scale differed significantly according to their prior training in AI. As shown in the table 18, participants with prior AI training (n=20) had slightly higher mean scores across the TP (M = 29.00, SD = 4.89) and LP (M = 15.55, SD = 3.28) subscales compared to those without such training (M = 28.04, SD = 3.856; M = 14.04, SD = 3.39, respectively). However, these differences were not statistically significant (p > .05). Similarly, in the EP subscale, the mean score of participants without AI training (M = 16.81, SD = 2.15) was slightly higher than that of those with AI training (M = 16.40, SD = 2.604), but the difference again was not significant (t = -0.760, p = .449). Finally, the analysis of the total scale scores revealed that participants with AI training (M = 60.95, SD = 8.672) scored marginally higher than those without training (M = 58.89, SD = 6.35). Nonetheless, this difference was also not statistically significant (t = 1.243, p = .216). The effect size analysis revealed small to moderate effects across the subscales (range = 0.18–0.45), suggesting that while prior AI training did not lead to statistically significant differences, it was associated with slightly higher perceptions of AI use among preservice teachers. In sum, while preservice teachers with prior AI training tended to score slightly higher on certain dimensions of the PAI scale, the differences were not statistically significant, indicating that prior AI training did not exert a measurable effect on participants' overall perceptions captured by the scale.

Table 19.
Mann–Whitney U Test Results of Preservice Science Teachers' PAI Scale Scores by Prior Training in Software/Programming

Scale Factor	Prior Training in Software/Programming	N	Mean Rank	U	z	p
Teaching perception	Yes	7	56,14	365	-.415	.678
	No	115	61,83			
Learning perception	Yes	7	70,50	339,5	-.697	.486
	No	115	60,95			
Ethical perception	Yes	7	76,07	300,5	-1.136	.256
	No	115	60,61			
Total Scale	Yes	7	63,14	391	-.127	.899
	No	115	61,40			

Table 19 presents the results of the Mann Whitney U test conducted to determine whether preservice science teachers' PAI scale scores differed significantly based on their prior training in software or programming. As shown in the table, participants with prior software/programming training and those without such training did not exhibit statistically significant differences across any of the PAI subscales or the total scale ($p > .05$ for all comparisons). The mean ranks for participants with prior training were 56.14 for TP, 70.50 for LP, 76.07 for EP, and 63.14 for the total scale, indicating a tendency toward slightly higher perceptions among those with training; however, these differences were not statistically significant.

Table 20.
ANOVA Results of Preservice Teachers' PAI Scale Scores by Class Level

Class	N	$\bar{X}$	Standard Deviation	F	p
1.	18	58,33	5,380	.383	.766
2.	41	60,10	5,924		
3.	43	58,79	7,812		
4.	20	59,20	7,452		
Total	122	59,23	6,783		

The one-way ANOVA results presented in Table 20 indicate that preservice science teachers' PAI scale scores did not differ significantly across class levels. The mean scores were 58.33 (SD = 5.380) for first year students, 60.10 (SD = 5.924) for second year students, 58.79 (SD = 7.812) for third year students, and 59.20 (SD = 7.452) for fourth year students. The overall mean score was 59.23 (SD = 6.783). The ANOVA test yielded an F value of 0.383 with a significance level of $p = .766$, which is greater than the threshold of .05. This result demonstrates that there were no statistically significant differences in PAI scale scores among preservice science teachers based on their class level.

Table 21.
ANOVA Results of Preservice Science Teachers' PAI Scale Scores by Urbanicity of Upbringing

Urbanicity of Upbringing	N	$\bar{X}$	Standard Deviation	F	p
City	58	59,45	7,64	.014	.869
District	49	59,22	5,92		
Village	15	58,40	6,24		
Total	122	59,23	6,78		

Table 21 presents the results of a one way ANOVA conducted to examine whether preservice science teachers' PAI scale scores differed based on the urbanicity of their upbringing (city, district, or village). The findings show that the mean scores were 59.45 (SD = 7.64) for participants raised in cities, 59.22 (SD = 5.92) for those from districts, and 58.40 (SD = 6.24) for those from villages. The overall mean score across all groups was 59.23 (SD = 6.78). The ANOVA results yielded an F value of 0.014 with a significance level of $p = .869$, which is well above the conventional threshold of .05. This indicates that there were no statistically significant differences in PAI scale scores according to the urbanicity of upbringing.

Table 22.
Descriptive Statistics of Preservice Science Teachers' PAI Scores by Type of Secondary School Graduated

Type of Secondary School Graduated	N	$\bar{X}$	sd
Science High School	17	62,00	5,87

Anatolian High School	88	58,81	6,52
İmam Hatip High School	17	58,65	8,54
Total	122	59,23	6,78

Table 22 presents the descriptive statistics of preservice science teachers' PAI scale scores according to the type of secondary school graduated. The results show that the mean score of science high school graduates (X = 62.00, SD = 5.87) is higher compared to those from Anatolian High Schools (X = 58.81, SD = 6.52) and Imam Hatip High Schools (X = 58.65, SD = 8.54). The overall mean across all groups was 59.23 (SD = 6.78).

Table 23.
ANOVA Results of Preservice Teachers' PAI Scale Scores by Type of Secondary School Graduated

PAI Scale		Sum of Squares	df	Mean Square	F	p	Post Hoc
Teaching perception	Between Groups	161,969	2	80,985	5.326	.006	1>2
	Within Groups	1809,309	119	15,204			
	Total	1971,279	121				
Learning perception	Between Groups	1,152	2	,576	.049	.952	
	Within Groups	1403,807	119	11,797			
	Total	1404,959	121				
Ethical perception	Between Groups	4,406	2	2,203	.442	.644	
	Within Groups	592,717	119	4,981			
	Total	597,123	121	80,985			
Total	Between Groups	151,976	2	75,988	1.670	.193	
	Within Groups	5415,598	119	45,509			
	Total	5567,574	121				

Table 23 presents the results of the one way ANOVA conducted to examine whether the differences among groups are statistically significant. The findings indicate that a significant difference was observed only in the TP sub-dimension of the PAI scale (F = 5.326, p = .006). This result suggests that the type of high school graduated has a statistically significant effect on preservice teachers' teaching perception scores. However, no significant differences were found in the learning perception (F = 0.049, p = .952), ethical perception (F = 0.442, p = .644), or total scale scores (F = 1.670, p = .193). In summary, while graduates of different high school types do not differ significantly in overall PAI scores or in most sub-dimensions, Science High School graduates tend to report higher scores in TP, and this difference reaches statistical significance. This finding may reflect the stronger academic orientation and science-focused curriculum of science high schools, which could positively influence preservice teachers' perceptions of teaching with respect to AI.

Table 24.
Descriptive Statistics of Preservice Science Teachers' PAI Scale Scores by Daily Use of Technology

Daily Use of Technology (e.g., Computers, etc.)	N	$\bar{X}$	sd
0-3 h	32	59,66	7,77
3-5 h	55	58,98	5,56
More than 5 h	35	59,23	7,70
Total	122	59,23	6,78

The table 24 presents the descriptive statistics of preservice teachers' PAI scale scores based on their daily use of technology (e.g., computers, etc.). The participants were divided into three groups: those using technology 0–3 hours (M = 59.66, SD = 7.77, N = 32), 3–5 hours (M = 58.98, SD = 5.56, N = 55), and more than 5 hours (M = 59.23, SD = 7.70, N = 35). The total mean score across all groups was 59.23 (SD = 6.78, N = 122), suggesting a relatively consistent perception across different levels of daily technology use.

Table 25.
ANOVA Results of Preservice Science Teachers' PAI Scale Subscale Scores by Daily Use of Technology

PAI Scale		Sum of Squares	df	Mean Square	F	p	Post Hoc
Teaching perception	Between Groups	13,757	2	6,878	.418	.659	
	Within Groups	1957,522	119	16,450			
	Total	1971,279	121				
Learning perception	Between Groups	21,814	2	10,907	.938	.394	
	Within Groups	1383,145	119	11,623			
	Total	1404,959	121				
Ethical perception	Between Groups	47,952	2	23,976	5.195	.007	2>3
	Within Groups	549,171	119	4,615			
	Total	597,123	121				
Total	Between Groups	9,202	2	4,601	.099	.906	
	Within Groups	5558,372	119	46,709			
	Total	5567,574	121				

The table 25 provides the results of the ANOVA test conducted to determine whether the PAI subscale scores differed significantly based on daily technology use. The findings indicate no statistically significant differences for TP ($F = 0.418$, $p = .659$), LP ($F = 0.938$, $p = .394$), and the total scale ($F = 0.099$, $p = .906$). However, a significant difference was observed for the EP subscale ($F = 5.195$, $p = .007$), indicating that preservice science teachers' ethical perceptions regarding AI integration in education varied depending on their daily use of technology. Post-hoc comparisons revealed that the difference emerged particularly between the groups using technology 2–3 hours and those with higher usage levels.

Table 26.
Descriptive Statistics of Preservice Science Teachers' PAI Scale Scores by Daily Internet Usage

Daily Internet Usage (including via mobile phone)	N	$\bar{X}$	sd
0-3 h	29	58,76	7,46
3-5 h	56	58,88	5,99
More than 5 h	37	60,14	7,44
Total	122	59,23	6,78

The table 26 presents the descriptive statistics for preservice science teachers' PAI scale scores according to their daily internet usage, categorized as 0–3 hours, 3–5 hours, and more than 5 hours. The mean scores are relatively close across groups (58.76, 58.88, and 60.14, respectively), with standard deviations ranging from 5.98 to 7.46. This suggests that internet usage time does not lead to large differences in the overall distribution of PAI scores.

Table 27.
ANOVA Results of Preservice Science Teachers' PAI Scale Scores by Daily Internet Usage

PAI Scale		Sum of Squares	df	Mean Square	F	p	Post Hoc
Teaching perception	Between Groups	67,844	2	33,922	2.121	.124	
	Within Groups	1903,434	119	15,995			
	Total	1971,279	121				
Learning perception	Between Groups	,820	2	,410	.035	.966	
	Within Groups	1404,139	119	11,799			

	Total	1404,959	121				
Ethical perception	Between Groups	58,152	2	29,076	6.420	.002	3>2
	Within Groups	538,971	119	4,529			2>1
	Total	597,123	121				
Total	Between Groups	43,814	2	21,907	.472	.625	
	Within Groups	5523,760	119	46,418			
	Total	5567,574	121				

The table 27 reports the results of the ANOVA test conducted to examine differences across these groups for specific subdimensions of the PAI scale. The results show no statistically significant differences in teaching perception (F=2.121, p=.124) or learning perception (F=.035, p=.966). However, a significant difference was found in the ethical perception subscale (F=6.420, p=.002). Post-hoc comparisons revealed that participants who reported using the internet more than 5 hours daily scored significantly higher in ethical perception compared to those in the 0-3 hour and 3-5 hour groups. The total scale scores, however, did not differ significantly across the groups (F=.472, p=.625).

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

4.1. Preservice Science Teachers' AI-TPACK Competencies

Preservice science teachers' AI-TPACK competency levels suggest that while they recognize the potential of AI in enhancing learning and professional growth, their relatively lower mean scores in areas such as frequent classroom use and domain specific applications reveal gaps in practical integration. Similarly, Bautista et al. (2024) reported that preservice teachers encountered challenges in transforming this knowledge into pedagogical practice despite demonstrating familiarity with AI based tools. Dogan et al. (2025) likewise emphasized that preservice teachers' AI-TPACK competencies remain particularly limited in practice-oriented contexts, showing a gap between technical proficiency and pedagogical application. Runge et al. (2025) further confirmed that preservice teachers' technical familiarity with AI does not automatically translate into pedagogically integrated practice. Oved & Alt (2025) also highlighted that preservice teachers' familiarity with AI remains technical mainly and does not translate into sustained pedagogical integration, reinforcing the need for practice-oriented approaches. This finding is also consistent with studies indicating that teachers holding constructivist beliefs are more inclined to adopt educational AI tools, and that perceptions of trust, usefulness, and ease of use play a decisive role in the adoption process (Abdelmoneim et al., 2024). Therefore, targeted training opportunities that emphasize hands-on, pedagogically integrated use of AI are essential to foster more comprehensive AI-TPACK competencies.

4.2. Preservice Science Teachers' Perceptions Regarding AI Use in Education

The findings highlight a dual perspective regarding preservice science teachers' perceptions of AI in education. On one hand, AI is recognized as a powerful tool for enhancing efficiency, providing rapid evaluation, and facilitating access to ready-made knowledge. On the other hand, concerns were raised about potential drawbacks such as reduced student engagement and dependency on AI systems. This dual perspective aligns with Bautista et al. (2024), who stressed that technological readiness must be accompanied by ethical awareness to prevent overreliance on AI. Dogan et al. (2025) similarly observed that while preservice teachers value AI's efficiency, they also recognize potential risks related to diminished student participation. Runge et al. (2025) reinforced this duality, noting that preservice teachers acknowledged AI's efficiency benefits but simultaneously expressed concerns about ethical risks and reduced learner engagement. Similarly, Spasopoulos, Sotiropoulos & Kalogiannakis (2025) found that while preservice science teachers valued AI for its efficiency in science instruction, they simultaneously voiced concerns over diminished learner autonomy and overdependence on automated systems. Preservice teachers' perception of AI as a tool that provides speed and convenience parallels findings from educational AI tool research, which emphasize that perceptions of usefulness and ease of use play a critical role in adoption (Abdelmoneim et al., 2024). This underscores the importance of integrating AI into teacher education with a balanced pedagogical approach that maximizes its instructional benefits while minimizing risks related to overdependence and superficial learning.

4.3. Relationship Between AI-TPACK Competencies and Perceptions of AI

This study's correlation between AI-TPACK and PAI scores highlights the interplay between preservice science teachers' technological pedagogical competencies and their perceptions of AI. This resonates with Bautista et al. (2024), who observed significant positive correlations between TPACK dimensions and ethical readiness, suggesting that competence and perception reinforce each other. In line with this, Dogan et al. (2025) also found that preservice teachers with higher AI-TPACK competencies exhibited more favorable perceptions of AI integration. Runge et al. (2025) confirmed these patterns, showing that preservice teachers with stronger AI-TPACK competencies consistently demonstrated more positive perceptions of AI in education. Similarly, Oved & Alt (2025) demonstrated that preservice teachers with stronger AI-TPACK skills not only felt more

competent but also expressed higher confidence in AI adoption, underscoring the reciprocal nature of competence and perception. This situation is further supported by findings indicating that teachers who use technology, attend AI related courses, and possess a background in science education demonstrate more favorable perceptions of and stronger intentions to adopt educational AI tools (Abdelmoneim et al., 2024). This finding suggests that teachers who feel more competent in integrating AI tend to also hold more positive attitudes toward its use in teaching and learning, underlining the mutually reinforcing nature of competence and perception in shaping future classroom practices.

4.4. Differences in AI-TPACK Competencies According to Demographic Variables

Overall, these results suggest that male preservice science teachers in this sample generally perceive themselves as more competent in applying AI within technological, pedagogical, and content knowledge frameworks than female preservice teachers, with differences being particularly pronounced in CK, PK, TPCK, and overall, AI-TPACK scores.

Prior experience with technology assisted teaching does not appear to significantly influence preservice science teachers perceived competencies in AI-TPACK dimensions within this sample. Empirical studies on TPACK and 21st-century teaching competencies indicate that teaching experience alone is often an insignificant predictor once the quality of learning opportunities is considered. For example, Shafie et al. (2023) found that years of teaching did not significantly enhance teachers' 21st-century TPACK levels, emphasizing that continuous and structured professional development plays a more crucial role than mere experience. Similarly, Koh and Chai (2014) reported that TPACK development depends more on pedagogically grounded design experiences than on teaching tenure. In the specific case of AI integration, Alejandro et al. (2024) and Li et al. (2024) demonstrated that prior exposure to educational technologies or AI tools does not automatically lead to higher AI-TPACK competence s supported by explicit training and reflection. This finding suggests that initial exposure to technology assisted teaching may not necessarily translate into higher self perceived competence in AI-TPACK domains. One possible explanation is that the quality and depth of such experiences vary, and short term or limited exposure may not be sufficient to foster measurable differences in teachers' technological, pedagogical, and content knowledge related to AI integration.

The results also indicate that AI training enhances preservice science teachers' technological knowledge but does not necessarily translate into significant improvements in pedagogical or content-related dimensions. This conclusion is consistent with Bautista et al. (2024), who underscored the need for AI education to move beyond technical skills toward integrated pedagogical and ethical applications. Similarly, Dogan et al. (2025) pointed out that existing AI training programs primarily strengthen technical competencies, with limited impact on pedagogical or content knowledge. Spasopoulos et al. (2025) also confirmed this tendency in science education contexts, showing that AI related training courses strengthened technical proficiency while offering limited contributions to pedagogical or content knowledge integration. Abdelmoneim et al. (2024) demonstrated that teachers who participate in AI courses exhibit more favorable intentions to adopt educational AI tools. However, the present study indicates that short term training programs focus primarily on technical knowledge and show limited effectiveness in fostering pedagogical integration. Future research could explore whether more comprehensive and practice oriented AI training has a broader impact on preservice teachers' AI-TPACK competencies.

Across all dimensions of the AI-TPACK scale, no statistically significant differences were found between participants with prior training. This suggests that limited or basic exposure to software/programming may not be sufficient to yield meaningful improvements in preservice teachers' AI-TPACK competencies. Instead, the findings indicate that more structured, comprehensive, and pedagogically integrated training programs may be necessary to foster significant growth in both technical and pedagogical dimensions of AI-TPACK. In other words, while prior programming knowledge provides a slight advantage, it does not ensure higher competency levels in applying AI within pedagogical contexts.

The study found no significant differences in preservice teachers' AI-TPACK competencies across demographic variables such as class level, school type, or socio geographic background. This is consistent with Bautista et al. (2024), who reported that readiness for AI integration is shaped more by technological and pedagogical competencies than demographic characteristics. Dogan et al. (2025) also confirmed that gender or class level does not produce significant differences in AI-TPACK competencies. Runge et al. (2025) found that demographic factors such as gender, socio-economic status, or class level did not significantly affect preservice teachers' AI-TPACK outcomes. Oved & Alt (2025) reached a similar conclusion, reporting that demographic characteristics such as age, class level, and prior schooling background had no significant effect on preservice teachers' AI-TPACK competencies. Abdelmoneim et al. (2024) emphasized that teachers with a background in science education tend to hold more favorable perceptions of educational AI tools. However, the present study revealed that neither school type nor socio geographic factors produced significant differences. Future research could investigate whether contextual factors, such as the availability of digital infrastructure or exposure to technology during schooling, might moderate the relationship between upbringing context and AI-TPACK development.

The results indicate that preservice science teachers' AI-TPACK competencies are not significantly affected by the amount of their daily technology use. While those who reported moderate daily use (3–5 hours) showed slightly higher mean scores, this difference was not statistically meaningful. This suggests that the frequency of technology use alone does not guarantee stronger competencies. These findings emphasize the importance of how technology is used rather than how often it is used. Structured, purposeful, and pedagogically integrated training in teacher education programs appears to be more critical for developing AI-

TPACK competencies than the mere duration of exposure to technology. Future research could investigate the quality of technology use, such as the types of digital tools employed or the extent to which they are integrated into teaching practices, to understand better their role in shaping preservice teachers' competencies.

The duration of daily internet use, including mobile phone use, does not significantly influence preservice teachers' AI-TPACK competencies. Although moderate use (3–5 hours) is linked with slightly higher scores, the absence of statistical significance suggests that time spent online alone is insufficient for competency development. This highlights the importance of purposeful and pedagogically integrated internet use rather than the sheer quantity of use. Future research could examine the quality of online activities (e.g., educational vs. recreational use) to better understand their potential role in fostering AI-TPACK growth.

These results indicate that preservice science teachers' ability to integrate technological, pedagogical, and content knowledge with AI is linked to their attitudes toward AI in educational contexts. However, the relatively low correlation coefficient suggests that while AI-TPACK competencies may contribute to shaping perceptions of AI, other contextual or personal factors likely play a more substantial role. Future studies could explore additional variables, such as teaching experience, digital literacy, or exposure to AI applications, to better understand the factors influencing preservice teachers' perceptions of AI.

4.5. Differences in Perceptions of AI Use in Education According to Demographic Variables

The analysis revealed no significant gender differences in preservice science teachers' perceptions of AI across the PAI scale and its subscales. Only in the ethical perception dimension did the results approach the significance threshold, with male participants reporting slightly higher scores. Overall, the findings suggest that gender is not a determining factor in shaping preservice science teachers' perceptions of AI in education. Nonetheless, the near significant difference in ethical perceptions points to a potential trend that may merit further exploration in future studies. This aligns with prior research demonstrating that demographic characteristics, including gender, have a limited impact on teachers' AI related perceptions, with attitudes being shaped more by pedagogical experiences and professional readiness than by personal background variables (Işık, Çakır & Korkmaz, 2024; Kotsis, 2025). Furthermore, the emerging emphasis on ethical sensitivity echoes findings highlighting ethics and responsibility as central aspects of teachers' AI perceptions (Alwaqdani, 2025; Uygun, 2024).

The independent samples t-test results revealed that preservice teachers' prior experience with technology assisted teaching did not produce significant differences in their scores on the learning, ethical, or total dimensions. This indicates that prior experience with technology supported instruction does not strongly influence preservice science teachers' perceptions of AI in education. While such experience may foster familiarity with digital tools, it does not substantially shape attitudes toward AI within the pedagogical, learning, or ethical domains. These findings highlight the necessity of structured and targeted training specifically focused on AI in education, rather than relying solely on general technology experience. This interpretation resonates with Nissim & Simon (2025), who emphasized that perceptions of AI adoption are primarily driven by teachers' trust in its usefulness and pedagogical value, rather than by general technological familiarity.

The results showed that preservice science teachers with prior AI training reported slightly higher scores in teaching, learning, and overall perceptions. In contrast, those without training scored marginally higher in ethical perception. However, these differences were not statistically significant, indicating that prior AI training alone does not substantially influence preservice science teachers' views on AI in education. This suggests the importance of structured, targeted AI focused training to meaningfully shape preservice science teachers' perceptions. Similarly, recent studies indicate that while short term exposure to AI related courses may enhance awareness, more comprehensive, contextually embedded training is required to foster sustained changes in teachers' perceptions (Işık, et al. 2024; Uygun, 2024).

The findings indicate that prior training in software/programming did not significantly affect preservice science teachers' perceptions of AI in education. This suggests that general programming knowledge alone is insufficient, highlighting the need for targeted and AI-specific training. These results mirror those of Sanusi et al. (2024), who found that differences in national and institutional contexts strongly mediate AI perceptions, underscoring that broader experiences or technical backgrounds do not automatically translate into favorable or critical perspectives.

These findings imply that having prior exposure to software or programming training does not necessarily translate into higher AI-TPACK competency levels among preservice teachers. While such experience might enhance basic technical familiarity, it appears insufficient to significantly improve integrated pedagogical applications of AI. This highlights the importance of targeted AI-specific teacher education programs rather than relying solely on general programming experience.

The results showed no significant differences in preservice science teachers' PAI scores across class levels and the urbanicity of upbringing. Perceptions of AI in education appeared consistent among students from different academic years. This suggests that class level does not substantially influence preservice science teachers' attitudes toward AI, indicating a relatively stable perception regardless of progression in their program. Whether participants were raised in urban, semi-urban, or rural areas, their perceptions of AI in education remained consistent. This suggests that the upbringing context does not play a determining role in shaping preservice teachers' attitudes toward AI. This finding is consistent with broader international evidence

suggesting that perceptions of AI are not primarily determined by demographic or geographical background, but by contextual and pedagogical variables (Kotsis, 2025; Sanusi et al., 2024).

The findings show that preservice science teachers' PAI scores differed significantly only in the teaching perception subscale, with science high school graduates reporting higher scores than their peers. This suggests that a science oriented educational background may enhance perceptions of AI in teaching. However, no significant differences were found in learning, ethical, or overall scores, indicating that the impact of school type on AI perceptions is limited and context-specific. These results parallel the emphasis in Nissim & Simon (2025) that perceptions of AI's pedagogical utility are strengthened when teachers possess prior exposure to science-oriented epistemologies that prioritize systematic inquiry and technological integration.

The results suggest that the duration of daily technology use does not significantly influence preservice science teachers' general teaching and learning perceptions about AI. This indicates a degree of stability in their pedagogical and learning related attitudes toward AI regardless of technology engagement. In contrast, ethical perception is sensitive to technology usage levels, with significant differences between groups. This implies that individuals who use technology for longer durations may have more nuanced or critical perspectives on ethical issues related to AI applications in education, such as fairness, data privacy, and responsible use. While teaching and learning perceptions remain relatively stable across different levels of daily technology use, ethical considerations are more dynamic and likely shaped by personal exposure and engagement with digital technologies. This finding corresponds with Alwaqdani (2025) and Uygun (2024), who stressed that teachers' perceptions of AI often converge around ethical awareness, which becomes more salient with increased exposure to digital environments.

These findings indicate that daily internet usage does not directly impact preservice teachers' teaching or learning perceptions within the PAI framework. Nevertheless, heavy internet users (more than 5 hours per day) exhibit stronger ethical perceptions than their peers with lower internet usage. This result may imply that extended exposure to digital platforms enhances awareness and sensitivity toward ethical considerations, such as responsible technology use, digital literacy, and online behavior. However, the lack of significant differences in other subdimensions suggests that the influence of internet usage may be context specific rather than pervasive across all domains of pragmatic attitudes. This conclusion resonates with international studies noting that while digital exposure alone may not affect teachers' overall perceptions of AI, it tends to heighten sensitivity to fairness, privacy, and responsibility (Sanusi et al., 2024; Alwaqdani, 2025).

4.6. Limitations and Recommendations for Future Research

This study relies on preservice science teachers' self-reported data, which may not fully capture their actual classroom practices, and its cross-sectional design limits the ability to observe changes in AI-TPACK competencies over time. Participants' AI-related training experiences were primarily short-term and technically oriented, restricting insights into the effects of more comprehensive, pedagogically integrated programs. Although demographic and experiential variables were examined, contextual factors such as institutional digital infrastructure and the quality of prior training were beyond the scope of this study.

Research and Publication Ethics Statement

The entire research process was conducted in strict accordance with established ethical standards. All data obtained from participants were utilized solely within the scope of the present study, and the reporting procedures adhered fully to recognized guidelines for research ethics.

Contribution Rates of Authors to the Article

The authors provide equal contributions to this work.

Statement of Interest

There is no conflict of interest.

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Examining the Relationship Between Artificial Intelligence Literacy, Attitudes Toward Artificial Intelligence, and Technostress Among University Students

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ABSTRACT

Artificial intelligence (AI) technologies have rapidly permeated educational contexts, influencing students' learning processes and digital experiences. This study aimed to examine the interrelationships among AI literacy, attitudes toward AI, and technostress in undergraduate students. A cross-sectional, descriptive, and correlational design was employed. Data were collected in June 2025 from 400 undergraduate students enrolled in the Faculties of Health Sciences, Education, Arts and Sciences, and Engineering at Artvin Çoruh University. Data collection instruments included a Sociodemographic Information Form, the Artificial Intelligence Literacy Scale (AILS), the General Attitudes Toward Artificial Intelligence Scale (GAAIS), and the Technostress Scale. Descriptive statistics, Pearson's correlation, and multiple regression analyses were conducted using SPSS 26.0. The results indicated that positive attitudes toward AI were significantly and positively correlated with AI literacy, whereas technostress showed negative associations with both positive attitudes and the evaluation subdimension of AI literacy. Regression analysis further revealed that academic achievement (GPA), IT competence, and positive attitudes were significant predictors of AI literacy, while negative attitudes exerted a diminishing effect. Technostress, however, did not emerge as a significant predictor. These findings highlight the multifaceted nature of AI integration in higher education. The findings of this study indicate that enhancing AI literacy is associated not only with improved technical competence but also with more positive perceptions and reduced technology-related stress. Educational strategies should therefore focus on strengthening students' AI literacy, promoting balanced and informed attitudes, and equipping learners with coping mechanisms to manage technostress. This study aims to contribute to the growing body of literature by emphasizing the importance of integrating cognitive, emotional, and psychological dimensions into AI education to support students' adaptation and academic success in the digital era.

Keywords: Artificial intelligence literacy; attitudes toward AI; technostress; higher education; university students

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1. INTRODUCTION

Artificial intelligence (AI) technologies have been rapidly developing in recent years, permeating all areas of social life and playing a transformative role in educational environments, including higher education (Long & Magerko, 2020). With AI becoming more than just a tool and evolving into an integral part of the learning process, the concept of AI literacy has emerged in the literature (Mertala et al., 2022). AI literacy is defined as a set of competencies that enable individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool online, at home, and in workplaces (Southworth et al., 2023). Considering the growing influence of AI in modern society, the importance of these competencies is greater than ever. Indeed, the ability to understand, evaluate, and use AI technologies has become a fundamental digital skill for individuals today (Ng et al., 2022; Zhai et al., 2021; Semerci Şahin et al., 2025).

To succeed in the AI era, students must be provided with learning opportunities to develop AI literacy (Yang et al., 2025). In the international literature, the development of AI literacy programs in higher education is suggested as an important step to address both the opportunities and challenges posed by the integration of AI into education (Francis et al., 2025; Sarikahya et al., 2025). In fact, AI literacy is considered a critical competency that university students should possess for their future professional careers and citizenship roles in a world increasingly dominated by AI (Hornberger et al., 2025).

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The importance of AI literacy has become even more pronounced with the rapid spread of AI in education. For example, ChatGPT, an AI chatbot introduced at the end of 2022, quickly attracted great interest among higher education students. A global study reported that 71% of university students tried ChatGPT at least once for academic purposes during its first year of release (Ravšelj et al., 2025). Students have been integrating AI tools like ChatGPT into their academic work for various purposes such as conducting research for assignments, summarizing texts, and generating new ideas. However, the rapid incorporation of such generative AI tools into education has also raised concerns regarding academic integrity and assessment methods.

Therefore, it is crucial to equip students with the necessary knowledge and skills to use AI tools consciously, ethically, and effectively that is, to raise their AI literacy levels. Some researchers, in fact, recommend that higher education institutions develop AI literacy programs for students in order to promote the responsible use of AI (Francis et al., 2025). In addition to students' AI literacy, their attitudes toward AI also emerge as a decisive factor in the acceptance and effective use of this technology in education (Fan & Zhang 2024; Zeng et al., 2025). Attitudes toward AI generally reflect individuals' cognitive evaluations and emotional orientations regarding AI technologies (Brauner et al., 2025). The literature indicates that attitudes toward AI have both positive and negative dimensions, and these can affect technology adoption in different way (Cicero et al., 2025; Makridakis, 2017). Positive attitudes reflect an optimistic outlook that highlights the potential opportunities and benefits of AI, whereas negative attitudes involve concerns such as anxiety, distrust, or fear (Schepman & Rodway, 2020, 2023). For instance, widespread misconceptions in public discourse may lead to unrealistic fears that AI will completely take over the labor market, or, conversely, to overly optimistic expectations that AI will solve all problems (Du, 2024; Rodrigues et al., 2023). Such perceptions can push individuals toward extreme positions in their attitudes toward AI. Studies have shown that positive attitudes toward AI are positively associated with students' intentions to adopt these technologies, while negative attitudes are linked to resistance and reluctance (Cave et al., 2019; Fast & Horvitz, 2017).

On the other hand, the phenomenon of "technostress," which arises from the intensive use of information and communication technologies, has regained importance with the spread of AI in education (Klimova & Pikhart 2025; Litan 2025). The concept of technostress refers to the difficulties of adaptation, anxiety, and psychological pressures that individuals experience when using new technologies (Lin & Yu, 2025; Upadhyaya & Vrinda, 2021). In the literature, technostress is often defined as a set of negative psychological conditions resulting from the cognitive and emotional burdens imposed by technology (Saleem et al., 2024). From the perspective of students, technostress can lead to outcomes that negatively affect learning processes, such as distraction, cognitive overload, and reduced motivation. Indeed, recent studies have reported that increasing levels of technostress among students negatively affect academic performance and weaken information processing and learning skills (Torales et al., 2022; Vallone et al., 2023). Especially during the COVID-19 pandemic, the accelerated shift to online learning revealed heightened technostress symptoms among many students; factors such as excessive exposure to technology, technical problems, and a lack of digital skills reduced students' learning satisfaction (Torales et al., 2022; Vallone et al., 2023). The rapid diversification and development of AI applications may similarly create an adaptation burden for students. The need to keep pace with constantly updated AI tools may increase anxiety and stress levels among individuals who lack sufficient digital literacy (Pertiwi et al., 2025). A study by Chen et al. (2024) indicated that generative AI could contribute to technostress in the workplace, as the rapid pace of change and the constant need for learning exert pressure on users (N. Chen et al., 2024). Similarly, individuals who perceive themselves as inadequate in AI are more likely to avoid or resist using such technologies (Chang et al., 2024). In short, technostress constitutes a significant barrier to the adoption of AI and plays a decisive role in individuals' ability to adapt to technology.

While the literature highlights the individual importance of AI literacy, attitudes, and technostress, understanding the interaction of these variables is considered critical, particularly in the higher education context. Individuals with higher AI literacy are better able to make sense of and adapt to new technologies, which may lead them to develop more positive attitudes toward AI and experience lower levels of anxiety regarding technological innovations. Indeed, previous studies have shown that students with solid knowledge and experience of AI approach these technologies with greater confidence and optimism, which in turn reduces their AI-related anxiety and stress (Bećirović et al., 2025; Chang et al., 2024; Jha et al., 2022). For example, a recent study conducted with university students in Middle Eastern countries found that those with higher levels of knowledge about the use and benefits of AI reported lower levels of concern about AI and were more willing to integrate AI into their future professional practice (Jha et al., 2022). Similarly, a study conducted with Chinese university students reported that digital literacy significantly predicted technostress: students with higher digital literacy experienced substantially lower levels of technology-related stress (Wang, 2024). hese findings suggest that developing digital skills and AI literacy can facilitate students' adaptation to technology and reduce technostress. Conversely, students with low AI literacy or limited exposure to AI may struggle to make sense of AI technologies, which may in turn foster misconceptions, heightened anxiety, and more negative attitudes (Al Omari et al., 2024; Du, 2024; Rodrigues et al., 2023). The literature also emphasizes the need for further investigation into the relationship between digital competencies and attitudes (Cicero et al., 2025; Mena-Guacas et al., 2023; Shima & Jaupaj 2025).

Accordingly, examining the relationship among university students' AI literacy, attitudes toward AI, and technostress fills an important gap both theoretically and practically. The findings may provide valuable insights into how educational programs and support mechanisms should be designed to enhance students' academic success and overall educational experience in the AI era. In this way, interventions such as curriculum development aimed at increasing AI literacy, promoting positive and informed attitudes toward AI, and reducing sources of technological stress can be grounded on a solid scientific basis. For this

reason, this study aims to contribute to the literature by investigating the reciprocal relationships among AI literacy, attitudes, and technostress in university students.

2. METHODOLOGY

2.1. Study design

This study is a cross-sectional, descriptive, and correlational research conducted to assess university students' AI literacy, attitudes toward AI, and levels of technostress in Türkiye.

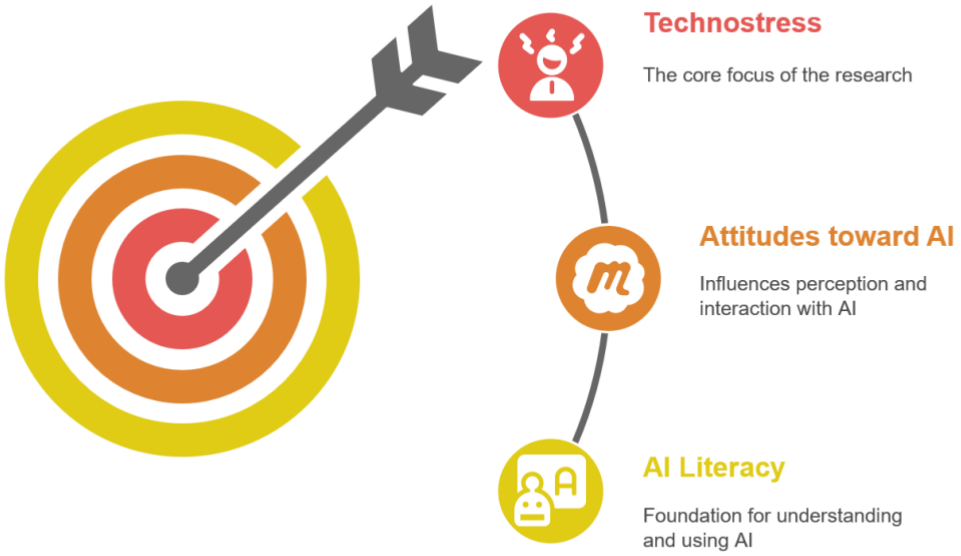


Figure 1. Framework models of the study

2.2. Participants

The study population consisted of undergraduate students enrolled in the Faculties of Health Sciences, Education, Arts and Sciences, and Engineering at Artvin Çoruh University. The university setting which integrates theoretical coursework, practical training, and digital learning resources provided an appropriate academic environment for examining students' AI literacy, attitudes toward AI, and experiences of technostress.

A convenience sampling method was used, as students who met the eligibility criteria and were accessible during the data collection period were invited to participate. This method was preferred due to practicality and feasibility in reaching a sufficiently large and diverse student population.

To determine an adequate sample size, an a priori power analysis was conducted for multiple linear regression with ten independent variables. Using G*Power software with a medium effect size (f^2 = 0.15), an alpha level of .05, and a statistical power of .95, the minimum required sample size was calculated as 175. In the present study, data were collected from 400 undergraduate students, exceeding the minimum requirement. This ensured adequate statistical power, enhanced the reliability of the findings, and allowed for subgroup analyses, thereby strengthening the generalizability of the results.

Inclusion criteria were based on ensuring that participants had sufficient exposure to AI-related educational environments and the digital tools necessary to complete the survey:

- Being enrolled in an undergraduate program at Artvin Çoruh University,
- Having access to a digital device (computer, smartphone, or tablet),
- Providing voluntary informed consent to complete the online survey.

Exclusion criteria were determined to ensure data accuracy and integrity:

- Providing incomplete or invalid responses,
- Inability to read or understand Turkish (the survey language),
- Voluntary withdrawal from the study at any stage.

2.3. Data Collection Instruments

2.3.1. Sociodemographic Information Form

Participants' demographic and academic characteristics were collected using a form developed by the researcher based on the relevant literature (Saleem et al., 2024; Vallone et al., 2023). To ensure clarity of the items, feedback was obtained from an expert in educational sciences. The form included items on age, gender, year of study, grade point average (GPA), prior training related to AI, and self-reported use of AI technologies.

2.3.2. Artificial Intelligence Literacy Scale (AILS)

AI literacy was measured using the AILS, developed by Wang, Rau, and Yuan (2023). The scale was adapted into Turkish and validated by Çelebi and colleagues (2023). The instrument comprises 12 items organized into four subdimensions: awareness, usage, evaluation, and ethics. Each item is rated on a 7-point Likert scale ranging from *Strongly Disagree (1)* to *Strongly Agree (7)*. Items 2, 5, and 11 are reverse-coded. Possible scores range from 12 to 84, with higher scores reflecting greater AI literacy. Reliability analyses for the original version yielded Cronbach's alpha values of 0.83 for the overall scale, and 0.73, 0.75, 0.78, and 0.73 for awareness, usage, evaluation, and ethics, respectively. In the Turkish version, Cronbach's alpha coefficients were 0.85 for the total scale, and 0.72, 0.74, 0.76, and 0.72 for the respective subdimensions. In this study, the Cronbach's Alpha coefficient was found to be 0.74.

2.3.3. General Attitudes Toward Artificial Intelligence Scale (GAAIS)

Students' attitudes toward AI were assessed with the GAAIS, originally developed by Schepman and Rodway (2023). The Turkish adaptation and validation were carried out by Kaya et al. (2024) (Kaya et al., 2024). The GAAIS includes 20 items and two subscales: positive and negative attitudes. All items are rated on a 5-point Likert scale. In the Turkish version, items 1–12 represent positive attitudes, whereas items 13–20 measure negative attitudes and are reverse-coded. On the negative attitude subscale, lower scores indicate more unfavorable orientations. The Cronbach's alpha coefficients for the Turkish version were 0.82 for the positive subscale and 0.84 for the negative subscale. In this study, the Cronbach's Alpha coefficient was found to be 0.74. In this study, the Cronbach's Alpha coefficient was found to be 0.81.

2.3.4. Technostress Scale

Technostress levels were measured using the "Technostress Levels of University Students in the Technology-Assisted Learning Environment" Scale, originally developed by Wang et al. (2008) and adapted into Turkish by Baş et al. (2021).The instrument contains 13 items scored on a 5-point Likert scale ranging from *Strongly Disagree (1)* to *Strongly Agree (5)*. Total scores range between 13 and 65, with higher scores reflecting greater levels of technostress. In the Turkish validation study, the Cronbach's alpha coefficient was reported as 0.91, and the split-half reliability was 0.93 (Baş et al., 2021). In this study, the Cronbach's Alpha coefficient was found to be 0.93.

2.4. Data Collection Process

The research data were collected in June 2025 from undergraduate students enrolled in the Faculties of Health Sciences, Education, Arts and Sciences, and Engineering at Artvin Çoruh University. Participants were recruited through student communication platforms and classroom announcements made by faculty members. In addition, with the necessary permissions obtained from the course instructors, recruitment was carried out during class hours.

At the beginning of the sessions, students were provided with detailed information regarding the aim of the study, the procedures to be followed, and ethical principles (confidentiality, voluntary participation, etc.). Questionnaires were distributed in person to students who voluntarily agreed to participate. Participants were given one week to complete the survey, and reminders were sent via e-mail and student communication groups during this period.

Prior to completing the questionnaire, students were explicitly informed that the data they provided would be used solely for scientific research purposes and that their personal information would remain confidential. Participation was based entirely on voluntariness, and informed consent was obtained from all participants prior to data collection.

2.5. Data Analysis

Data analysis was conducted using IBM SPSS Statistics for Windows, Version 26.0. Descriptive statistics (mean, standard deviation, frequency, and percentage) were employed to summarize participants' demographic characteristics, AI-related experiences, and their scores on the AILS, the GAAIS, and the Technostress Scale. Pearson's correlation analysis was performed to examine the relationships between AI literacy, attitudes toward AI, and technostress. Correlation coefficients were interpreted based on Cohen's guidelines: values of approximately .10 indicated a small effect, .30 a moderate effect, and .50 or higher a large effect (Cohen 2013).

Multiple linear regression analyses were then conducted to determine the predictive roles of AILS, GAAIS, and technostress subdimensions. Prior to regression, assumptions of multicollinearity were checked using Variance Inflation Factor (VIF), tolerance, and condition index values. Independent variables were considered acceptable when VIF < 10, tolerance > 0.20, and condition index < 15. All analyses were performed at a 95% confidence level, with results considered statistically significant at $p < .05$.

3. FINDINGS

Demographic Characteristics

A total of 400 students participated in the study, with the majority being female (60.5%). Among the participants, 56.8% were between the ages of 21 and 23, 32.3% were in their fourth year, and 29.3% were in their third year of study. The students' average academic grade point average (GPA) was 2.89 ± 0.42. In terms of information technology proficiency, 45.8% of the participants described themselves as having a moderate level of competence (Table 1).

Table 1.
Demographic Variables and Artificial Intelligence Usage Among University Students

Variables		n	%
Demographic variables			
Gender			
	Male	158	39.5
	Female	242	60.5
Age			
	18–20 years	123	30.7
	21-23 years	227	56.8
	24 and above years	50	12.5
Class			
	1st year	81	20.3
	2nd year	73	18.3
	3rd year	117	29.3
	4th year	129	32.3
Academic GPA (4.0 scale)		Mean (SD)	
Information technology proficiency		2.89±0.42	
	Poor	15	3.8
	Moderate	183	45.8
	Good	167	41.8
	Very good (Advanced)	35	8.8
Artificial Intelligence Usage and Perceptions			
Knowledge of artificial intelligence			
	Yes	361	90.2
	No	39	9.8
Having received education about artificial intelligence			
	Yes	22	5.5
	No	378	94.5
Perception of artificial intelligence reliability			
	Very reliable	20	5.0
	Reliable	112	28.0
	Not sure	242	60.5
	Unreliable	21	5.3
	Not reliable at all	5	1.3
Familiarity with artificial intelligence applications			
	ChatGPT	374	93.5
	Bard/Gemini	150	37.5
	Bing	78	19.5
	DeepSeek	25	6.3
	Grok	16	4.0
Use of artificial intelligence tools in lessons or the educational process			
	Yes	342	85.5
	No	58	14.5
Purpose of using artificial intelligence			
	Preparing assignments	309	77.3
	Learning new information	255	63.8

Translating	226	56.5
Writing articles or reports	181	45.3
Accessing evidence-based information	133	33.3
Conducting literature review	131	32.8
Preparing presentations or training materials	110	27.5
Solving questions or practicing	110	27.5

Artificial Intelligence Knowledge and Education

The vast majority of participants (90.3%) reported that they had knowledge about AI. However, only 5.5% stated that they had received any formal education or training in this area. When asked about their perceptions of AI's reliability, 60.5% reported being uncertain, 28.0% found AI to be reliable, 5.0% considered it very reliable, 5.3% said it was unreliable, and 1.3% believed it was completely unreliable.

Familiarity with AI Applications

The AI application that students were most familiar with was ChatGPT (93.5%). This was followed by Bard/Gemini (37.5%), Bing (19.5%), DeepSeek (6.3%), and Grok (4.0%). A large majority of participants (85.5%) indicated that they had used AI tools during lessons or in educational settings.

Purposes of AI Use

When examining the purposes for which students use AI tools, it was found that the most common uses were for preparing assignments (77.3%), acquiring new knowledge (63.8%), and translating texts (56.5%). Less frequent uses included writing articles or reports (45.3%), accessing evidence-based information (33.3%), conducting literature reviews (32.8%), preparing presentations or educational materials (27.5%), and solving problems or practicing questions (27.5%) (Table 1).

Correlation Analysis

Correlation analysis revealed several significant relationships among the study variables. Technostress showed a weak but significant negative correlation with both positive attitudes toward AI ($r = –.13$, $p < .01$) and negative attitudes ($r = –.26$, $p < .01$). This indicates that higher levels of technostress are associated with more negative perceptions of AI. Additionally, there was a weak but significant negative correlation between technostress and the *Evaluation* subdimension of AI literacy ($r = –.17$, $p < .01$), suggesting that students with stronger evaluation skills experience less technostress.

AI literacy was moderately and positively correlated with positive attitudes toward AI ($r = .42$, $p < .01$). This finding indicates that as students' AI literacy increases, so do their positive attitudes. Conversely, AI literacy showed a weak but significant negative correlation with negative attitudes ($r = –.10$, $p < .05$), suggesting that higher literacy is associated with fewer negative perceptions.

At the subdimension level, *Awareness* ($r = .24$, $p < .01$), *Usage* ($r = .42$, $p < .01$), *Evaluation* ($r = .36$, $p < .01$), and *Ethics* ($r = .26$, $p < .01$) were all positively correlated with positive attitudes. This result indicates that students who score higher in AI literacy skills are more likely to hold favorable views of AI. On the other hand, weak but significant negative correlations were found between negative attitudes and the subdimensions of *Awareness* ($r = –.12$, $p < .05$), *Usage* ($r = –.13$, $p < .01$), and *Ethics* ($r = –.13$, $p < .01$). No significant relationship was observed between the *Evaluation* subdimension and negative attitudes. These results suggest that the dimensions of AI literacy support positive attitudes and that subskills like awareness and usage may also serve a protective function against negative perceptions (Table 2).

Table 2.
Correlation Matrix Among Technostress, AILS, positive GAAIS, and negative GAAIS

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Technostress	-							
2. AILS	-.03	-						
3. Awareness	.00	.68**	-					
4. Usage	-.00	.80**	.39**	-				
5. Evaluation	-.17**	.81**	.34**	.58**	-			
6. Ethics	.08	.73**	.33**	.46**	.48**	-		
7. Positive GAAIS	-.13**	.42**	.24**	.42**	.36**	.26**	-	
8. Negative GAAIS	-.26**	-.10*	-.12*	-.13**	.04	-.13**	-.10*	-

'*' indicates $p < .05$.
'**' indicates $p < .01$.

Regression Analysis

The regression analysis presented in Table 3 examined the predictive power of age, GPA, information technology competence, technostress, and both positive and negative attitudes toward AI on AI literacy. The overall model was found to be significant, $F(6,393) = 22.01$, $p < .001$, with an R^2 value of .25, indicating that approximately 25% of the variance in AI literacy could be explained by these variables.

Further examination revealed that GPA ($B = 4.18$, $p < .001$) and information technology competence ($B = 2.71$, $p < .001$) were significant and positive predictors of AI literacy, suggesting that students with higher academic performance and stronger tech skills also had higher AI literacy levels. Positive attitudes toward AI were also found to be a strong and significant predictor ($B = 0.53$, $p < .001$), indicating that favorable perceptions of AI increase literacy scores. In contrast, negative attitudes had a significant negative impact ($B = –0.15$, $p = .036$), showing that negative views decrease AI literacy.

However, neither age ($p = .132$) nor technostress ($p = .824$) had a significant effect on AI literacy. Overall, the findings suggest that the strongest predictors of AI literacy are academic success, information technology proficiency, and positive attitudes toward AI, while negative attitudes have a diminishing effect (Table 3).

Table 3.
Regression Results for Predictors of AILS

Variable	***B***	***SE***	**95.00% CI**	**β**	***t***	***p***
(Intercept)	9.21	7.50	[-5.53. 23.95]		1.22	.220
Age	0.35	.23	[-0.10. 0.81]	.06	1.51	.132
GPA	4.18	1.02	[2.17. 6.19]	.18	4.09	.000
Information technology proficiency	2.71	.63	[1.47. 3.95]	.19	4.30	.000
Technostress	-.10	.04	[-0.09. 0.78]	-.01	-.22	.824
Positive GAAIS	.53	.06	[0.41. 0.65]	.39	8.66	.000
Negative GAAIS	-.15	.07	[-0.29. -0.01]	-.09	-2.10	.036
$F(6, 393) = 22.01$, $p < .001$, $R^2 = .25$						

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

4.1. Results and Discussion

This study revealed significant relationships between university students' AI literacy, their attitudes toward AI, and their levels of technostress. The findings indicate that especially positive attitudes and strong digital competencies contribute to higher levels of AI literacy while helping to reduce stress related to technology use. By addressing the interaction between cognitive skills (literacy), emotional tendencies (attitudes), and psychological effects (technostress) in an integrated framework, the study makes a meaningful contribution to the existing literature. It offers a deeper understanding of how higher education students adapt to emerging technologies and highlights the necessity of developing AI literacy programs that go beyond technical skills to also foster ethical awareness and emotional resilience. These findings underline the importance of designing educational programs that are multidimensional in nature to effectively support students in the process of digital transformation.

Attitudes Toward AI and Technostress

The results of this study reveal that technostress plays a significant role in shaping students' perceptions and attitudes toward AI. As technostress increases, students tend to display weaker positive attitudes and stronger negative orientations toward AI. This finding is consistent with prior research, which suggests that technostress functions as an inhibiting factor in the adoption and effective use of emerging Technologies (Saleem et al., 2024; Vallone et al., 2023). Students experiencing high levels of technostress are often reluctant to engage with new technologies, and in the case of AI, this hesitancy may hinder their willingness to learn and apply AI tools in academic contexts, potentially affecting academic performance and digital skill development.

Recent evidence underscores the buffering effect of positive attitudes toward AI on technostress. A positive orientation where students perceive AI as beneficial, useful, and manageable appears to reduce stress, whereas negative attitudes, such as fear, distrust, or avoidance, exacerbate it (Bagaskara et al., 2024; Liţan, 2025). This aligns with studies on "AI anxiety," which

demonstrate that students who approach AI applications with curiosity and optimism report lower psychological discomfort, less perceived risk, and greater willingness to adopt generative AI tools (Almaiah et al., 2022; Zhu et al., 2025). Positive attitudes are theorized to increase adaptive cognitive appraisals, thereby reducing the perception of threat when encountering AI (Ali et al., 2024; Baidoo-Anu & Ansah, 2023; Matyushok et al., 2021). Students with positive attitudes toward AI tend to view challenges as opportunities for learning, whereas those with more negative attitudes may perceive similar situations as obstacles that reinforce their concerns, leading to higher levels of stress.

Empirical studies further highlight attitudes as key predictors of AI-related anxiety. For example, a study in nursing education found that students' general attitude toward AI was the strongest predictor of AI anxiety, with negative orientations particularly driving anxiety among students who lacked prior AI exposure (Ayed et al., 2025). These findings are consistent with technology acceptance models such as TAM and UTAUT, which propose that users' attitudes, shaped by perceived usefulness and ease of use, directly influence their comfort level and stress when adopting technology (Cengiz & Peker, 2025; Venkatesh et al., 2003). Our results complement these frameworks by illustrating that negative attitudes intensify technostress, whereas cultivating positive perceptions may act as a protective factor against stress when using AI in educational settings.

At the same time, the literature highlights that attitudes toward AI are multifaceted (Fan & Zhang, 2024; Zeng et al., 2025; Brauner et al., 2025). Negative attitudes may involve both cognitive components (e.g., skepticism about AI's usefulness) and emotional reactions (e.g., fear of social or personal consequences). Both aspects heighten technostress: skeptical students may feel alienated by mandated AI use, while anxious students may experience panic when interacting with AI tools (Wang & Wang, 2022). Conversely, positive attitudes can reflect curiosity, optimism, or trust, all of which generally reduce stress. However, studies caution that extremely optimistic views may also have downsides. For instance, Sindermann et al. (2022) found that young adults with highly positive attitudes toward AI sometimes exhibited problematic digital behaviors, such as excessive reliance on AI-driven applications (Sindermann et al., 2022). This indicates that balanced positivity seeing AI as valuable but remaining realistic about its limitations is essential. Such an outlook minimizes technostress by reducing fear without creating overdependence.

Importantly, our findings resonate with integrative models that examine AI literacy, attitudes, and stress together. Hsu et al. (2023), for example, proposed a sequential mediation model in which students' positive attitudes and AI literacy mediated the relationship between AI adoption and AI anxiety. Their results suggest that merely introducing AI into education is insufficient: outcomes depend on students' attitudinal and cognitive readiness. If AI adoption is supported by literacy training and attitude cultivation, stress is minimized; without these supports, stress and anxiety are likely to increase (Hsu et al., 2023). Our findings strongly reinforce this interpretation, emphasizing that both affective (attitudes) and cognitive (literacy) dimensions must be addressed to manage technostress effectively.

AI Literacy and Technostress

This study found a negative relationship between the Evaluation dimension of AI literacy (AI literacy) and technostress. The more critically and analytically students are able to evaluate AI tools, the lower their levels of technology-related stress. Recent research also shows that AI literacy strengthens students' relationship with technology and helps reduce technostress. In short, students who have a better understanding of AI experience less stress when interacting with these tools (Chukwuere & Chukwuere, 2024; Feng & Liu, 2024).

Multinational studies conducted among university students emphasize that insufficient ICT skills are among the main causes of technostress and burnout during online learning processes (Mohd Daud, 2024). The rapid advancement of AI tools can make it difficult for students to understand these systems, leading to feelings of uncertainty. However, as students' AI literacy improves, this uncertainty decreases, and they become more resilient in the face of new technologies (Steinbauer et al., 2021).

That said, the literature also suggests that this relationship is not one-dimensional. Individuals with high AI knowledge may become more aware of complex issues such as algorithmic bias, ethical concerns, and privacy risks, and this awareness itself can become a new source of stress (Stahl & Wright, 2018; Zhan et al., 2024). Therefore, AI literacy programs should not only focus on technical skills but also include ethical awareness and emotional resilience training.

In conclusion, AI literacy offers students significant advantages in understanding technology and managing the stress that comes with it. However, developing this competency should be approached through carefully structured and supportive strategies (Long & Magerko, 2020).

AI Literacy and Attitudes Toward AI

This study identified a significant relationship between AIL and students' attitudes toward AI. The findings show that students with higher levels of AIL tend to develop more positive attitudes toward AI technologies and experience lower levels of technostress. This suggests that digital competencies shape not only technical skills but also individuals' emotional responses and attitudes toward technology (Feng & Liu, 2024; Ng et al., 2021). Students with greater knowledge of AI tend to express less fear or skepticism, while those with limited understanding are more likely to hold negative attitudes such as mistrust or anxiety.

Ng et al. (2021) observed that individuals with low AI literacy struggled to recognize or use AI-related tools effectively, indicating that a lack of knowledge and negative attitudes often co-occur. (Ng et al., 2021). Long and Magerko (2020) further emphasize that AI literacy not only enhances technical understanding but also transforms how individuals think about AI; increasing knowledge, education, and analytical ability tends to foster more positive perceptions (Long & Magerko, 2020; Steinbauer et al., 2021). Accordingly, AI literacy education should incorporate not only technical content but also critical thinking, ethical awareness, and emotional readiness.

Moreover, the relationship between attitudes and literacy may be bidirectional. Positive attitudes toward AI can motivate individuals to learn more, increasing their literacy levels (Lacity & Willcocks, 2016). This is consistent with technology acceptance models (e.g., UTAUT), which suggest that past experience and perceived usefulness significantly shape user attitudes (Cengiz & Peker, 2025; Venkatesh et al., 2003). However, having a positive attitude does not always eliminate anxiety. In a study by Ayed et al. (2025), nursing students in Palestine expressed generally positive views of AI in healthcare, but also reported high levels of AI-related anxiety (Ayed et al., 2025). This paradox reveals that superficial positivity may coexist with underlying fears, such as concerns about job displacement or feeling unprepared to use AI tools. Therefore, AI education should address both cognitive and emotional aspects, equipping students not just with knowledge but also with the confidence and coping skills needed to manage AI-related challenges.

In conclusion, AI literacy plays a critical role in shaping students' attitudes and emotional responses to technology. Yet, given the complex and dynamic nature of this relationship, AI education should adopt a holistic approach that integrates knowledge, skills, ethical sensitivity, and psychological support.

AI Literacy Predictors Among Undergraduate Students

The regression findings are consistent with the growing body of literature on students' digital competence and technology adoption. Prior research indicates that students with higher academic performance often demonstrate stronger digital and technical skills, which supports the result that higher GPA predicts greater AI literacy. Recent studies have similarly reported that digital or digital-learning literacy positively influences college grades; for example, Chen et al. (2025) found that undergraduate digital literacy significantly and positively predicts GPA. Likewise, nursing students who feel confident in their digital abilities tend to achieve higher academic outcomes (Clercq et al., 2013; Hayat et al., 2020; Ulfert-Blank & Schmidt, 2022). These findings suggest that students with well-developed academic habits may also possess effective study strategies and stronger self-efficacy, which can facilitate the acquisition of new technologies.

A contrasting pattern was reported by Mansoor et al. (2024), who observed that lower-GPA students showed higher self-reported AI familiarity; however, the authors attributed this to at-risk students' overreliance on AI tools without critical engagement. In the present study, the positive association between GPA and AI literacy aligns with the broader literature on 21st-century skills.Strong information-technology proficiency likewise augments AI literacy. Our students' tech-confidence reflects digital competence that TAM/UTAUT models identify as crucial for new-technology uptake. In other words, learners comfortable with computers and online tools tend to engage more deeply with AI. Sergeeva et al. (2025) emphasize that individuals with advanced digital literacy "exhibit greater confidence in utilizing technology," which fosters more positive attitudes toward generative AI (Sergeeva et al., 2025). Rodafinos et al. (2024) likewise found that basic ICT skills strongly predict students' intention and willingness to use learning technologies (Rodafinos et al., 2024), even if the link to grades was indirect. Taken together, these studies suggest that undergraduates who are competent with digital media and devices can more easily acquire and apply AI concepts, explaining our finding that IT proficiency is a significant AI literacy predictor.

Attitudes toward AI powerfully modulated students' literacy in our model. This too echoes prior work: positive AI attitudes are consistently linked to greater engagement and understanding. Bewersdorff et al. (2025) report that favorable attitudes toward AI substantially boost students' interest and self-efficacy around AI (Bewersdorff et al., 2025). More directly, Cengiz and Peker (2025) found that a positive attitude toward AI "can positively affect AI literacy," while negative attitudes do the opposite. In their structural model, negative AI attitudes significantly reduced AI literacy scores (Cengiz & Peker, 2025). These findings are consistent with technology-acceptance theory: students who view AI optimistically are more likely to try and learn it, whereas distrust or anxiety about AI creates a barrier to skill development.

Overall, the findings indicate that AI literacy among undergraduates is shaped by a combination of academic skills, technical competencies, and affective dispositions. This pattern aligns with evidence reported across multiple countries; for example, studies from China and Russia demonstrate that digital-literacy competencies support learning outcomes (Chen, 2025; Sergeeva et al., 2025), while Western surveys document similar associations between AI-related attitudes and efficacy (Bewersdorff et al., 2025). The contribution of the present study lies in illustrating how these factors operate simultaneously within a single regression model, suggesting that students with higher academic achievement, stronger digital backgrounds, and more positive attitudes toward AI may be better prepared for AI-integrated learning environments. These results further imply that educational programs aiming to enhance AI literacy should extend beyond teaching AI concepts to strengthening general academic skills and fostering balanced, realistic attitudes toward AI. In summary, the findings are consistent with previous research indicating that 21st-century learning depends on multifaceted digital competence (Chen, 2025; Khan et al., 2022), and they highlight that the promotion of AI literacy requires integrating both skill development and attitudinal components.

4.2. Limitations and Recommendations

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design restricts causal inferences. Although significant associations were identified between AI literacy, attitudes toward AI, and technostress, the directionality of these relationships cannot be determined. Longitudinal or experimental research designs are recommended to better capture causal pathways and the temporal dynamics of these variables. Second, the study was conducted at a single university in Türkiye, which may limit the generalizability of the results. Although the sample size was adequate and included students from various faculties, cultural and institutional characteristics may have influenced participants' experiences with AI. Future research would benefit from multi-center and cross-cultural studies to enhance external validity and enable international comparisons. Third, all data were collected through self-report instruments, which may introduce biases such as social desirability or inaccuracies in participants' perceptions of their digital competence and attitudes. The incorporation of mixed-methods approaches such as behavioral tracking of AI tool use, qualitative interviews, or focus groups could provide deeper insights into actual practices and subjective experiences. Fourth, the focus of the study was primarily on cognitive and attitudinal dimensions of AI integration. Other contextual factors, including institutional support, instructional strategies, and access to technological resources, were not examined. Future studies may expand the scope to include these structural variables, which are likely to play an important role in shaping students' adaptation to AI technologies.

Based on these limitations, several recommendations can be made. Higher education institutions are encouraged to develop and implement AI literacy programs that extend beyond technical training to include ethical awareness, emotional resilience, and strategies for managing technostress. Educators may support the development of balanced attitudes toward AI by emphasizing both its opportunities and potential risks, thereby preventing excessive anxiety or overreliance. Policy makers and curriculum designers should consider integrating AI-related content across disciplines to ensure that students from diverse academic fields acquire competencies necessary for future professional and civic life. Finally, collaboration among researchers, practitioners, and technology developers is essential for creating evidence-based interventions that promote students' digital well-being and academic success in the AI era.

Research and Publication Ethics Statement

The study was carried out in accordance with ethical principles governing research with human participants. Ethical approval was obtained from the Scientific Research and Publication Ethics Committee of Artvin Çoruh University prior to data collection (Approval Date: 13 June 2025, Decision No: E-18457941-050.99-181922).

Contribution Rates of Authors to the Article

The research was prepared by a single author

Statement of Interest

There is no conflict of interest.

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How Should Innovative Schools Be in the 21st Century?*

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ABSTRACT

In the 21st century, rapid technological advancements and digital transformation have significantly impacted education, making innovation a central component of modern educational systems. Creating a school culture that values and sustains innovation has become increasingly important. This study explores the structural characteristics of innovative schools from the perspectives of school administrators who are actively leading innovative efforts. Employing a qualitative research design based on the phenomenological method, data were collected through focus group interviews. The participants consisted of 11 school administrators specializing in educational management, selected through criterion sampling. A semi-structured interview form with open-ended questions was developed by the researchers to guide the focus group discussions. The data obtained were analyzed through content analysis using the MAXQDA 2020 qualitative data analysis software. The findings of the study were categorized under six main sub-dimensions: the defining characteristics of innovative schools, the roles of innovative school managers, the contributions of teachers and parents to the innovation process, the outcomes of innovative educational practices, and practices that should be adopted or avoided in innovative school environments. The study contributes to the understanding of how school leadership shapes and sustains innovation, offering insights for policymakers and practitioners aiming to foster innovation in educational settings.

Keywords: Innovative Schools, Innovation in Education, Innovation, 21st Century Skills, Focus Group Study

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1. INTRODUCTION

In the 21st century, there have been technological improvements and digital transformations in every field of our lives together with the changing and improving world order. In an information age where societies go from agriculture to industry and then become information society and where technology is at the center nowadays, rejuvenescence and innovations have become inevitable in all branches such as education, health, industry, environment, politics. Information develops the basis of innovation and innovation develops the production of information (Kermally, 2004, p. 105). The key to achieving organizational differentiation and productivity in this process lies in creativity and organizational innovativeness. Organizations, who succeed in adopting innovative culture and establishing such a structure, acquire important achievements related to adaptation with their environment and developments (Erdoğan, 2012, p. 2).

Innovation is the process of creating a new product, process, service, method, technique and practicing the aforesaid innovations. (Bodur, 2019). Innovation is the key to economic growth, increasing employment and life quality. All kinds of companies operating in all sectors need innovations in all business lines (Elçi, 2010). Innovation seems to be an important building stone in the agenda of all countries, governments and organizations in the 21st century. Governments and businesses allocate more resources to research-development and innovative strategies in almost all business lines to hold their positions in the market and, even, to move further and to increase their power of competition. (Gül, 2018). Products put forth because of innovative studies ensure the fulfillment of the needs of people in a more effective way. For example, innovations in the medical field make people benefit from health services in a better way, the innovations in the automotive sector make transportation easier (Aslaner, 2010).

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Innovativeness is very important to ensure sustainable growth, social welfare and employment in a country. For that reason, the setting needed for innovation should be created in a country. Innovativeness policy has emerged as a mixture of science & technology policy and industrial policy. Innovativeness has become the focus of governmental policies as its importance has been understood in so many countries, developed countries being in the first place. Countries, which have noticed the importance of innovativeness at the present time, provide necessary investments with legal and administrative regulations needed for the companies to conduct their innovativeness operations successfully and by promoting resource allocation for innovativeness (Açıkgöz Ersoy & Şengül, 2008).

Changes and innovations in technology alone are not sufficient for social transformations to be productive and effective. Education, as the fundamental structure of society, should also be updated in coordination with the aforementioned factors (Öztemel, 2018). Education has always been important across all societies. It requires not only reflecting on the past but also moving beyond the present and focusing on the future, thereby guiding the next generations in this direction. In this sense, education serves as a means of reconstruction for both individuals and society (Balay, 2004). The process of transition from an industrial society to an information society and the corresponding changes in education are presented in the following table.

Table 1.
Changing Education Model

Criterion	**Industrial Society Education Model**	**Informational Society Education Model**
Teacher	Knowledge Transmitter	Leading, Advisor
Student	Passive, Individual Study	Active, Cooperation
Manager	Management Leader	Educational Leader
Learning Method	Class learning	Individual research
Learning Form	With Individual Studies	Teamwork
Training Programs	Standard Programs	Changing Programs
Development	In-service Education	Organizational Learning
Success Criterion	Measurement of Memorized Information	Multidimensional Thinking

Resource: (Aytaç, 1999, p. 75).

In modern ages as summarized above in Table 1; it is aimed that measurements would be made by thinking with changing programmes and multi-dimensional concepts where the student is active ever after, the teacher is the leader, the manager is the teaching leader, and the teamwork is dominant.

Schools are open systems that are in a considerable amount of interaction with the individual, society and its surroundings. While rejuvenescence is aimed at all lines and organizations with the developing science and technology, schools which are open for development, change and innovations are also affected as there are innovations in the field of education. (Aslan & Beycioğlu, 2010). In schools, innovation requires innovative individuals, culture, climate, structures, and processes, together with continuous development, risk-taking, and the creation of new products (Watt, 2002). Schools that resist innovation cannot develop or adapt to their environment and therefore risk becoming isolated (Bodur, 2019). A supportive social environment, adequate resources, and a common culture with a shared vision and mission should be provided in order to ensure continuous renewal in schools and to integrate them into an innovative school culture. All stakeholders should be involved in this process of innovation, under the guidance of a strong leader who can create such an environment and foster intrinsic motivation to overcome barriers (Kirkland & Sutch, 2009). Innovation also requires changes in the structures of schools and learning environments. Schools, as educational institutions, must have a multi-functional structure that is always open to innovation, where knowledge is produced, used, and developed; where teamwork provides confidence; ensuring accessibility at all times; and where the information needs of society are met while fostering students' original and creative thinking.

Developing science and technology bring about change and innovation to the various areas of society. Bringing change into life and its adaptation are included in the change and innovation in terms of practice, in schools. For that reason, innovative schools are organizations who have adopted innovation as a vision and who have already created an innovative climate (Tezcan, 1998). Innovative schools contribute to the development of the educational system and thus, they help for the growth of highly qualified talents. Raising individuals, showing and developing their talents, transferring social values, culture and functions to future generations are some of the important functions of a school. Educational organizations are expected to bring those functions into practice by developing and renewing themselves (Özçiçek, 2016). An innovative school could be defined as an institution which shows tendency for being open to change and development, where a new idea, practice, teaching principles and methods, teaching technologies and understanding of all life learning are adopted (Kocasaraç & Karataş, 2018). Generally, if we are to list the characteristics of innovative schools, it should be thought of as a sum of structure of the school, learning areas, managers, teachers, students and parents. Structure, goals, learning areas, learning and teaching processes should be designed according to these characteristics in order to raise teens who would be able to keep pace with the changing speed of world.

A school manager should be a leader who is openminded, initiator and pragmatic at the learning environment, in need of innovation, aware of needs, setting new goals for education, bringing technological developments to the school by following them, providing flexibility for studies, able to see the school as a whole with everything in it and attempting for the changes (Aslan & Beycioğlu, 2010). Teachers teach students how to reach the information and how to benefit from the same, within the process of innovation. The teacher should aim and support learning of the student. He should take action in accordance with the learning style of each student and by taking his/her talents into consideration. They should organize a learning environment of students, which would motivate individual interests of students, and which is enriched by technology where students would be able to evaluate their own goals, learning and processes (Cansoy & Turan, 2021, p. 51).
Numanoğlu (1999, p. 348) defined innovative teens of 21st century as the ones who are able to use technology in the best way, have the spirit of teamwork, could take place in different projects, could think in a different and unique way, could think, research and question continuously while having respect for other ideas with high level of imagination. If we would like to raise teens who will change the world, we should take care of how we take action as mothers and fathers and we should not make this according to the past times and the period we lived, rather, we should prepare and raise them according to the future where they will have a voice.

In addition to structural and cultural dimensions, innovative schools also need to be examined through the lens of curriculum development. Program development principles—consistency between objectives, content, learning processes, and assessment—provide a framework that can integrate 21st century skills into educational practice (Ornstein & Hunkins, 2018). Skills such as critical thinking, creativity, collaboration, communication, problem solving, and digital literacy require curricula that emphasize active learning, interdisciplinary approaches, and project-based or inquiry-driven methods (Trilling & Fadel, 2009; Voogt & Roblin, 2012). Similarly, assessment in innovative schools should move beyond memorization and standardized tests toward alternative approaches such as performance-based evaluation, portfolios, and formative assessment tools that better capture students' ability to apply knowledge in authentic contexts (Pellegrino & Hilton, 2012). While previous studies have highlighted certain features of innovative schools, fewer have explicitly linked these features to curriculum design and instructional practices that directly cultivate 21st century competencies. Addressing this dimension is therefore essential for understanding how innovative schools can systematically support student learning and long-term educational outcomes. This perspective emphasizes that innovative schools should not only adapt their organizational structures but also redesign their curricula to ensure coherence between educational aims and the competencies demanded by the 21st century.

In the direction of increasing need for information and demand of education, as necessities for the educational system and technological developments have increased, there is a need for educational innovations (Çiftçi & Gündüz, 2016). Standards should be increased, new resources should be found, and some changes should be made for the educational innovation, however those would not be sufficient (Özdemir, 2019: 36). The means of educational system, schools, should be restructured in accordance with the needs of each and every period and those should not stand behind the times. Societies are in need of more young people who have skills of 21st century in the area of science, technology and engineering, who do not memorize information, rather who is able to produce information and make difference with innovation (Wagner, 2016). Governments should transform schools into innovative schools by adopting the educational system and schools to innovate. A deep analysis is needed in order to define innovative school characteristics of schools and related to how all stakeholders should be.

Although both national and international studies have examined the concept of innovative schools (Beycioğlu, 2004; Giles & Hargreaves, 2006; Aslaner, 2010; Bülbül, 2012; Mishra, 2014; Aslan & Kesik, 2016; Morente et al., 2018; Bodur, 2019; Dağhan, 2019; Vincent-Lancrin et al., 2019; Lewis & Basford, 2020; White & Noble, 2020; Yaşar, 2020), many of these works focus on specific elements such as teacher practices or technological applications, and only a limited number consider the perspectives of different stakeholders together. There is still a need for studies that discuss the structural features of innovative schools in relation to the roles and responsibilities of administrators, teachers, students, and parents in a more integrated way. Unlike prior studies that have examined innovation primarily from a technological or instructional perspective, this study highlights the organizational and stakeholder-related dimensions of innovative schools, thereby offering a more holistic framework.
In this context, the present study aims to contribute to literature by combining findings from previous research with qualitative data gathered from school administrators who are directly involved in innovation processes. Through this approach, the study offers a more comprehensive view of the characteristics of innovative schools and sheds light on the ways in which various stakeholders can support and sustain innovation. This contribution is expected to enrich both the theoretical discussions and the practical understanding of innovation in educational settings.

2. METHODOLOGY

The pattern of phenomenology (phenomenological) of qualitative research methods has been used in this research. Qualitative research is a mode of study where data is obtained by the researcher directly from its source, according to the understanding and interpretation of participants in order to understand facts and events deeply (Büyüköztürk et al., 2016). In research on phenomenology, researchers analyze perspectives of individuals towards a specified matter of fact, one to one, and reach conclusions according to their individual experiences and practices. In this research method, data is generally collected from interviews (Fraenkel et al., 2012). Phenomenological studies may not yield entirely accurate results according to the structure of qualitative research methods; however, conceptualization of the data and achievement of themes according to the facts are

aimed at analysis (Ak, 2020). The focus of these studies, which are conducted within the concept of phenomenology, is represented by "innovative schools."

2.1. Participants

As qualified and enriched data is aimed to be reached for the sampling selection of the research, parameter sampling method was used for the specification of sampling and working group. Intentional sampling gives chance to deeper research by selecting equipped people or cases in terms of information and experience depending on the purpose of the study. In criterion sampling, individuals, events or cases, intended with specified characteristics in terms of the area to be reviewed in the research, are formed (Büyüköztürk, 2016). According to the parameter sampling, 11 school managers composed of 4 males and 7 female managers who are found at city center of Istanbul and who are experienced at education and teaching with at least ten years of experience and who are professionals at the said area, are selected. The number of participants (11 school managers) was determined in accordance with the methodological standards of focus group studies, which generally include between 6 and 12 participants (Krueger & Casey, 2000). This range ensures that the discussion remains manageable while still allowing for the inclusion of diverse perspectives. In this study, the selection of 11 participants enabled the representation of managers from different school types (public and private, as well as primary, secondary, and high schools) and contributed to maintaining a dynamic focus group interaction. The chosen size provided a balance between diversity and depth: a larger group could have made the discussion difficult to manage, whereas a smaller group might have limited the variety of views. Data saturation was considered achieved when recurring codes and themes began to emerge and no new categories or perspectives were identified, confirming that the sample size was adequate for the purposes of this study.

As the focus group interview was conducted, no advance information was given to the managers regarding the questions, and participation was based on voluntary participation. Demographic information of participants is shown in Table 2.

Table 2.
Demographic Information

Participant	Gender	Age	Professional Seniority	Educational Background	Corporation of his/her Job	Title at School
K1	F	46	23	Postgraduate	Government-High School	Assistant Manager
K2	M	45	22	Postgraduate	Government-High School	Assistant Manager
K3	M	43	21	Postgraduate	Government-Primary School	Manager
K4	F	39	18	Postgraduate	Government-Primary School	Assistant Manager
K5	F	47	19	Postgraduate	Government-Kindergarten	Assistant Manager
K6	F	41	21	Postgraduate	Private-Primary School	Manager
K7	F	38	17	Postgraduate	Private-Second. School	Manager
K8	M	47	22	Postgraduate	Government-High School	Manager
K9	M	42	18	Postgraduate	Government-High School	Manager
K10	K	47	24	Postgraduate	Private-High School	Assistant Manager
K11	K	38	16	Postgraduate	Government-Primary School	Assistant Manager

As seen in Table 2, there are four male (36.3%) and seven female (63.7%) school managers in the working group. The ages of school managers in the working group range between 38 and 47, and their professional seniority ranges between 16 and 24. All school managers in the working group are postgraduates. Eight of them work in government schools and three in private schools. Finally, the working group is composed of 11 managers, six of whom are assistant managers and five are managers.

2.2. Data Collecting Tool

In the research, focus group interview was made in order to analysis structure and characteristics of innovative schools deeply according to the opinions of school managers. In this interview, semi-restructured interview form developed by researchers was used. Semi-restructured interview form is composed of two sections. In the first section, demographic information was asked to define gender, age, professional seniority, educational background of school managers, the institution they work and

their job descriptions at school. In the second section, six different open-ended questions which were developed as a result of the scanning of the literature were asked. Prepared questions were analyzed by a professional and a professional opinion was taken, and a pilot practice was made with 2 participants and questions were finalized by taking care of issues such as clarity of questions, competence of responds.

2.3. Data Collection: Focus Group Interview Process

Research data was made by taking approval from Istanbul Provincial Directorate for National Education for the work permit in the teaching period of 2020-2021 and on the basis of, especially, voluntariness. The interview form prepared for the research was made in the form of focus group interview together with 11 school managers selected in accordance with purposeful sampling and by preferring the pattern of phenomenology of qualitative researching methods. The aim of the focus group interview is to obtain deep and multi-dimensional qualitative information related to the point of view, experience, attitude, thought and habits of participants in respect of any subject matter. According to Krueger & Casey (2000); focus group interviews could be explained as a discussion platform planned for learning ideas of a group of participants who were selected beforehand in respect of any subject which was also determined beforehand.

Following steps were taken for the focus group practice process in the research (Şahsuvaroğlu & Ekşi, 2013):
Step 1: Researcher designates the subject, agenda and plan.
Step 2: Researcher determines with whom the interview would be made, who would be selected and questions and order of questions for the interview.
Step 3: Place, time of the focus group interview, the professional and supervisor who would be managing the interview are determined. According to the plan, the session is completed within the course 2-3 hours with 3-4 general and 2-3 deeper questions.
Step 4: In the last part, the interview is summarized, and the content analysis of obtained data (supervisor's short notes, voice or image records) is made and then the research is reported (Akşit, 1992).

While focus group interview questions were prepared for this research as a data collection tool, draft questions were developed by the researcher based on a review of the literature related to innovative schools. The questions were analyzed by a professional, and his/her opinion was taken into consideration to ensure the validity of qualitative analysis questions. A pilot study was conducted with two participants. The interview form, composed of six open-ended questions, was prepared by considering the clarity of questions and the competence of responses. The following questions were designed to serve the purpose of the researcher.

1. Have you heard of the concept of an innovative school? What do you think about this concept?
2. What should be the difference of development model of an innovative school from other classical schools, in terms of the relation between curriculum, operation, parents, students, teachers and managers?
3. What should be the manager's and teacher's role in the concept of innovative school?
4. What should be the role and share of parents in the concept of innovative school?
5. What are the short-, mid- and long-term achievements aimed for the students in the innovative school model?
6. What should/should not be done in innovative schools?

Before collecting data with focus group interview in the direction of the study conducted, interviews were organized with all participants by contacting them through telephone, e-mail or short message. As there are an extraordinary situation and Covid-19 epidemic around the world, group interview was made with ZOOM application in the direction of all necessary permits. Before the interview began, aim of the research was explicitly told to the participants and it was said that they could leave the interview at any time they would like and withdraw their participation in the research, by paying regard to the conscious consent. No participant left the interview in this context. Interviews were recorded by taking consent of participants, without any name and identity information, to contribute to the study.

Questions related to the innovative schools were asked to the managers and they were guided by making necessary explanations where needed. Responses of all participants were taken for each and every question. An environment was established for each participant for the discussion of concepts and subjects, in such a way that they would present their opinions freely; therefore, different aspects of the subject could be discussed. After the session was ended, data was put down on paper by the researcher by analyzing the camera records.

2.4. Data Analysis

Qualitative data analysis involves the systematic transformation of raw data into meaningful findings and their interpretation (Patton, 2014). In this study, the collected data were analyzed using the content analysis technique, guided by the principles of thematic analysis (Braun & Clarke, 2006). The main purpose of content analysis is to reach concepts and relationships that can explain the data in depth.

The analysis followed several systematic stages. First, the interview transcripts were read repeatedly for familiarization, and initial notes were taken. In the stage of open coding, the text was examined line by line and meaningful units were labeled with preliminary codes, aiming to capture the richness of participants' expressions without imposing pre-defined categories. These codes were then compared and organized during axial coding, where conceptual similarities were grouped, overlapping codes were merged, and relationships among codes were established. This process corresponded to Braun & Clarke's generating and reviewing codes steps (Braun & Clarke, 2006). In the subsequent stage, broader categories were developed into themes and sub-themes, representing the central patterns that explained the data (selective coding). These themes were reviewed, defined, and named in line with the thematic analysis framework, ensuring both internal coherence and external distinctiveness. Finally, the analysis was reported with illustrative quotations, tables, and visual models to strengthen the interpretive validity of the findings.

To support systematic analysis, the qualitative data analysis program MAXQDA 2020 was employed. Transcribed data were imported into the program, where codes were systematically assigned, retrieved, and organized. The software was further used to conduct frequency analyses, examine co-occurring codes, and generate visual outputs such as code maps, matrices, and models. These functions enhanced transparency, enabled the traceability of analytical decisions, and supported the clear presentation of themes in the findings section (Çakır & Saritas, 2017).

2.5. Validity and Reliability

In qualitative research, validity and reliability are strengthened through strategies that enhance the accuracy, consistency, and credibility of the findings. In this study, several measures were implemented to ensure methodological rigor. First, focus group interviews were conducted on a voluntary basis, and participants were fully informed about the purpose of the research and their right to withdraw at any stage. Informed consent was obtained, and confidentiality and anonymity were guaranteed. The session was both video- and audio-recorded with participants' permission and monitored by the moderator and a rapporteur simultaneously, ensuring that no data was lost. These procedures encouraged participants to provide authentic and candid responses, thus enhancing the credibility of the data (Yıldırım & Şimşek, 2011).

To preserve participants' voices, the interviews were transcribed verbatim and systematically documented. Member checking was applied by sharing summary notes with selected participants to confirm that the interpretations reflected their perspectives accurately (Lincoln & Guba, 1985). Furthermore, data analysis was conducted with MAXQDA 2020, and coding was performed by the researcher and reviewed by an independent qualitative research expert. In order to ensure coding reliability, the transcripts were independently coded by the researcher and a second qualitative research expert. After comparing the codes, discrepancies were discussed until a consensus was reached. Inter-coder agreement exceeded the 80% threshold generally accepted in qualitative research (Miles & Huberman, 1994), indicating a high level of consistency in the analysis.

Methodological rigor was further enhanced through prolonged engagement and persistent observation. Participants were contacted and briefed before the session, and sufficient time was devoted during the focus group to explore themes in depth (Krueger & Casey, 2000). Reflexivity was also maintained, as the researcher continuously reflected on her own role and potential biases throughout the process. Finally, the consistency of emerging themes was cross-checked with the literature to establish both internal coherence and external validity. Taken together, these strategies contributed to the credibility, transferability, dependability, and confirmability of the study (Lincoln & Guba, 1985).

2.6. Researcher's Role

In this study, the researcher undertook responsibility for the overall design and implementation of the research process. She identified the research problem, developed and refined the semi-structured interview form, secured official permissions, and organized the focus group interview. During the session, the researcher assumed the role of observer and rapporteur, ensuring ethical compliance and systematic documentation of the discussions. In the analysis phase, interviews were transcribed verbatim, coded, and thematically analyzed using MAXQDA 2020. Reliability was enhanced through collaboration with an independent qualitative research expert. Throughout the process, the researcher-maintained reflexivity, critically evaluating her own assumptions and minimizing potential biases, thereby contributing to the methodological rigor and integrity of the study.

3. FINDINGS

In this section, questions of the research are presented under six themes by analyzing responds of participants to open-ended questions which were asked in focus group interviews. These themes are as follows: (1) characteristics of innovative schools, (2) innovative manager, (3) innovative teacher, (4) innovative parent, (5) achievements in innovative schools, (6) what should/should not be done in innovative schools. This figure 1 presents the hierarchical code–subcode structure that emerged from the focus group interviews. It visualizes how participants conceptualized the characteristics of innovative schools by grouping related codes under broader categories, thereby illustrating the main dimensions of innovation in educational settings.

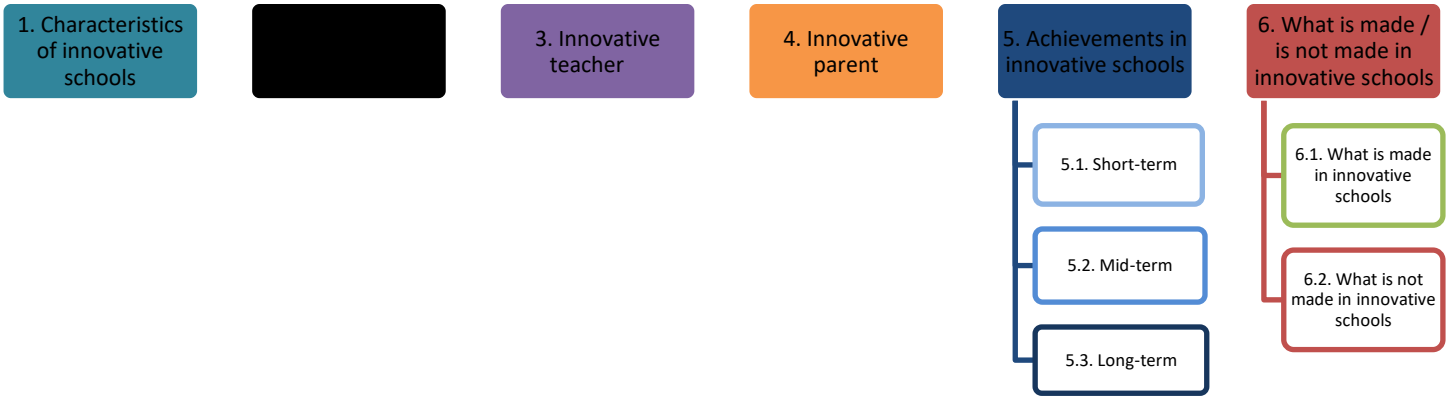


Figure 1. Main themes and sub-themes

Characteristics of Innovative Schools: The codes derived from participants' responses to the question "What are the characteristics of the concept of an innovative school?" are presented in Figure 2 according to the hierarchical code–subcode model.

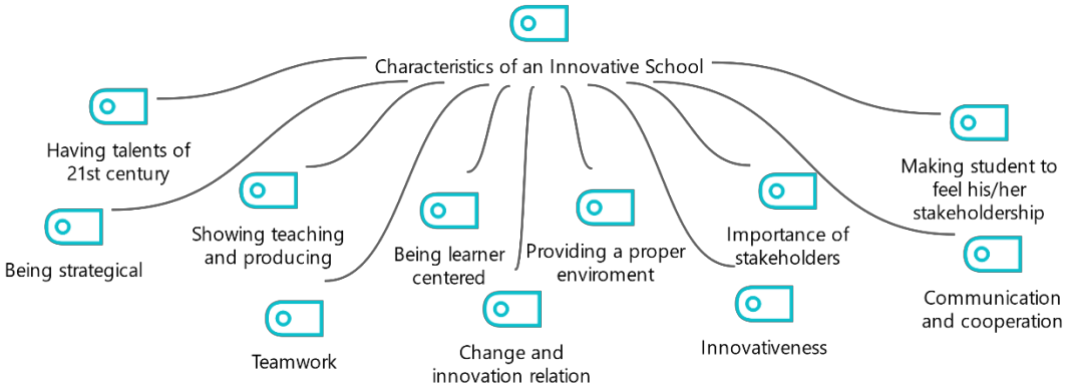


Figure 2. Characteristics of an innovative school

Figure 2 presents the hierarchical code–subcode model derived from participants' responses, showing how school managers conceptualized the characteristics of innovative schools. The figure highlights dimensions such as 21st-century skills, strategic orientation, teamwork, learner-centered approaches, stakeholder involvement, and effective communication.
The participants' views provided deeper insights into these characteristics. Some illustrative quotations are presented below:

> *K5: ...I think a school which is open to new ideas when one says innovative school. And I think this should be a free school which ensures people production new ideas by suggesting debates.*
> *K8: This could be a school and a manager who have new approaches, who are able to say different things by taking support of the classical one, who are open to development, who can adopt themselves to developments and who are leading new developments.*
> *K7: Children should not be raised according to the period you lived; they should rather be raised according to the period they will live. And with this saying, they should be innovative, each school manager, instructor, and even parents could take a share from this cake. It would be beneficial if innovations are made by taking care of our national and moral values.*
> *K11: Innovative schools should be productive instead of transferring information. We should raise generations who have the ability of solve problems and analyze problems. We should understand the information and carry this to the process of analyzing ... Other than that, we should produce new ideas, and these ideas should be put into practice. Risks should be taken.*

These findings suggest that innovative schools are perceived not only as institutions that adopt technological tools but also as holistic learning environments where collaboration, stakeholder engagement, and learner-centered approaches are prioritized.

Innovative Manager: The codes created from participants' responses to the question "How should managers and teachers be in innovative schools?" are shown in Figure 3 according to the hierarchical code–subcode model.

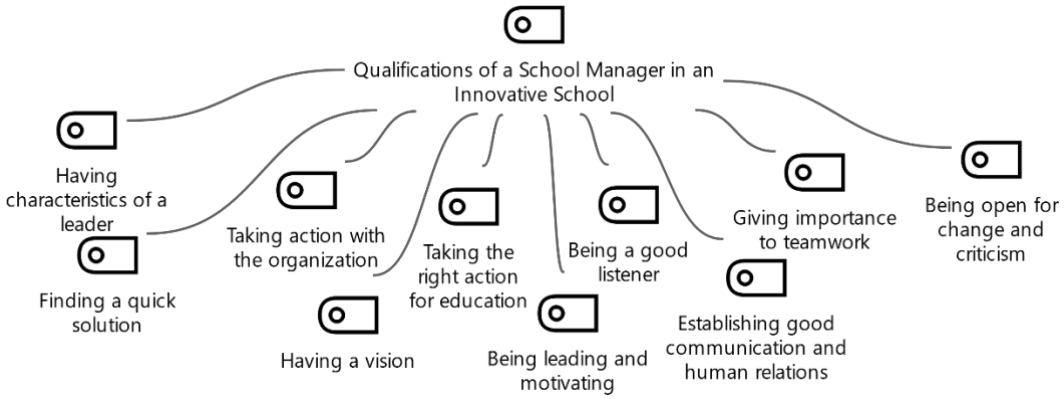


Figure 3. Qualifications of a school manager in an innovative school

Figure 3 illustrates the key qualifications attributed to managers in innovative schools. It visualizes how participants emphasized leadership, openness to change and criticism, effective communication, teamwork, problem-solving, and vision as essential managerial qualities to sustain innovation in educational settings.
The participants' views provided deeper insights into these qualifications. Some illustrative quotations are presented below:

> *K3: Manager of an innovative school should have a good communication and human relations. He/she should take decisions together with the whole organization. He/she should be giving accounts. Both school managers and teachers should give importance to feedback. Managers should give importance to teamwork at school. They should be cooperative. Especially, school managers should have control over the corporate organizational memory.*
> *K7: I think an innovative manager should always be open to change. At the same time, he/she should be open to criticism. He/she should add his/her own vision and point of view into the system and should specify the management system.*
> *K10: Manager should first of all be a good listener. He/she should be motivating and giving confidence, I have always believed that. He/she should create opportunities. He/she should improve himself/herself. He/she should not lose his/her respectability. He/she should see and appreciate good works and should set an example where necessary. He/she should know her team very well. And he/she should absolutely have goals.*

These findings highlight that the role of an innovative manager extends beyond administrative duties, emphasizing leadership, vision, and the ability to foster teamwork and open communication, which are essential for sustaining a culture of innovation in schools.

Innovative Teacher: The codes created from participants' responses to the question "How should managers and teachers be in innovative schools?" are shown in Figure 4 according to the hierarchical code–subcode model.

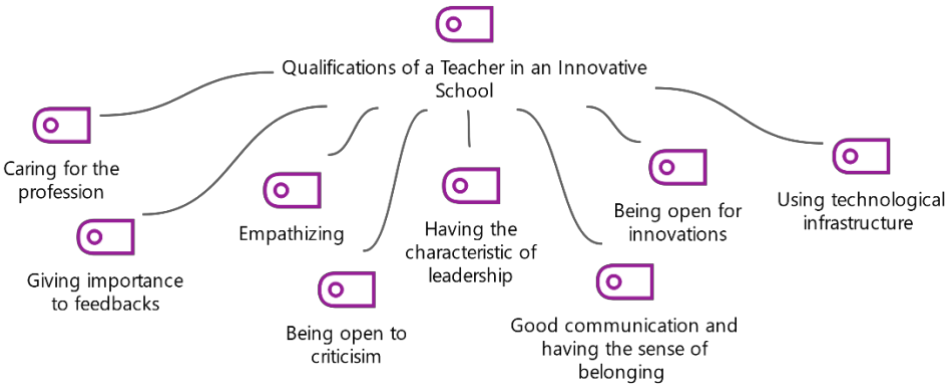


Figure 4. Qualifications of a teacher in an innovative school

Figure 4 presents the main qualifications attributed to teachers in innovative schools. It highlights dimensions such as professional commitment, sense of belonging, effective communication, empathy, openness to criticism, receptiveness to feedback, use of technological infrastructure, and willingness to embrace innovation. These qualities illustrate how participants perceive teachers as central actors in shaping and sustaining innovative school culture.

The participants' views provided deeper insights into these qualifications. Some illustrative quotations are presented below:

> *K9: Innovative teacher should absolutely care for his/her profession and should embrace his/her institution …If teacher feels that he/she is valuable, he/she will embrace. Precondition of innovative teacher is, again, reading. The one who is not reading could not bring any innovation.*

K6: Teacher should be able to produce projects, open to innovations, self-confidence, compatible with the team, embrace the institution, open to improvement, embrace his/her job at the same time and again he/she should be open to empathy and criticism. Both manager and the teacher should be open to empathy and criticism and embrace the institution.

These findings indicate that innovative teachers are not only defined by their openness to change and technological integration, but also by their strong professional commitment, empathy, and collaboration, which position them as central actors in fostering an innovative school culture.

Innovative Parent: The codes created from participants' responses to the question "How should parents be in innovative schools?" are shown in Figure 5 according to the hierarchical code–subcode model.

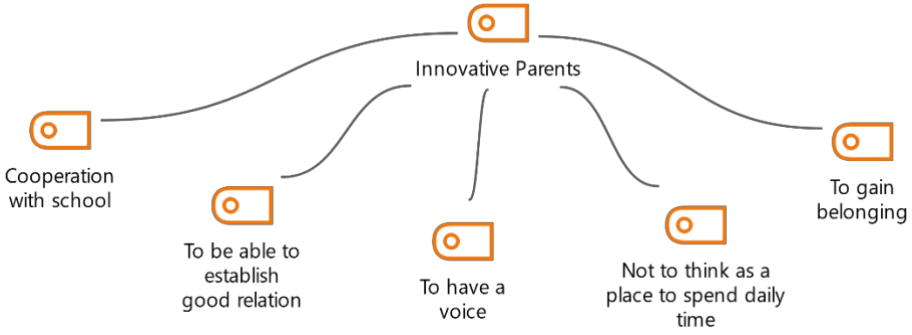


Figure 5. Innovative parents

Figure 5 illustrates the qualities attributed to parents in innovative schools. It highlights their role as stakeholders who build a sense of belonging, participate in decision-making, maintain close cooperation with the school, and embrace technological as well as social changes. The figure emphasizes that parents are expected to go beyond passive involvement and actively contribute to shaping school culture.

The participants' views provided deeper insights into these qualifications. Some illustrative quotations are presented below:

K2: Trainings for parents, projects of the type of parent academies and even parent meetings are held both face-to-face and online in order to make the parent feel as a stakeholder of the school. The parents should have all this technological infrastructure, technology-able education and thought structure.
K5: It should make the parents feel that they have a part to play in this organization and integrate with it. In the success of innovative processes, the parent should be able to take part in the decisions taken and be willing to bear this responsibility. In innovative schools, parents should be willing and prepared to embrace change and differences.
K1: Parents should be ready for development and aware of technological developments. Especially in recent times, parents have been a major stakeholder in school administration. It is intertwined with the school administration, especially thanks to the training programs applied to parents. Since the school carries out its communication with the parents via social media, message and e-mail, it is obvious that it is a stakeholder.

These findings underline that innovative parents are perceived as active stakeholders in school life, contributing to decision-making processes and embracing technological and social changes, which reinforces the collaborative dimension of innovative school culture.

Achievements in Innovative Schools: The codes created from participants' responses to the question "What could be short-, mid-, and long-term achievements aimed to be brought to the students in the Innovative School Model?" are shown in Figure 6 according to the hierarchical code–subcode model.

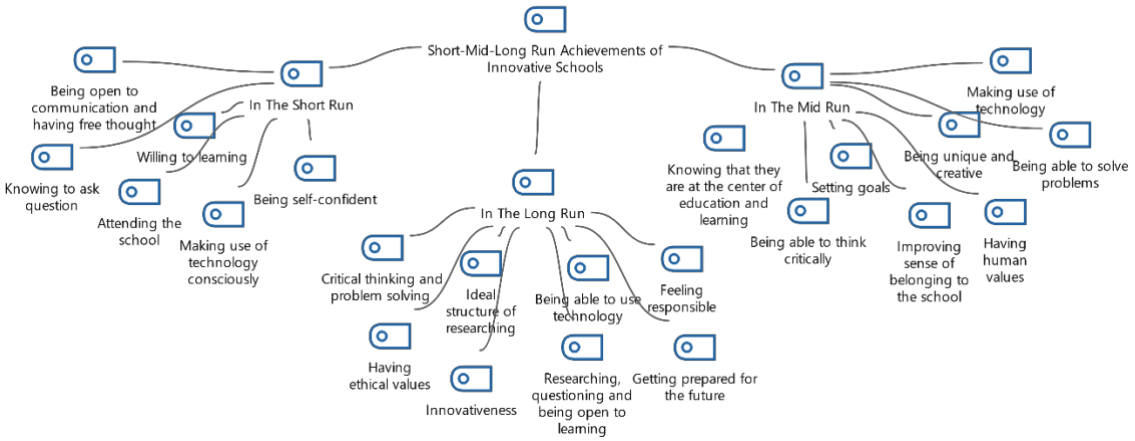


Figure 6. Short-mid-long run achievements of innovative schools

Figure 6 illustrates how participants conceptualized the expected achievements of innovative schools over time. In the short term, students are expected to develop conscious technology use, open communication, curiosity, and self-confidence. Mid-term goals focus on critical thinking, problem-solving, creativity, and a strong sense of belonging. Long-term achievements emphasize responsibility, moral and human values, effective use of technology, and readiness for future challenges. The figure demonstrates the progressive and holistic development trajectory envisioned for students in innovative schools.
The participants' views provided deeper insights into these achievements. Some illustrative quotations are presented below:

> *K11: It will teach the student to use technology in the short term but to use it consciously. Then, in the medium term, he will realize that he is in the education and training center. In the long term, we will see an individual who thinks, questions, research, and is open to learning.*
> *K5: Students in the short term; by arousing interest and desire to learn, it is necessary to enable them to discover ways of learning and to find ways in which they can express themselves. In the medium term, Gains should be targeted to make him realize how to position himself as an individual and to have universal values. It should ensure that it can keep up with the development with changing technology and knowledge. In the long run, it promotes the development of communication, intercultural understanding and global connection skills necessary for 21st century life.*
> *K4: Short: Instead of just hearing the information from the teacher, he should have access to the information himself. He should be able to investigate and draw conclusions. Medium: Be able to solve the problems it encounters and propose solutions. Long: They are individuals who produce, question, wonder and research long-term gains.*

These findings demonstrate that the innovative school model aims to cultivate students' skills progressively across short-, medium-, and long-term horizons, integrating technological literacy, critical thinking, creativity, and social responsibility. This layered perspective highlights how innovative schools contribute not only to immediate learning outcomes but also to the long-term preparation of students as globally competent and future-ready individuals.

What is made / is not made in Innovative Schools?: The hierarchical codes created from participants' responses to the question "What is made / is not made in innovative schools?" are shown in Figure 7 and Figure 8 according to the subcode model.

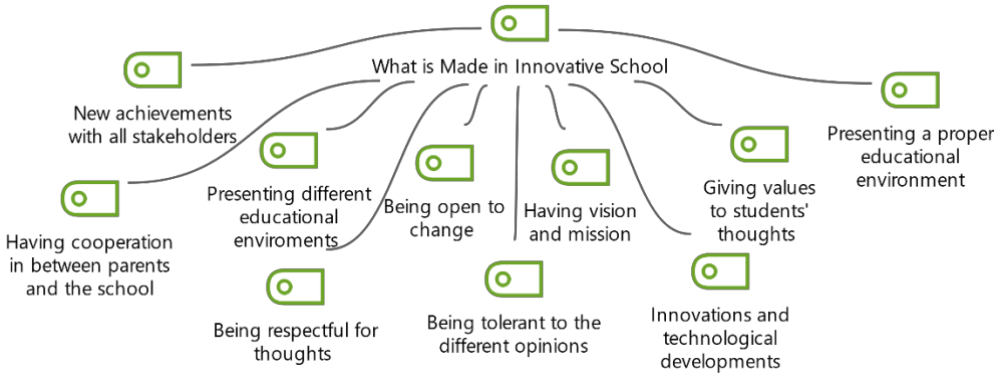


Figure 7. What is made in innovative school?

Figure 7 presents the main practices that participants associate with innovative schools. These include the integration of technology, creating supportive learning environments, fostering tolerance for diverse ideas, establishing cooperation between parents and schools, and promoting democratic and participatory management. The figure highlights how innovation in schools is perceived as both structural and cultural, extending beyond technology to include values, collaboration, and vision.
The participants' views provided further insights into these practices. Some illustrative quotations are presented below:

K11: Innovative schools are open to innovations, ready for the changes, open to new ideas, cooperative and their communication is strong. They know the importance of teamwork. Stakeholders have the sense of belonging. A school which could adapt to the dynamic environment should be built. There should be democratic and participative management understanding.
K2: All kinds of technological infrastructure is built in innovative schools as those make learning easier which is the necessity for the era. While decisions are taken in management process, decisions are made with common mind by taking ideas of all stakeholders. Concepts of respect and politeness are prioritized in top to bottom, bottom to top and lateral communications. Environmental resources which would bring innovation should be provided in schools. School climate which will make innovativeness attractive, and which will encourage the same in schools, should be provided.

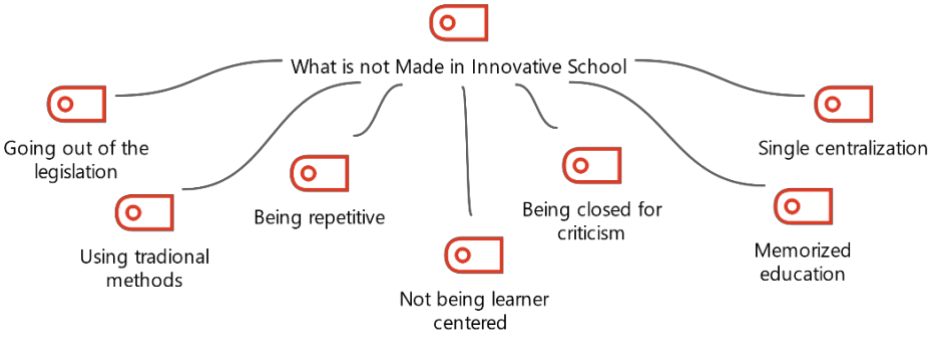


Figure 8. What is not made in innovative schools?

Figure 8 illustrates the practices and characteristics that participants believe should not exist in innovative schools. These include reliance on memorization, centralized decision-making, traditional teacher-centered methods, resistance to criticism and new ideas, and repetitive practices outside legislative frameworks. The figure emphasizes that innovative schools are expected to move away from conventional approaches and instead foster learner-centered, participatory, and flexible models of education.

The participants' views provided further insights into these perspectives. Some illustrative quotations are presented below:

K2: There must not be a centralized management style where one person makes decisions, in innovative school. Traditional structure of mind and one-track mind manager could not be found in an innovative school. With an old expression, course processes are not composed of one teacher and one board. Education should not be teacher centered. There is no resistance to technology and changes.
K5: It does not repeat itself. Traditional methods are not used. It is learner centered. It does not close itself to criticism.
K10: There should not be memorized education, multiple choice examinations and students should not be immersed in test books.

These findings reveal that innovative schools are characterized by openness to change, stakeholder participation, and democratic practices, while rejecting memorization, centralization, and teacher-centered approaches. This contrast underscores the transformative role of innovative schools in shifting from traditional to learner-centered and participatory educational models.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

This study examined school managers' perceptions of the concept of the innovative school and explored how such schools should function together with their stakeholders. Drawing on qualitative data from 11 school managers selected through criterion sampling, the findings revealed six thematic dimensions: (1) characteristics of innovative schools, (2) innovative manager, (3) innovative teacher, (4) innovative parent, (5) achievements in innovative schools, and (6) practices that should/should not be implemented in innovative schools. The results demonstrated that innovative schools are not defined merely by technological integration, but rather represent holistic environments where leadership, pedagogy, stakeholder collaboration, and long-term student development converge.

The findings of this research align with and extend existing literature on educational innovation. Characteristics of innovative schools correspond to Naktiyok's (2007) and Özçiçek's (2016) definitions of schools as open to new ideas and committed to systemic improvement, while also supporting Öğüt, Aygen and Demirsel's (2007) argument that individual creativity within schools is indispensable. Consistent with Cemaloğlu (1999), factors such as organizational culture, leadership, and motivation emerged as enablers or barriers. Blandul (2015) highlighted difficulties with technology integration, and Aydın (2019) emphasized the role of physical infrastructure; however, this study revealed that cultural and pedagogical elements are equally crucial.

The innovative manager emerged as a leader who embraces change, listens actively, and motivates stakeholders. These findings reinforce Develi's (2015) conclusion that shared goals and knowledge-sharing foster innovation, while also resonating with

Çelik's (2017) study on leadership styles and risk-taking behaviors. Moreover, the OECD TALIS 2018 report underlines that leadership for innovation requires participatory decision-making and openness to accountability, both of which were strongly emphasized by participants (OECD, 2019a). The innovative teacher was described as committed to their profession, empathetic, collaborative, and open to feedback and technology use. This is consistent with Özbek's (2014) findings that teachers view themselves as pioneering, and Gürbüz's (2015) study showing mid-level innovativeness among teacher candidates. Kocasaraç & Karataş (2018) and Bodur (2019) also found that teachers associated innovation with technology and cooperation. The current study, however, extends these perspectives by emphasizing empathy, professional belonging, and creativity as central attributes. This aligns with the OECD Learning Compass 2030 framework, which places teachers at the heart of fostering student agency and well-being (OECD, 2019b).

The role of parents was identified as an original contribution of this study. Participants emphasized that parents should not be passive supporters but active stakeholders in decision-making processes. This complements Esen's (2002) findings on the socioeconomic background of innovative families and echoes the 2024–2028 Strategic Plan of the Turkish Ministry of National Education (MEB, 2023), which prioritizes strengthening school–parent cooperation. Student achievements were mapped across short-, medium-, and long-term horizons: responsible use of technology and confidence (short-term), critical thinking and school belonging (medium-term), and responsibility, ethical values, and innovation (long-term). These results align with Thorsteinsson (2014) and Jin et al. (2018), who found that innovative schools cultivate democratic values and problem-solving skills. Similarly, UNESCO's Futures of Education (2021) highlights curiosity, critical thinking, and global citizenship as indispensable outcomes of future schooling.

Practices implemented in innovative schools were associated with openness to innovation, tolerance for diverse opinions, and stakeholder cooperation, echoing Özen & Bingöl (2010) and Könings et al. (2007). Conversely, practices rejected in innovative schools—such as memorization, centralization, and teacher-centered methods—parallel Watt's (2002), Töremen's (2002), and Çelik's (2017) analyses of barriers to organizational innovation. Importantly, participants highlighted that innovation requires not only new methods but also the abandonment of rigid, repetitive, and exam-centered practices. Taken together, this study not only confirms previous research but also contributes novel insights by highlighting the active role of parents, the long-term developmental outcomes of students, and the rejection of traditional hierarchical models. By linking these findings to MoNE strategic objectives, OECD benchmarks, and UNESCO's vision of future learning, the study provides a valuable theoretical and practical framework for understanding and advancing innovative schools.

From a theoretical perspective, future research should conceptualize innovative schools as multidimensional entities that integrate leadership, pedagogy, organizational culture, and stakeholder engagement. Such an approach would allow for a more comprehensive understanding of innovation in education, moving beyond technology-focused definitions. Furthermore, mixed-method studies conducted across diverse regions and populations could test, refine, and generalize the model developed in this study, providing broader insights into how innovative practices adapt to different cultural and institutional contexts.

In terms of practical implications, several points emerge. For school leaders, it is essential to strengthen democratic leadership practices, foster collaboration, and build organizational memory to ensure sustainability of innovation. Teachers, as key agents of change, should engage in continuous professional development that emphasizes technology integration, empathy, and creative pedagogy. Parents should also be positioned as active stakeholders through platforms such as parent academies or digital participation mechanisms, thereby increasing their involvement in decision-making processes. At the same time, students should be provided with enriched learning environments that nurture critical thinking, creativity, and responsibility through learner-centered approaches.

Finally, policy recommendations highlight the need for systemic reform. National curricula should integrate project-based learning and creativity-oriented assessment methods alongside traditional examinations to reduce reliance on rote memorization. Ministries of Education should pilot innovative school models, evaluate their outcomes, and scale them based on evidence of success. Institutionalized professional development programs must equip both teachers and school leaders with innovative teaching and leadership competencies. In addition, legal and institutional frameworks for school–family cooperation should be strengthened, with targeted policies to support disadvantaged communities. Aligning national reforms with international benchmarks such as OECD's 21st-century skills framework and UNESCO's global citizenship and sustainability goals will further enhance the relevance and effectiveness of educational innovation. Finally, disseminating best practices and success stories from innovative schools across the system can foster a culture of shared learning and continuous improvement.

Research and Publication Ethics Statement

Ethical principles were followed in the process of data collection, analysis and writing of the article. Istanbul Sabahattin Zaim University Institute of Educational Sciences Research and Publication Ethics Committee Decision. It is the ethics committee decision dated 30.04. 2021, confirmation number E-20292139-050.01.04-5463.

Contribution Rates of Authors to the Article

Both authors contributed equally to the conduct of the research.

Statement of Interest

The authors of this study do not have any conflict of benefit with any person, institution or organization.

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Effectiveness of Video Modeling in Teaching Employment Skills to Individuals with Autism Spectrum Disorders*

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ABSTRACT

Employment is a critical and challenging area for individuals with autism spectrum disorder (iwASD), and thus, additional research in this area is warranted. In this single-case research design, we taught six employment skills to three iwASD (ages 15-17) using video modeling. We assessed the generalization of the skills after 1, 5, and 12 weeks. In addition, we also examined whether participants acquired non-target information about each skill. Finally, we collected social validity data from participants and their parents after the study was completed. The findings showed that the participants acquired, generalized, and maintained the target skills. They also acquired non-targeted information at varying levels of accuracy. Further, the participants and their parents reported high satisfaction with the procedures. This study showed that video modeling can be an effective tool for teaching sector-based multi-step employment skills to individuals with autism, with generalization outside of the clinical setting.

Keywords: Autism spectrum disorders, employment skills, vocational skills; video modeling.

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1. INTRODUCTION

Among individuals with disabilities, individuals with autism spectrum disorder (ASD) have the lowest rates of paid employment (Frentzel et al., 2022; Roux et al., 2015). Their diagnostic characteristics, such as difficulties in social interaction and communication, insistence on sameness (Walsh et al., 2014), potential for exhibiting challenging behaviors, problems with generalization (Chappel & Somers, 2010; Hendricks & Wehman, 2009), and hypersensitivity to sensory stimuli, as well as the fact that employment skills are often neglected during school years compared to other skills such as academic, social, and communication skills (Schall et al., 2012), hinder their employment. Previous research has provided substantial evidence on the employment challenges of individuals with ASD, highlighting barriers such as limited vocational training (VT), inadequate social communication skills, and employer bias (Bross et al., 2019; Lopez & Keenan, 2014; Roux et al., 2015). VT that ignores iwASD characteristics, strengths, and difficulties and does not include social, daily life, and vocational skills cannot be successful (Chen & Yakubova, 2023). Vocational skills should therefore be taught to iwASD in real workplaces, including social and community life skills (Parsons et al., 2022). Receiving VT that does not provide sufficient experience of workplace culture, work-related social skills, and learning to adapt to changes in workplace conditions, tasks, or routines negatively affects adaptation to the workplace (Zhou et al., 2023). The acquisition of these skills in combination with vocational skills is critical for long-term employment outcomes (Munandar et al., 2020; Rausa et al., 2016).

The difficulties encountered in acquiring and generalizing these vocational skills clearly demonstrate the need for instructional practices that are compatible with the learning characteristics of individuals diagnosed with ASD. Video modeling (VM) is a promising method in this context, as many individuals with ASD possess strong visual processing skills and benefit greatly from

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structured, predictable, and visually salient presentations (Wong et al., 2015). Furthermore, the literature consistently shows that VM is effective in teaching a wide range of skills, including vocational tasks and workplace routines. Therefore, the use of VM in vocational skill instruction provides a theoretically and empirically strong foundation for addressing the learning challenges described above (Bellini & Akullian, 2007). Although numerous studies have demonstrated the effectiveness of VT and evidence-based interventions like VM in teaching job-related skills (Ayres et al., 2017; Bross et al., 2020; Thirumanickam et al., 2018), most have focused on isolated, single-task performance-such as photocopying or data entry-rather than preparing iwASD for multi-component, socially embedded vocational roles. Moreover, these studies often took place in simulated or school-based environments rather than authentic workplaces, limiting ecological validity and sustainability (Chen & Yakubova, 2023; Parsons et al., 2022).

Employers prefer individuals with strong communication skills. This can be a disadvantage for individuals with disabilities. To address this, it is necessary to provide them with social and vocational skills (Newman et al., 2011). Society, employers, and peers think that iwASD cannot work in high-performance jobs or perform repetitive tasks (Mai, 2019). However, when iwASD work in isolation, their social skills are further reduced. These individuals must be employed in workplaces where they frequently interact with others (Hurley-Hanson et al., 2020). VT affects the employment of iwASD (Holwerda et al., 2012). Qualified VTs impact employer attitudes (Lopez & Keenan, 2014) and ensure job sustainability. Statistics show that most individuals with ASD lack VT (National Core Indicators, 2017; Seaman & Canella-Malone, 2016). To increase the employability of iwASD, it is vital to use effective, easy-to-implement methods to develop vocational skills (Parsons et al., 2022).

There is also a paucity of research integrating social interaction skills with vocational performance in real-world employment contexts. While social competence is known to influence job retention and satisfaction (Baldwin et al., 2014; Giarelli et al., 2013), few studies have systematically examined how social behaviors can be fostered alongside vocational instruction. Additionally, research on competitive work environments-where performance, communication, and adaptation coexist dynamically-remains scarce (Bross et al., 2020; Martin et al., 2023). VM is an evidence-based intervention in which skill steps are recorded and presented to the learner (National Autism Center, 2015), demonstrating high social validity in teaching vocational skills (Bross et al., 2020). There are numerous studies in the literature that use VM to teach vocational skills. In these studies, gardening (Kim, 2018); photocopying (Bereznak et al., 2012); store clerk skills (Bross et al., 2019; Bross et al., 2020); car washing (Parsons et al., 2022); office cleaning, stocking materials, and using cash registers (Stauch & Plavnick, 2020). Studies have focused on specific job tasks of iwASD. However, there is a need for studies on competitive work environments that often lack job descriptions and can be paid in return (Bross et al., 2020). It is essential to equip iwASD with the skills to work in competitive environments and prepare them for jobs that require interaction with others (Bross et al., 2019). In addition, there is a need for research on the acquisition of jobs that are not isolated from society (Martin et al., 2023)

This study aims to address these gaps by teaching multiple interrelated vocational skills to iwASD in an authentic food and beverage workplace using a VM approach. The study uniquely combines task performance, problem solving, and social interaction within a realistic employment context, offering evidence on how comprehensive vocational instruction can enhance both skill acquisition and workplace integration for iwASD.

The food and beverage sector is a market that requires a workforce in almost every country. According to data from the Turkish Employment Agency (ISKUR, 2023), "service personnel" is among the most employed occupations and has the highest employment growth expectations. However, the objectives of vocational education programs in Turkey do not include teaching all these skills (MoNE, 2023). This prevents individuals from being employed even in the most highly employed fields.

1.2. Purpose of the Study

Employment in a specific sector ensures that individuals learn the basic skills required for the job, rather than learning every skill. Also, employment prepares them for future roles. Skills such as taking orders, preparing food, delivering, and collecting empties encourage participation in society, increase responsibility, and social interaction. The acquisition of these skills will increase the employability and sustainability of employment. These skills are only remunerated when exhibited as a whole. Targeted skills and most of the non-targeted information gained will reduce social inadequacies that are an obstacle to employment. This study aimed to provide iwASD with the skills to take orders, prepare orders, deliver orders, and collect empties using VM. The following questions were asked for this purpose:
1. Was VM effective in the acquisition, maintenance (1-5 weeks), and generalization of order-taking, preparation, delivery, and empty collection skills for iwASD?
2. Did iwASD acquire non-targeted information?
3. Was the study socially valid for iwASD and their parents?

2. METHODOLOGY

In this study, we used a multiple-probe design across behaviors, which is a single-case research design (SCRD). This design replicated across behaviors. In the study, a multiple-probe model with probe trials was used. We taught six different target behaviors to three participants using the same setting and the same tools within the same intervention process. In the model,

experimental control is established by obtaining the intervention effect (prediction) with the first participant, verifying it with the second, and repeating it with the third.

2.1. Participants

Two boys and one girl with ASD aged 15-17 years participated in the study (Table 1). To take part, they had to have a medical diagnosis of autism, no hearing or vision problems, no prior instruction on vocational skills in the study, and deficiencies in these skills. The participants' hospital diagnosis report was requested from their families and examined by the first and second researchers. Additionally, because the dependent variables posed a safety risk, participants needed to be able to take basic safety precautions when using electronic appliances (e.g., coffee makers, toasters, juicers). To this end, the interventionist asked participants to mark the correct behaviors on a list of pictures showing safe and unsafe behaviors related to the use of electronic appliances to be used in the study. For this purpose, the word document included two pictures for each question, illustrating safe and unsafe behaviors related to the use of electronic devices with independent variables (for example, two pictures showing someone touching a plug with wet and dry hands, and two pictures showing someone touching a toaster while the power button is on/green light is on and while the power button is off/red light is on). For each question, the participant was asked, "Which of the pictures is correct? Mark it." There were 10 questions and 20 pictures showing safe and unsafe behaviors. Participants were expected to answer at least 8 of these questions correctly. If they answered incorrectly or did not answer, the correct and incorrect behaviors were explained to the participant. Then, they waited until they gave the correct answer. We also obtained information from their mothers about their use of electronic devices at home. Their vocational skills were measured through interviews with their families and two teachers who taught the vocational course. The Gilliam Autism Rating Scale-2 Turkish Version (GARS-2-TV) and the Reynolds Intellectual Assessment Scales-1 (RIAS-1) were administered to assess participants' autism level, verbal and non-verbal intelligence, and memory. However, the parents of two participants (Can and Ayfer) stated that they did not want the test to be applied to their children and only allowed the intervention process. Therefore, these tests were not administered to these participants. GARS-2-TV was administered by a special education specialist, and RIAS-1 by an expert. According to GARS-2-TV, if the autism spectrum disorder index is 69 or below, the likelihood of occurrence is nonexistent; if it is between 70 and 84, the likelihood of occurrence exists; and if it is 85 or higher, the likelihood of occurrence is interpreted as very high (Diken et al., 2011). Scores for RIAS-2 are generally interpreted as follows: below 70: extremely low, 70–79: borderline, 80–89: low average, 90–109: average, 110–119: high average, 120–129: superior, 130 and above: very superior (Brueggemann et al., 2006). We obtained the necessary ethical committee approval from the university where the research was conducted.

Table 1.
Characteristics of participants

Pseudonyms	Diagnosis	Age/Gender	Grade	GARS-2-TV		RIAS-1			
				Result	Explanation	Verbal intelligent	Visual intelligent	General intelligent	General memory
Emre	ASD**	15/male	8th	81	It is possible	81	70	72	66
Can*	ASD	17/male	10th						
Ayfer*	ASD	17/female	10th						

**Their parents did not allow an assessment of autism and intelligence*

According to the autism rating scale, Emre was classified in the “Possible” group for autism. According to RIAS-1, his scores in the three main sections placed Emre in the 2% percentile. The parents of the other two participants did not want their children evaluated with any tests, so the tests could not be administered to them.

Emre was a 15-year-old boy. He was receiving special education services for autism. He could read and write and use multi-word words and sentences to communicate. He understood and fulfilled instructions consisting of at least three words and could read and explain a reading text consisting of at least six sentences and 30 words. He had fine and gross motor skills appropriate for his age. He made purchases.

Can was a 17-year-old boy. He can express his thoughts, feelings, and comments with complex words and sentences. He can read a text consisting of at least 15 different sentences and 80 words, whether written on a computer or by hand, and can explain it when asked. He has fine and gross motor skills appropriate for his age. Vocation-al/workshop teachers stated that Can can do addition, subtraction, and multiplication, solve simple addition and subtraction problems, and shop by calculating money.

Ayfer was a 17-year-old girl. She received special education services for autism. She could read, write, and communicate with others. She used simple vocabulary and sentences. Ayfer could express her thoughts with simple words and sentences. She could read a text consisting of at least eight sentences and 30 words, written by computer or hand. She could partially explain when

asked. Her fine and gross motor skills were appropriate for her age. She could add and subtract, count money, and calculate change.

Participants and their parents provided written and verbal consent for the study, which they signed and delivered to the researchers before it began. In addition, we obtained permission from the Scientific Research and Publication Ethics Committee of the Social and Human Sciences at the university where the research was conducted (protocol no: 71095).

2.2. Interventionist

SDA, the first author, carried out the interventions for the participants. SDA was a PH.D. candidate in special education when she conducted this study. Before this study, she had experience with video modeling and teaching vocational skills to iwASD.

2.3. Setting and Materials

This study's intervention process was conducted in the kitchen, corridors, and offices of a public university's special education intervention unit. The unit is 250 m2 and includes four classrooms, five offices, a kitchen, and two toilets.

Taking and preparing orders (toasting, making sandwiches, and making Turkish coffee) were carried out in this unit's kitchen. The kitchen is $40m^2$. There's a counter with a tap, a refrigerator opposite the door, a window on the other side, a toaster, and a Turkish coffee machine on each side. There were four cabinets with double doors above the counter. These contain personal kitchenware.

The unit's offices and corridors were used to pick up dirty glass, plates, etc. It was $60m^2$ with desks, chairs, computers, and cabinets. The corridors were 6-7m long and had two wall-mounted cabinets.

The orders were delivered to the people working in this unit's offices, who placed the order by calling the participant. The offices were about 50 m2 each, and each had an office phone, a desktop computer, two tables, chairs, and a cupboard.

The target skills teaching materials were toaster, Turkish coffee machine, refrigerator (for toasting, preparing Turkish coffee, storing sandwiches). Consumable items: paper cups, coffee cups, toast paper, napkins, plates, knives, cutting boards, Turkish coffee, sugar cubes, bread, feta cheese, tomatoes, lettuce. Tools and equipment for sales: notepad, paper, pen, landline phone. Data recording tables, paper, pen, laptop, video camera, and tripod.

2.4. Dependent Variables and Measurement

In this research, six different skills were taught. Individual preferences were taken into account when determining the target skills. The interventionist took certain precautions against risks, such as burning and cutting, for the participants. These were as follows: (a) The interventionist marked the spot where they should stand on the floor to adjust the distance from appliances, such as toasters and coffee makers, (b) They wore double-layered gloves for each skill. The dependent variables were taking phone orders, preparing orders (toasting, making sandwiches, making Turkish coffee), order delivery, and picking up empties (cardboard and glass cups, plates, spoons, and forks) in the intervention unit. The dependent variables were based on individuals' employment in the canteen, workplace, or restaurant kitchen. Participants' independent performances on the steps of the task analysis for six skills are the dependent variables in the research.

The first and second authors created the task analysis for the five target skills, excluding pickup empties, by observing a staff member at the state university cafeteria for 3 days. Turkish coffee was made by the third author, and the task analysis was created by the first and second authors. After analyzing the task, we found 21 steps in taking orders, collecting dirty utensils (5), delivering (6), preparing sandwiches (21), toasting (19), and making Turkish coffee (18). We shared our results with autism and special education experts, who made no changes. Participants' completion of the relevant step in the task analysis was accepted as correct and marked '+' on the form; incorrect responses were marked '-'. The percentage of correct responses was calculated by dividing the number of steps performed correctly by the total number and multiplying by 100. Mastery criteria for six target skills were determined with 100% independent correct responses in three consecutive sessions.

2.5. Independent Variable

The independent variable was VM. The second researcher served as a model during the video creation. A trial rehearsal session was held because the second researcher had experience and knowledge of both research and skills, and had previously participated as a model in different studies on video models. The purpose of this trial rehearsal was to capture the second researcher's performance and skills in the video recordings as accurately as possible. This is because skill analysis in video modeling depends not only on the model's experience, but also on their performance in the recording. There are four types of video models: the basic video model, the self-video model, the perspective-based video model, and the video cue (Dittoe and Bridgman, 2017). In this study, we used the perspective-based video model. The perspective-based video model involves creating video images that focus on the point the viewer should observe while the skill/behavior is being demonstrated (Murray

and Noland, 2013). The viewpoint can be either first-person or third-person (Lockwood, 2018). In the first-person viewpoint, the target skill/behavior is recorded from the perspective of the individual watching/expected to learn the video, as if they were performing the skill/behavior themselves (Dittoe and Bridgman, 2017). The videos are filmed from a first-person viewpoint and sent to five expert reviewers (who hold master's degrees in special education) for evaluation. Experts confirmed that the videos are suitable for teaching.

2.6. Experimental Design

To determine whether there is a causal relationship between the six dependent variables and independent variables, a single-case research design (SCRD) was used and replicated across behaviors. In the study, a multiple-probe model with probe trials was used. The design was chosen because it does not require continuous baseline data collection, as it assesses the effectiveness of an intervention on multiple occasions (Gast & Ledford, 2014). The multiple-probe design is used when collecting data continuously and simultaneously across all intervention targets is either too difficult or unnecessary. Instead of continuous measurement during the initial non-intervention phases, a multiple-probe design uses intermittent checks, or "probes," to sample the participant's performance. This method significantly reduces the burden of data collection while still providing the necessary documentation to show that the intervention, and not some other factor, caused the change (Horner & Baer, 1978). In implementing the multiple-probe design, procedures were conducted in accordance with the single-case design standards proposed by the What Works Clearinghouse (WWC, 2017) to ensure methodological rigor and adequate phase structure.
The experimental design was implemented as follows: Baseline data were collected from each skill for five consecutive sessions. Once each participant met the initial 100% accuracy criterion in the first skill during the baseline sessions, five more baseline sessions were conducted for the second skill, and intervention sessions were implemented after stable data were obtained. During this time, intermittent probe sessions were conducted for the other skills. Upon achieving the first 100% correct response in the probe sessions for the second skill, five more baseline sessions were collected for the third skill, following the same procedure as for the first skill.

2.7. Procedure

2.7.1. Baseline

The baseline phase lasted at least 5 sessions per skill and continued until stable data were obtained. In these sessions, there were no prompts, feedback, error correction, instruction, or reinforcement. This phase was organized as a single session per day, on weekdays, for each skill. Taking orders by phone, preparing the orders (toasting, making sandwiches, and brewing Turkish coffee), and delivering the orders were done in the kitchen. Dirty kitchen utensils were collected in the corridors. In these sessions, only the interventionist and the participant were present. The interventionist said, "We will work with you today. I want you to do what I tell you the best way you can, but it's okay if you can't. Shall we start working now?" The participant said "Yes". The interventionist then said the target stimuli for each skill (take orders when the phone rings/calls!", "make a toast!", "prepare a sandwich!", "make Turkish coffee! "Deliver the orders to the offices of the people who asked you!" "Pick up the dirty kitchen utensils in the hallway!"). The participant was called by someone from the offices while she was in the kitchen, taking phone orders. The participant was shown the lines in the video scenario. For the skill of delivering orders, Turkish coffee, sandwiches, and toast were placed in the kitchen, and the first author said, 'Deliver these orders to... office!' The participant waited 5 seconds for the participant's response to the task directions for the relevant skill. She recorded each step the participant performed on the skills analysis data recording form (see dependent variables section). The interventionist thanked the participant for participating in the study and ended the phase after the first step, as the participant performed incorrectly.

2.7.2. Daily probe sessions

Participants reflected on the graphs for each skill in daily probe sessions. These sessions were held just before instruction sessions, except for the first one. They lasted until the participant showed 100% correct responses. The daily probe session procedures mirrored those during the baseline phase.

2.7.3. Intervention

The intervention phase was conducted every weekday and one session per day for each skill. The interventionist met with the participant in the environment designated for each target skill and told the participant they would watch a video and to watch it carefully, as they would be expected to do the same thing immediately afterward. The participants watched a video of each skill in the unit's waiting area. The interventionist paused the video when the participant did not watch it, and when the participant turned it back on, the interventionist asked the participant to watch it carefully and reinforced the video by saying "Great!" when the participant did so. After the entire video was over, the interventionist said to the participant, "Now you will do the same thing as the girl you watched in the video!" and together they went to the environment (kitchen or corridor) where the relevant skill was demonstrated. While the participant was performing, the interventionist took a data recording form. The skills were taught through scenarios in the video. For example, the kitchen where the participant was located was called by phone to take orders, and the caller said the line from the video ("Hello. I would like a Turkish coffee with sugar, 1 feta cheese

sandwich, 1 toast with bleu cheese"). To deliver the orders, the Turkish coffee, toast, and sandwiches prepared before the training were left in the kitchen. The participant took them to the office in the video, and the person there said the lines. Each step the participant completed correctly was reinforced with "You are great!" and "Bravo!" until the participant reached 75% correct responses, and every fifth correct response thereafter. The session was terminated at the first incorrect step, and the participant was thanked for participating in the study. The intervention phases continued for at least three consecutive sessions for each skill until a 100% independent and correct response was achieved in probe sessions.

2.7.4. Maintenance and Generalization

Maintenance sessions were conducted 1, 5 and 12 weeks after the intervention, using the same procedure as the baseline. We did the generalization sessions before and after the intervention, using the same procedure as the baseline. Each skill was generalized differently: for instance, taking orders by phone involved asking for different orders from instructions; toasting, pre-paring sandwiches and making Turkish coffee involved working with different people; delivering orders meant giving different order quantities, types and prices from instructions, and working on different floors, such as the first and second; collecting empty utensils involved using colors and materials not used in the instructions and canteen settings.

2.7.5. Non-targeted information

Non-targeted information is one way to ensure teaching efficiency. With non-targeted information, it is hoped that systematic teaching practices will result in multiple learning outcomes. With non-targeted information, the participant/learner is provided with additional stimuli that are not targeted for teaching, in addition to the targeted responses. The stimuli presented in relation to non-targeted information do not affect the time spent teaching the target behavior, the speed of the target behavior, or the teaching outcomes (Werts et al., 1996; Werts et al., 1993; Werts et al., 1992). Since it increases teaching efficiency, we also looked at participants' acquisition of non-targeted information in our study.

The interventionist tested non-targeted information before and after the intervention. For non-targeted information, you can check https://avesis.anadolu.edu.tr/proje/d8310904-a172-4576-8c50-e1f8740c23cb/bagimsiz-yasama-gecis-donemindeki-gelisimsel-yetersizligi-olan-bireylere-istihdam-becerilerinin-ogretimi or send an e-mail to SDA. The interventionist, in accordance with the rationale for non-targeted information, verbally read the non-targeted information to each participant at the end of each intervention session, outside the probe sessions [R1] [SD2], and referred to the paper on which the non-targeted information was written. Non-targeted information was presented as a consequence. At this time, the interventionist did not provide any feedback or reinforcement on the participant's responses. In these sessions, in which non-targeted information was presented, the interventionist's purpose was to verbally convey this information to the participant. Beyond this, the interventionist did not expect any response from the participants (such as a correct or incorrect response).

During the intervention sessions, the researcher presented non-targeted information, critical steps in the skill analysis, and the whole skill. Critical skill steps were determined based on the opinions of 13 experts in special education, 2 teachers in VT schools, 1 employer, and 1 canteen personnel. During these sessions, the interventionist asked each participant questions about non-targeted information related to each dependent variable and recorded their answers on a form. During the intervention sessions, the interventionist provided participants with information about non-targeted details related to each dependent variable and critical steps in skill analysis. After the criteria for each target skill were met, the interventionist conducted post-test sessions. During these sessions, the interventionist asked participants questions about the non-targeted information the interventionist had provided before the intervention and asked them to respond. The interventionist recorded correct answers as "+" and incorrect or incomplete answers as "-" on a form. The interventionist calculated the percentage of correct answers by dividing the number of correct answers by the total number of answers and multiplying by 100.

2.7.6. Social validity

The interventionist asked the participants, Can and Emre's fathers, and Ayfer's mother about the study's purpose, dependent and independent variables, and process using social validity questions. The parents' ages ranged from 48 to 56. The interventionist presented video clips to the parents consisting of baseline, intervention, follow-up, and generalization. Then, the interventionist asked the parents to answer questions while reflecting on the video clips they had watched. For the parents, 10 yes-no questions and three open-ended questions (e.g., 'What are your views on the selection of these target skills?'), and for the participants, 6 yes-no questions and 2 open-ended questions (e.g., 'What makes you the happiest about this study?'). Social validity data were analyzed qualitatively.

2.7.7. Interobserver agreement (IOA) and Procedural fidelity (PF)

PF was collected by a trained observer, a special education specialist, and a PhD candidate. For each skill, 30% of the videos from each phase were randomly selected, and the observer recorded the participant's reactions on the data recording form. The interobserver agreement (IOA) was calculated using the point-by-point method.

Following the observer's recordings, IOA was calculated by dividing the agreement by the sum of agreement and disagreement, then multiplying by 100 to obtain 100% for each phase of each skill. PF was collected at each session (baseline, follow-up, generalization, and non-targeted information) and at the time of intervention implementation by a different second observer (different from the IOA observer). While collecting fidelity data for probe, maintenance, and generalization sessions, the observer recorded it on the "Data Collection Form" after reviewing the recordings. The fidelity data were calculated by dividing the number of steps the interventionist completed correctly by the total number of steps and multiplying by 100%. Procedural fidelity data for each skill for the participants were: baseline 100%, taking orders; generalization and probe Can and Emre 100%, Ayfer 95%, maintenance 100% for all three, preparing orders; generalization, maintenance and probe 100% for all three, order delivering; generalization, maintenance and probe Can and Ayfer 100%, Emre 95%, and treatment fidelity taking orders; Can 92%, Emre and Ayfer 100%, preparing orders; Can 86%, Emre and Ayfer 87%, order delivering; Can 100%, Emre 89%, and Ayfer 92%, picking up the empties; 100% for all three.

2.7.8. Data analysis

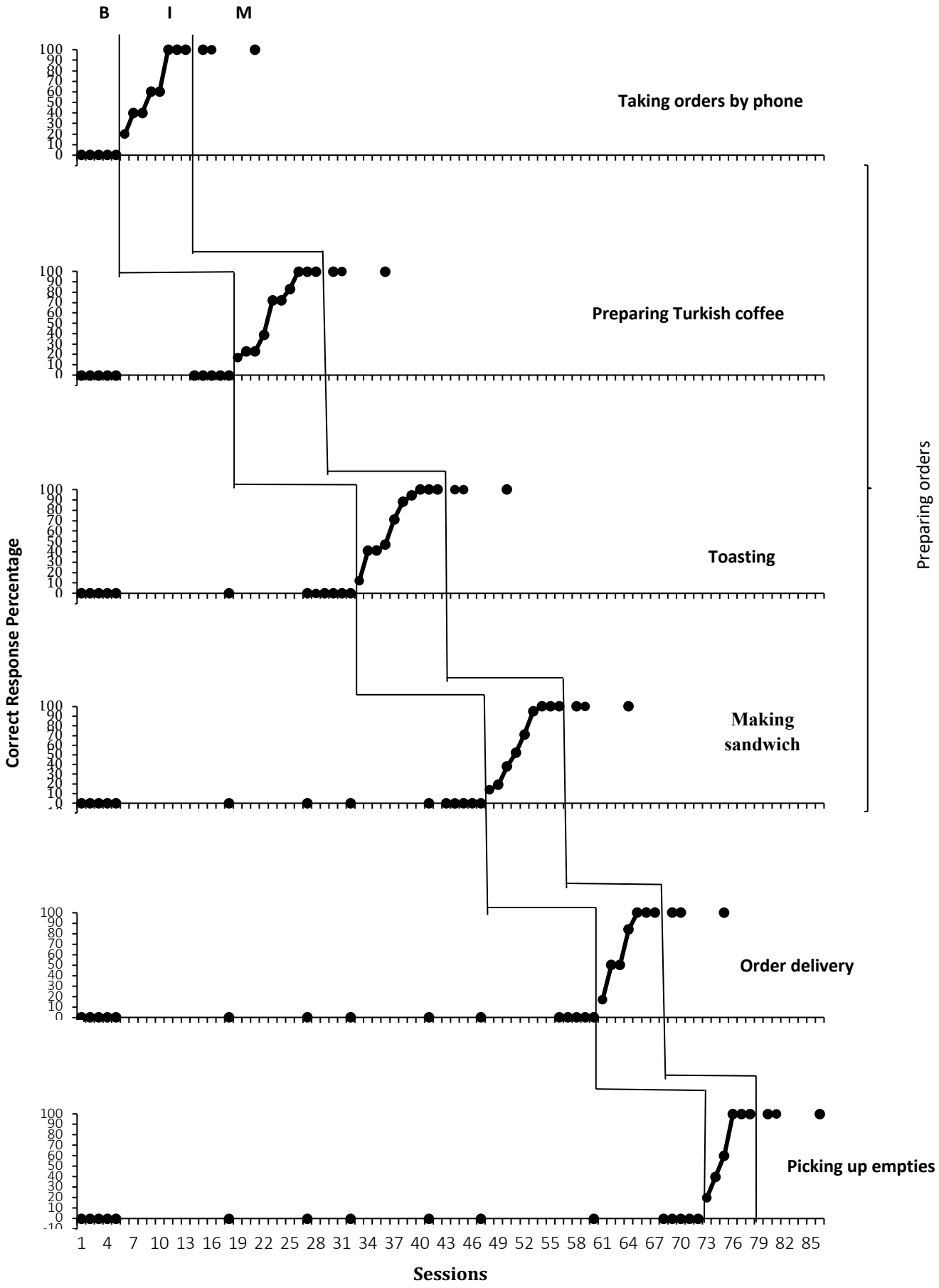
For the experimental effect, we used visual analysis. In addition, we looked at level and trend. For the level, we interpreted the average of the data in each phase as 0%-20% low, 20%-20%-40% low-moderate, 40%-60% moderate, 60%-80% moderate-high, and 80%-100% high (Kratochwill, 1992; Kratochwill et al., 2010). We calculated the trend with the equal-half method and defined it as increasing, decreasing, or zero. We also calculated the percentage of nonoverlap data (PND) and the Tau-U baseline-corrected effect size via the web-based calculator at http://ktarlow.com/stats/pnd/. PND is interpreted as having no effect when below 50%, questionable when between 50% and 70%, effective between 70% and 90%, and highly effective when 90% and above (Scruggs and Mastropieri, 1998). Tau-U baseline-corrected values of 0.20 and below were interpreted as low impact, 0.20 to 0.60 as moderate impact, 0.60 to 0.80 as high impact, and 0.80 and above as very high impact (Parker et al., 2011).

3. RESULTS

3.1. Effectiveness Results

Figures 1, 2, and 3 show the percentage of correct responses for each participant on the dependent variables at each stage. A visual analysis showed a functional relation between the independent and six dependent variables. Table 2 shows the percentages and standard deviations for each variable and participant at each stage, as well as the effectiveness of VM for each dependent variable.

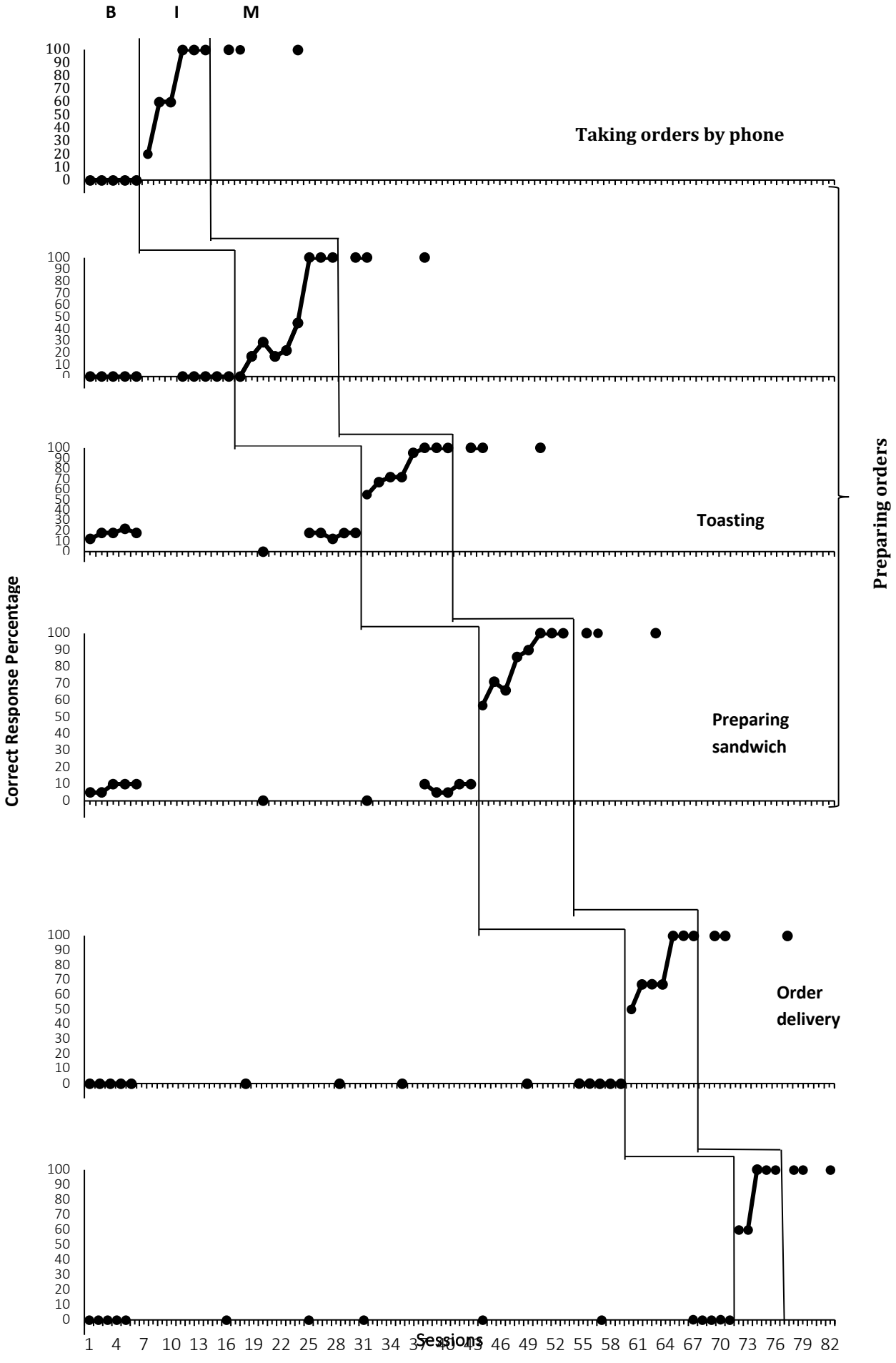
Emre acquired the six dependent variables with 100% accuracy with VM and maintained them (Figure 1). Also, for each target skill, generalization was 0% before the intervention and 100% after. The mean correct response percentages in the baseline phase were 0% for all of Emre's targeted skills, indicating a low level and stable trend. In the intervention phase, which consisted of 8 sessions, the mean percentage of correct responses was 65%, indicating moderate effectiveness at a high level. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.797 ($p = 0.003$; SETau = 0.237), indicating it was highly effective. The Turkish coffee-making skill's intervention phase consisted of 10 sessions; the mean percentage of correct responses was 63%, indicating moderate effectiveness at a high level. There was no overlap between baseline and intervention, and Tau-U, baseline-corrected, was 0.745 ($p = 0.002$; SETau = 0.243), indicating it was highly effective. The mean percentage of correct responses during the 10-session intervention phase of the toasting skill was 70%, indicating moderate effectiveness at a high level. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.741 ($p = 0.002$; SETau = 0.245), indicating it was highly effective. In the intervention phase of the sandwich preparation skill, which consisted of 10 sessions, the mean percentage of correct responses was 70%, it was moderately high and effective, there was no overlap between baseline and intervention, the trend was increasing, and Tau-U baseline corrected 0.741, $p = 0.002$ (SETau = 0.245), that is, it was highly effective. The mean percentage of correct responses in the intervention phase of the order delivery skill, comprising 7 sessions, was 72%, indicating moderate-to-high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.820 ($p = 0.004$; SETau = 0.233), indicating it was very highly effective. In the intervention phase, consisting of 6 sessions, the mean percentage of correct responses was 67%, indicating moderate effectiveness at a high level. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.845 ($p = 0.005$; SETau = 0.228), indicating it was very highly effective. Emre's mean percentage of correct responses across the three maintenance sessions for each skill was 100%, indicating very high effectiveness; his tendency was stable, and his level was high.



Note: B: Baseline, I: Intervention, M: Maintenance

Figure 1. Correct responses of Emre on target skills

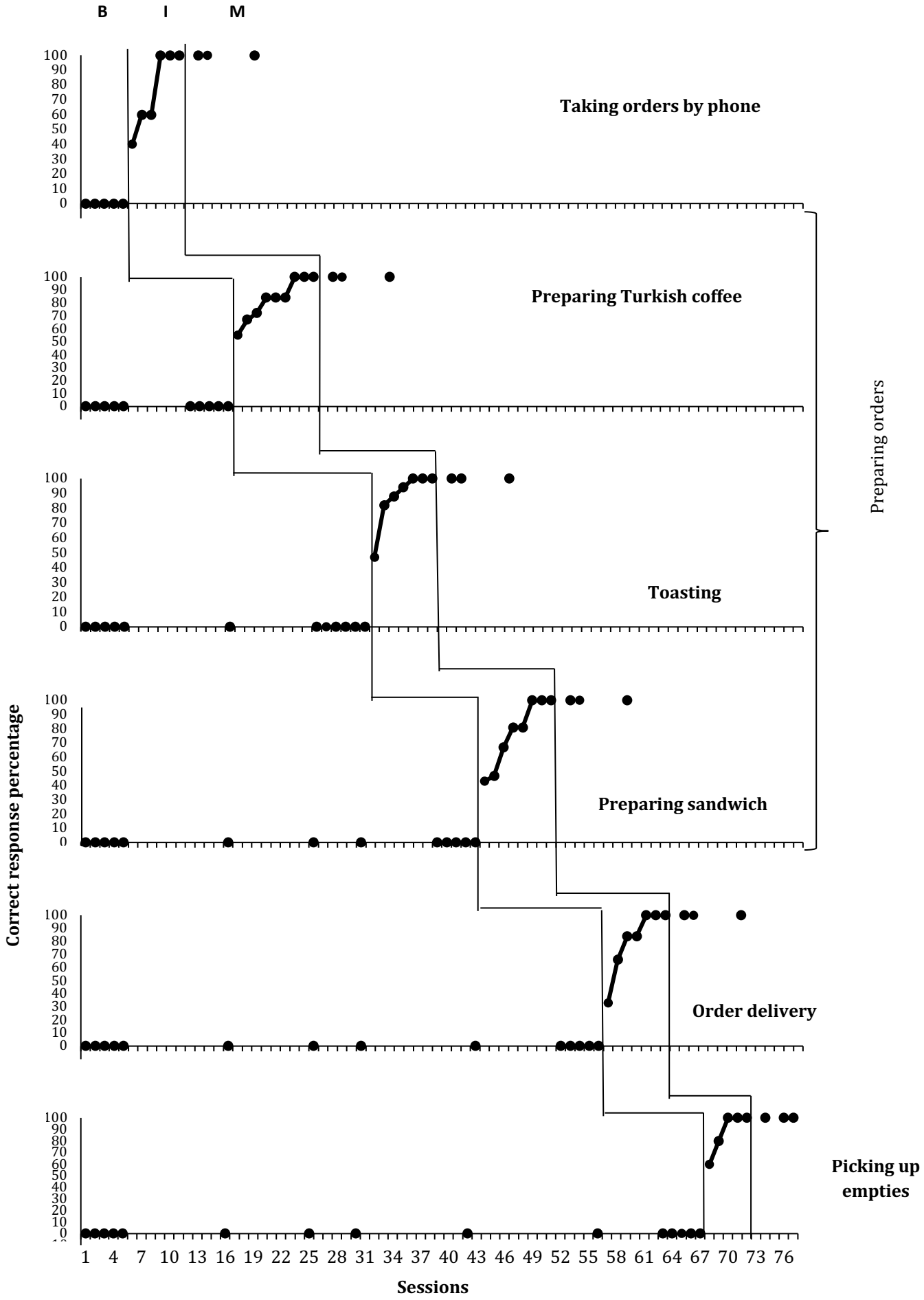
Can learned the six dependent variables with 100% accuracy with VM and maintain them (Figure 2). Also, for each target skill, generalization was 0% before the intervention and 100% after. In all of Can's order taking, Turkish coffee, toast making, sandwich preparation, delivery of orders, and picking up the empties in the unit, the mean correct response percentages in the baseline phase were 0%, 0%, 14%, 6%, 0%, 0%, 0%, respectively, with a low level and a stable trend. The mean percentage of correct responses during the intervention phase of the order-taking was 73%, indicating moderate effectiveness at a high level. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.855 ($p = 0.005$; SETau = 0.221), indicating it was very highly effective. In the intervention phase of Turkish coffee-making, the mean percentage of correct responses was 56%, indicating moderately high effectiveness; there was no overlap between baseline and intervention, and Tau-U, baseline-corrected, was 0.764 ($p = 0.003$; SETau = 0.244), indicating high effectiveness. The mean percentage of correct responses during the intervention phase of toast-making was 83%, indicating high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.791 ($p = 0.003$; SETau = 0.240), i.e., highly effective. The mean percentage of correct responses during the sandwich preparation intervention phase was 84%, indicating high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.784 ($p = 0.003$; SETau = 0.243), i.e., highly effective. The mean percentage of correct responses during the intervention phase of the order delivery skill was 88%, indicating high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.837 ($p = 0.004$; SETau = 0.224). This is very highly effective. The mean percentage of correct responses in the intervention phase was 84%, highly effective; there was no overlap between baseline and intervention, the trend was increasing, and Tau-U baseline corrected 0.898, $p = 0.007$ (SETau = 0.197), that is, it was very highly effective. 's mean percentage of correct responses in the three follow-up sessions for each skill was 100%, very highly effective, with a stable trend and a high level.



Note: B: Baseline, I: Intervention, M: Maintenance

Figure 2. Correct responses of Can on target skills

Ayfer learned the six dependent variables with 100% accuracy with the VM and maintained them (Figure 3). Also, for each target skill, generalization was 0% before the intervention and 100% after. The mean correct response percentages in the baseline phase were 0% across all of Ayfer's targeted skills, indicating a low level and a stable trend. The mean percentage of correct responses during the intervention phase of the order-taking was 77%, indicating moderate effectiveness at a high level. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.855 ($p = 0.005$; SETau = 0.221), indicating it was very highly effective. The mean percentage of correct responses in the intervention phase of Turkish coffee-making was 83%, highly effective; there was no overlap between baseline and intervention, and Tau-U, baseline-corrected, was 0.791 ($p = 0.003$; SETau = 0.240), indicating a highly effective intervention. The mean percentage of correct responses during the intervention phase of the toast-making skill was 88%, indicating high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.813 ($p = 0.004$; SETau = 0.238), indicating very high effectiveness. In the intervention phase of the sandwich preparation, the mean percentage of correct responses was 78%, which was moderately high and effective. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.791 ($p = 0.003$; SETau = 0.240), indicating high effectiveness. The mean percentage of correct responses during the intervention phase of the order delivery was 81%, indicating high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.820 ($p = 0.004$; SETau = 0.233), indicating very high effectiveness. The mean percentage of correct responses during the intervention phase was 88%, indicating high effectiveness. There was no overlap between baseline and intervention; the trend was increasing, and Tau-U, baseline-corrected, was 0.884 ($p = 0.007$; SETau = 0.209), indicating it was very highly effective. Ayfer's mean percentage of correct responses in the maintenance sessions for each skill was 100%, indicating very high effectiveness; her trend was stable, and her level was high.



Note: B: Baseline, I: Intervention, M: Maintenance

Figure 3. Correct responses of Ayfer on target skills

Table 2.
Mean Percentage of Correct Responses Per Skill Type and Phase with Standard Deviation

	Taking orders by phone			Making Turkish coffee			Toasting			Preparing sandwich			Delivering the orders			Picking up the empties		
	Emre	Can	Ayfer	Emre	Can	Ayfer	Emre	Can	Ayfer	Emre	Can	Ayfer	Emre	Can	Ayfer	Emre	Can	Ayfer
B	0%	0%	0%	0%	0%	0%	18%	0%	0%	8%	0%	0%	0%	0%	0%	0%	0%	0%
SD	0	0	0	0	0	0	3.2	0	0	2.44	0	0	0	0	0	0	0	0
I	65%	73%	77%	63%	56%	83%	70%	83%	88%	65%	84%	78%	72%	88%	81%	67%	84%	88%
SD	29.5	29.8	24.2	32.7	35.5	15.3	30.4	16.9	17.6	33.7	15.7	21.5	30.4	11.6	22.7	34.6	19.5	16
G	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
SD	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
M	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
SD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: B: Baseline, I: Intervention, G: Generalization, M: Maintenance, SD: Standard deviation

Table 2 indicates that all participants demonstrated progressively higher accuracy in acquiring the target skill through video modeling instruction. Analysis of the standard deviation scores revealed that the data remained closely clustered around the mean. Specifically, a standard deviation of zero signifies that all values in the dataset are identical to the mean, reflecting an absence of variability. Furthermore, participants both acquired and retained the target skills with 100% accuracy.

3.2. Non-targeted Information Results

Each participant's non-targeted information percentage results were in Table 3.

Table 3.
Non-targeted information Results

Participants	Taking orders by phone		Preparing Turkish Coffee		Toasting		Preparing sandwich		Order delivery		Picking up the empties	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Emre	0	0	0	30	0	70	0	30	0	0	0	100
Can	0	50	0	60	0	30	0	30	0	0	0	50
Ayfer	0	0	0	30	0	30	0	30	0	0	0	100

Table 3 shows that participants acquired non-targeted information with varying degrees of accuracy, except for one skill (order delivery). However, Table 3 shows that, except for order delivery, some target skills were acquired with at least a 30% increase in non-targeted information, while others were acquired with 100% accuracy. The average increase in untargeted knowledge across all skills was approximately 40%.

3.3. Social Validity

3.3.1. Social validity findings of participants with ASD

IwASD's opinions about the study were generally positive. They stated that the target skills were useful and that they were pleased to participate. They stated that cooking made them happy. For example, Emre said, "I picked up dirty things. I cleaned." Ayfer mentioned, "Giving people the food I made," while Can said, "Looking at phones." When asked what bothered them during the study, all three participants said, "Nothing."

3.3.2. Social validity findings of parents with ASD

Parents' opinions about the study were generally positive. In response to yes/no questions, Emre's father agreed that video modeling was useful for teaching target skills to his child and expressed satisfaction with his child's participation; Ayfer's mother also agreed with these points. Both Emre's father and Ayfer's mother considered the skills taught important for employment. When asked what aspect of the study they were most satisfied with, Emre's father replied, "My child could also work in the food and beverage industry." He added, "I am happy that my child is learning things that will be useful in the future."

Ayfer's mother remarked, “She learned to cook his meals and to serve his neighbors when they came over. I was very happy about this.” All three parents also answered "No" to the question, "Is there any situation that disturbs you in this study?"

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

In this study, iwASD were taught the skills of "taking orders by phone, preparing orders (making Turkish coffee, toasting and preparing a sandwich), delivering the orders, and picking up the empties in the unit" using VM. The findings show that the participants acquired the target skills, maintained them 1, 5, and 12 weeks after the intervention was completed, and were able to generalize them across different people, situations, environments, and tools. It was observed that the level of non-targeted information acquisition varied among participants. The social validity findings indicate that the study's results were satisfactory for participants and their parents. In this section, the study's findings are discussed in detail. The findings of the study show that the VM was highly effective in teaching the skills of "taking orders by phone, preparing orders, delivering orders, and picking up empties inside the building" to individuals with ASD. All participants met the criterion set for the skills in an average of seven sessions. Results from similar studies using VM for teaching vocational skills confirm these findings (English et al., 2017; Kim, 2018; Stauch & Plavnick, 2020).

Conducting research in a real-world environment is a key factor that enhances the generalizability and sustainability of the findings. Previous studies also support the idea that instruction in real environments yields greater skill generalization than simulation-based environments (Alexander et al., 2013; Burke et al., 2020; Migliore et al., 2018). In this study, the applications were conducted in a workplace kitchen, where participants could demonstrate their skills, and their performance was systematically recorded through direct observation throughout the process. In particular, participants demonstrated appropriate problem-solving behaviors in response to unexpected situations (e.g., spilling coffee, making a mistake when giving change). These findings show that individuals with ASD can develop independent problem-solving behaviors in response to naturally arising workplace problems. The fact that participants completed their tasks more quickly and with fewer errors indicates that their productivity in the workplace has increased. However, these results are based solely on systematic observation records; therefore, future research should re-examine these findings using controlled or quasi-experimental designs (Stauch & Plavnick, 2020; Campanaro et al., 2021). Furthermore, teaching practices conducted in real work environments have been found to have the potential to support the social interaction, problem-solving, and occupational adaptation skills of individuals with ASD. The active participation of participants throughout the process facilitated their easier adaptation to the work environment and different task conditions. These findings suggest that teaching in real environments can contribute to the sustainability of employment (Bross et al., 2019; Morgan & Wine, 2018).

The study found that the targeted skills not only support professional abilities but also enhance social interaction skills. It was seen that participants engaged in natural dialogues such as “Hello, how are you?”, “May I repeat your order?” and “Thank you” while demonstrating their skills and initiating interaction with customers. Although these expressions were not included in the teaching objectives, they show that participants were able to use their social communication skills in natural contexts. Systematic observations made throughout the research process revealed that participants completed tasks in less time and with fewer errors as the training sessions progressed. For example, the time taken to prepare toast was approximately 25 minutes in the first training sessions but decreased to 12 minutes in the final sessions. Similar reductions in time were observed for other skills. This indicates that as the teaching process progressed, individuals adapted more to the work environment and performed tasks more effectively. However, since these findings are based solely on the researcher's observations, the statement that “they worked with the same level of efficiency as individuals who had been working at the same workplace for a long time” should be approached with caution. Previous studies also support the idea that training programs conducted in real work environments can have positive effects not only on professional skills but also on social interaction, problem solving, and job fit (Alexander et al., 2013; Burke et al., 2020; Migliore et al., 2018). The observations from this study show that individuals with ASD can respond appropriately to unexpected workplace situations and, in this context, develop independent problem-solving skills. The reduction in participants' performance times suggests that their overall productivity in the workplace has increased. However, to generalize these results, future studies are recommended to use more systematic measurement tools (e.g., task-time recording, video analysis) and to examine performance differences using controlled or quasi-experimental designs (Stauch & Plavnick, 2020; Campanaro et al., 2021). Furthermore, findings suggesting that training conducted in real-world settings can contribute to employment sustainability are supported in the literature (Bross et al., 2019; Morgan & Wine, 2018).

On-the-job training environments are an effective approach for teaching professional skills, enhancing individuals' task performance and adaptation to the work environment (Alexander et al., 2013; Burke et al., 2020; Migliore et al., 2018). In this study, teaching practices were conducted in the workplace kitchen, a real work environment where individuals could demonstrate their skills. Previous studies also support the idea that instruction conducted in real environments provides greater generalization and retention than simulation-based applications (Stauch & Plavnick, 2020).

Participants demonstrated appropriate problem-solving behaviors when faced with unexpected situations during the teaching process. For example, when the second participant spilled coffee while preparing coffee, they cleaned it up on their own after delivering the order, even though this was not included in the teaching objectives. The third participant, unable to give change, went to the cafeteria to get coins and resolved the issue. Such behaviors demonstrate that individuals can functionally use the

skills they learn in natural environments. The observations were systematically recorded by researchers, and the performance data were supported by video analysis.

The findings show that training conducted in real work environments supports not only skill acquisition but also the development of problem-solving and social interaction skills. This suggests it can help individuals with ASD adapt to the work environment and sustain employment (Bross et al., 2019; Morgan & Wine, 2018). Future research should test this finding using more systematic performance measures (e.g., task-time analysis, eye-tracking, or behavior-coding techniques).

In the study, generalization across persons, situations, settings, and equipment was systematically demonstrated. It is observed that studies in the literature generally examine the generalization process by varying a single variable (Babb et al., 2019; Beaver et al., 2017; Bross et al., 2020; Kim, 2018; Morgan & Wine, 2018). The unique aspect of this study, which differs from other studies in the literature, is that the generalization of person, situation, environment, and equipment is included together. The study's generalization data on food and beverage preparation skills are consistent with those of other studies (e.g., Aldi et al., 2016; Bereznak et al., 2012; Johnson et al., 2013). In the study, maintenance data were collected from each participant at 1, 5, and 12 weeks after the criteria were met. It was observed that maintenance data were collected in some studies in which iwASD were taught vocational skills with VM, and the longest period in these studies was 6 weeks (Rausa et al., 2016). In this study, maintenance data were collected after twelve weeks. Although each of the four skills acquired was complex and multi-step, it is imperative that participants still perform at 100%.

It is observed that the non-targeted information gains in the research vary across participants. In the literature, numerous studies have examined non-targeted information acquisition (e.g., Değirmenci & Özen, 2019; Falkenstine et al., 2009). These studies have found that participants' levels of non-targeted knowledge (i.e., skills or knowledge not directly taught but acquired spontaneously during the process) vary. This variation was observed both among participants and across different teaching sessions (see Findings). The findings show that some participants were able to generalize additional knowledge and behaviors more effectively, beyond the targeted skills. In this context, the differences in off-target knowledge levels observed in the study are similar to those reported in previous studies. It is thought that participants' ability to convey off-target knowledge more accurately in some skills may stem from conceptual or functional connections with the relevant target skills. For example, individual past experiences or observations related to order-taking and sandwich-preparation skills may differ. However, there is insufficient evidence to say that this situation stems solely from experiences related to target skills. If this assumption were correct, pre-test results would also be expected to be similarly high. Therefore, an alternative explanation for this finding is that participants used indirect learning pathways during the teaching process, such as observing a model, learning from peers, or sensitivity to contextual cues. Such indirect learning may have supported the unconscious internalization of extraneous information (e.g., Burke et al., 2020; Stauch & Plavnick, 2020).

The social validity findings obtained from the research show that the research is socially valid. iwASD stated that their favorite aspect of the study was learning how to cook and presenting what they had made to others, while their families stated that their belief in their children's ability to work increased. The study's social validity findings are consistent with those of previous studies (Aldi et al., 2016; Bereznak et al., 2012). Another finding that the study is socially valid is that other individuals working in the environment where the skills were acquired shared positive statements with the researchers about the participant's ability to perform these skills easily. This is thought to have contributed to changing the common belief that iwASD cannot be employed in the society they live in.

In addition to its many positive aspects, the study also had some limitations. While the advantage of conducting the intervention in a real-world setting was evident, the intervention also had some limitations. For example, during the intervention, people other than the researchers were present in the workplace, and sometimes the telephone did not work due to power outages.

We have many suggestions based on these concerns and the research process. In this study, social validity data were collected from iwASD and their parents. Opinions of employers and other individuals working in the workplace can also be obtained to increase social awareness and better visualize the research's widespread impact. In addition, the study's findings can be expanded by collecting data on social comparisons. In this study, the skills required of individuals working in the food and beverage sector were identified. In different studies, the skills required across sectors (e.g., for a store clerk) can be taught to facilitate the recruitment and retention of individuals with ASD in employment. In this study, VM, an evidence-based practice, was used. However, in recent years, web-based interventions (such as Web 2.0 and Web 3.0 tools), virtual and augmented reality, and auditory coaching technologies have been used to teach skills to iwASD (Li et al., 2022). These technologies enable iwASD to acquire vocational skills with little or no intervention or support (Bennet et al., 2013; Campanaro et al., 2021). Vocational training is a key element of successful employment for individuals with ASD. While the number of effective practices for teaching vocational skills is increasing, there is still a need for evidence on the best practices for teaching these skills to improve future employment rates among iwASD and maximize their job performance (Chen et al., 2023; Campanaro et al., 2021). In addition, using these practices reduces the time required for face-to-face instruction and can be more efficient and less costly (Campanaro et al., 2021). From this point of view, new studies can be planned that use the mentioned teaching methods to teach professional skills. In this study, the implementation was conducted by the researchers. In future studies, implementations can be carried out by vocational education teachers, job coaches, and peers working in vocational education schools.

Research and Publication Ethics Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of Anadolu University Social and Human Sciences Scientific Research and Publication Ethics Committee (protocol code 71095 and 06.21.2017).

Contribution Rates of Authors to the Article

Conceptualization, Serap Dogan Aslan; methodology Serap Dogan Aslan and Esra Orum Cattik; writing-original draft preparation, Serap Dogan Aslan and Esra Orum Cattik; writing-review and editing Serap Dogan Aslan and Esra Orum Cattik; visualization, all authors; supervision, Yasemin Ergenekon; project administration, Yasemin Ergenekon.

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Statement of Interest

The authors declare no conflicts of interest.

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The Impact of Quizizz on Turkish EFL High School Students' Vocabulary Learning*

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ABSTRACT

Mastering vocabulary plays a pivotal role in the overall process of foreign language learning. Owing to technological progress, mobile-based learning tools have gained significant popularity in aiding learners of English as a foreign language. This research, adopting a mixed-methods design that integrated both quantitative and qualitative perspectives, examined how using the Quizizz platform influenced Turkish EFL learners' vocabulary growth. Participants comprised 64 eleventh-grade students enrolled in a Turkish vocational and technical high school, who were randomly divided into experimental and control groups. During a six-week intervention, students in the experimental group practiced new vocabulary via Quizizz, whereas those in the control group learned identical word sets using conventional whiteboard-based lists. Improvements in vocabulary knowledge were measured through pre- and post-tests specifically developed by the researchers. Students' attitudes toward Quizizz were explored using a 12-item survey complemented by semi-structured interviews. Findings indicated that participants in the experimental group demonstrated notably higher vocabulary improvement than those in the control group. Students further expressed that the Quizizz platform was easy to use, enjoyable, and practical. The overall outcomes highlight how mobile-assisted technologies can effectively foster vocabulary acquisition and boost learner engagement within EFL settings.

Keywords: Vocabulary learning, Quizizz, mobile-assisted tools, language learning

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1. INTRODUCTION

The swift evolution of information and communication technologies in the twenty-first century has significantly reshaped many aspects of daily life, particularly the field of foreign language education. Advances in educational technology have shifted traditional teacher-centered instruction toward more learner-oriented settings that stimulate collaboration, enable instant feedback, encourage autonomy, and promote higher-order thinking and problem-solving abilities (Alsied & Pathan, 2013; Haswani, 2014). Among the most notable innovations in technology-supported language learning is Mobile-Assisted Language Learning (MALL), which involves the integration of mobile devices—especially smartphones—into the process of acquiring new languages (Alotumi, 2020; Hassan et al., 2016). Over recent years, MALL has become increasingly popular because of its accessibility, adaptability, and potential to provide personalized learning experiences (Hu, 2013). In a similar vein, mobile learning (m-learning) allows students to interact with educational materials anytime and anywhere. A variety of mobile-based platforms, including Edpuzzle, Flipgrid, Kahoot, Padlet, Socratic, Quizlet, and Quizizz, have been widely adopted in second language (L2) contexts to promote effective language teaching, learning, and vocabulary development (İpek & Üstünbaş, 2021; Klimova & Polakova, 2020).

Mobile technologies have the potential to extend learning beyond the classroom, responding to shifts in learners' motivation (Kukulska Hulme, 2015). In English as a Foreign Language (EFL) contexts, such technologies are widely used to support the development of core language skills, including listening, speaking, reading, and writing (Klimova, 2021). Among these skills, vocabulary acquisition plays a central role in language learning. Regardless of whether learners are acquiring a first, second, or foreign language, expanding vocabulary is essential for effective communication (Decarrico, 2001, p. 285). However, learners often face challenges such as limited exposure to the target language, lack of autonomy, and insufficient awareness of effective vocabulary learning strategies (Ismail et al., 2017). Research has shown that mobile technologies have been extensively applied

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to second language (L2) vocabulary learning and are generally more effective than traditional methods (Hao et al., 2021). In this regard, educators play a critical role in guiding learners toward the appropriate use of vocabulary learning techniques (Saeidi & Mozaheb, 2012). Technology can support this process by addressing difficulties such as unfamiliarity with learning strategies and limited ability to use new words meaningfully (Heil et al., 2016). As Prensky (2001) suggested, providing learners with a rich digital environment can enhance engagement, sustain attention, and deepen learning. Consequently, MALL is increasingly recognized as a valuable tool for facilitating vocabulary acquisition in EFL classrooms in the digital age (Klimova, 2021; Lei, 2018).

Several studies have reported the effectiveness of MALL programs in promoting vocabulary development in EFL contexts, highlighting the central role of vocabulary in language acquisition (Al-Ahdal & Alharbi, 2021; Bieńkowska et al., 2021; Hu, 2013; Xodabande et al., 2022). For example, Epp and Phirangee (2019) examined the use of a MALL application in a Japanese high school language course with 47 male students. After twelve weeks, participants using mobile tools showed substantial improvements in vocabulary knowledge. Similarly, Xodabande et al. (2022) investigated 55 high school students and found that those who engaged in mobile-based vocabulary learning achieved higher post-test scores than peers who studied using paper flashcards. Fathi et al. (2018) conducted a study with Iranian students and reported significant vocabulary gains for learners using the Memrise app compared to a control group. In another mixed-methods study, Saeidi and Mozaheb (2012) involved 80 upper-intermediate college students who learned 1,200 new words over seven weeks. The experimental group utilized SMS and a mobile learning system, whereas the control group relied solely on paper flashcards; the mobile-assisted group demonstrated higher vocabulary acquisition. Likewise, Başoğlu and Akdemir (2010) observed that 60 Turkish EFL students using mobile technologies outperformed peers who studied with traditional flashcards. Collectively, these findings suggest that MALL programs can significantly enhance vocabulary learning compared to conventional methods.

A growing body of research has explored how gender influences second language (L2) vocabulary development, yielding diverse outcomes. Gu (2002) carried out an extensive investigation revealing that female learners generally performed better than their male counterparts in both lexical range and fluency. In a related longitudinal study, Llach and Gallego (2012) followed 176 Spanish EFL learners (82 girls and 94 boys) over a six-year period spanning grades 4 through 9. Their findings demonstrated that female participants achieved faster vocabulary expansion during the initial three years, reaching their highest progress around grade 7, whereas male students exhibited stronger improvement in the subsequent two years. Collectively, these results underscore the necessity of continued examination into gender-related variations in vocabulary acquisition, particularly during the developmental stage of puberty.

In more recent years, a growing number of investigations have indicated that MALL environments may help to reduce gender-related disparities in vocabulary acquisition. For instance, Jafari and Chalak (2016) explored the use of WhatsApp for daily vocabulary practice among 60 Iranian high school learners (30 males and 30 females) over a four-week period. Their findings demonstrated statistically no significant difference between male and female participants in vocabulary improvement following MALL-based instruction. Likewise, Hassan et al. (2017) examined a computer- and mobile-supported vocabulary program with 122 university students (61 males and 61 females) and concluded that gender had minimal influence on learning performance. In a similar vein, Ashiyan and Salehi (2017) found that, after incorporating WhatsApp for vocabulary instruction, both male and female students exhibited comparable progress, particularly in mastering collocations. Taken together, these findings suggest that while earlier research pointed to possible gender-based differences in vocabulary learning outcomes, more contemporary studies imply that such variations have become less pronounced in MALL-supported contexts. Furthermore, considering the potential influence of factors such as learner motivation, exposure, and sociocultural background, it becomes evident that further empirical research is necessary to better clarify the role of gender in second language (L2) vocabulary development.

Building upon the expanding body of research on MALL, many scholars have examined learners' perceptions and attitudes toward mobile-based vocabulary learning (Alavinia & Qoitassi, 2013; Dizon, 2016; Hu, 2013; Lam et al., 2018; Lander, 2016; Lu, 2008). For instance, Lu (2008) compared mobile-assisted and traditional paper-based vocabulary instruction among 30 Taiwanese vocational high school students and found that learners in the mobile group not only achieved higher vocabulary scores but also displayed more positive feelings toward mobile-supported learning. Similarly, Hu (2013) studied 24 adult Chinese learners and discovered that using smartphones offered a flexible, autonomous, and time-efficient alternative to traditional study routines, which students regarded as both motivating and practical. In addition, Alavinia and Qoitassi (2013) reported that Iranian primary school girls receiving vocabulary input through mobile text messages demonstrated positive attitudes toward technology-enhanced learning experiences.

Extending this line of inquiry, Dizon (2016) investigated Japanese university students' use of Quizlet, a gamified vocabulary application, over a ten-week period. The results revealed that learners perceived the tool as both effective and convenient for improving vocabulary knowledge. Likewise, Lander (2016) observed similar positive outcomes among college students, emphasizing the practicality and motivational value of mobile tools in higher education contexts. Taken together, these studies confirm that MALL not only contributes to measurable gains in vocabulary acquisition but also nurtures learners' autonomy, confidence, and engagement in the language learning process. Therefore, integrating mobile-assisted platforms such as Quizlet into formal EFL instruction can be viewed as a powerful pedagogical approach that harmonizes language development with learner motivation and technological literacy.

1.1. Statement of the Problem

Previous investigations have focused on how mobile technologies contribute to vocabulary learning and have also explored students' perceptions regarding the use of MALL in this area. However, there remains a need to investigate how contemporary mobile applications are utilized by EFL learners across diverse contexts (Kukulska-Hulme & Arcos, 2011). Given the wide range of apps claiming to optimize language learning, the introduction of new programs in EFL classrooms should be guided by educators (Alhadiah, 2020). Among these tools, Quizizz has emerged as a promising application for vocabulary instruction. The platform offers a variety of interactive question formats, including multiple-choice, cloze tests, checkboxes, open-ended questions, and polls (Quizizz, 2022). In addition, Quizizz promotes student engagement through gamified and competitive learning, supports learner autonomy outside the classroom, and encourages active participation during lessons (Degirmenci, 2021; Unesa, 2022).

1.2. Purpose of the Study

Building on the issues identified above, the present study seeks to explore the impact of Quizizz, as a MALL platform, on both vocabulary acquisition and learners' perceptions within a Turkish K–12 EFL context. Specifically, this research aims to evaluate how the use of Quizizz contributes to vocabulary learning outcomes and how students perceive its integration in English language classrooms. In line with these objectives, the study addresses the following research questions:

1. To what extent are there significant differences in vocabulary knowledge between the experimental and control groups before and after the intervention?
2. Does students' vocabulary development vary according to gender?
3. What are participants' perceptions of using Quizizz for vocabulary learning in EFL classes?
4. How does learners' use of Quizizz relate to their behavioral intention (BI), perceived usefulness (PU), and perceived ease of use (PEOU)?

1.3. Problem of the Study

Although MALL has been extensively explored in second language education, most existing studies have concentrated on general aspects of vocabulary acquisition rather than on specific quiz-based mobile applications. In particular, there is a noticeable lack of empirical research examining how interactive tools such as Quizizz contribute to vocabulary learning among high school students in Turkish EFL contexts. Previous investigations have primarily focused on university learners or adult populations, leaving a significant research gap regarding younger learners' engagement with gamified mobile environments. Given this gap, there is a pressing need to explore how contemporary MALL platforms can enhance vocabulary development, learner motivation, and classroom participation in secondary-level EFL instruction. Quizizz, with its game-like interface and instant feedback features, presents a promising digital alternative to traditional teaching methods by combining competition, enjoyment, and autonomy in the learning process. Therefore, this study seeks to examine the implementation of Quizizz as a vocabulary learning tool in Turkish high school settings, aiming to determine its effectiveness, pedagogical relevance, and learner perceptions within the broader framework of technology-enhanced language education.

2. METHODOLOGY

2.1 Research Design

This study adopted a quasi-experimental design with a mixed-methods approach, incorporating pre-tests, post-tests, and interviews to examine the effects of Quizizz as a Mobile-Assisted Language Learning (MALL) tool on EFL learners' vocabulary performance and to explore their attitudes toward using the application over a six-week period. Mixed-methods data collection allows for a more comprehensive understanding of the research problem than either quantitative or qualitative methods alone (Creswell, 2012). Quantitative data were obtained through a multiple-choice vocabulary test administered as both a pre-test and a post-test to both of the groups, as well as a questionnaire. Qualitative data were collected via individual interviews with randomly selected participants from the experimental group, providing an opportunity for learners to describe their experiences in their own words (Merriam & Tisdell, 2015).

2.2. Participants

The participants of this research were 64 voluntary 11th-grade students, aged 16 to 17, enrolled in a state-run vocational and technical high school in Turkey. To ensure comparability, two intact classes were randomly assigned to serve as the treatment and control groups, with 32 learners in each class. The treatment group included 19 male and 13 female students, whereas the control group comprised 22 males and 10 females. All participants were native speakers of Turkish and had received approximately two hours of English instruction per week as part of their formal curriculum. It was also confirmed that none of the students had attended any extra English language courses beyond their regular school program, ensuring a relatively homogenous proficiency level at the outset of the study. The research lasted for six weeks and was implemented during the

spring semester of the 2022–2023 academic year. Students in the experimental group, often referred to as "digital natives" (Prensky, 2001), were already familiar with mobile technologies and demonstrated a strong willingness to integrate digital tools into their learning routines. They were asked to use their personal mobilephones for the Quizizz activities and were provided with reliable internet access throughout the intervention. Before data collection began, informed consent was obtained from all participants and their parents, and official administrative approval was secured from the school management.

2.3. Instruments

2.3.1. Multiple-choice vocabulary test

To assess the participants' vocabulary development, a 60-item multiple-choice vocabulary test was administered to both the experimental and control groups before and after the instructional intervention. The test items were primarily drawn from the eleventh-grade English textbook, while additional distractor items were created from supplementary workbook activities to broaden content variety and ensure comprehensive coverage of the target vocabulary. The instrument functioned as both a pre-test and a post-test, allowing the researchers to measure changes in vocabulary knowledge throughout the study period. To guarantee reliability and internal consistency, a pilot version of the test was first administered to a comparable class of the same grade level that did not take part in the main study. Feedback from this pilot helped refine the clarity and difficulty level of the items, ensuring that the final version accurately reflected participants' vocabulary knowledge.

2.3.2. Online questionnaire

In order to explore learners' perceptions of Quizizz following the intervention, a 12-item online questionnaire was distributed to the experimental group through Google Forms. This instrument was adapted from Dizon (2016) with the author's permission, and the original references to Quizlet were replaced with Quizizz to align with the present study's focus. The questionnaire comprised 5-point Likert-scale statements, ranging from "strongly agree" to "strongly disagree." To enhance clarity and ensure linguistic accuracy, the instrument was translated into Turkish with the assistance of two bilingual experts. The first two items of the survey focused on students' access to Quizizz and the time spent on vocabulary activities each week. The remaining ten items were adapted from Davis's (1989) Technology Acceptance Model (TAM) and centered on three key constructs: Behavioral Intention (BI), Perceived Usefulness (PU), and Perceived Ease of Use (PEOU). Here, PU represents the degree to which learners believe the system improves their performance, while PEOU reflects students' perceptions regarding the simplicity and convenience of using Quizizz as a learning tool.

2.3.3. Face-to-face interviews

Individual interviews were held with six volunteer students from the treatment group to gain deeper insight into their experiences with the vocabulary learning tasks. Each interview lasted at least fifteen minutes. Participants were permitted to use their native language (Turkish) to ensure they could express their thoughts accurately and fully. The interviews were audio-recorded, with participants' consent, and subsequently transcribed into English for analysis. Measures were taken to maintain confidentiality throughout the process.

2.3.4. Quizizz app

Quizizz is a free, online Mobile-Assisted Language Learning (MALL) tool that enables students to complete quizzes and tests at their own pace (Unesa, 2022). For this study, Quizizz was employed to enhance students' L2 vocabulary by providing questions aligned with the seventh unit of the eleventh-grade curriculum. The application engages learners through features such as leaderboards, memes, progress reports, and interactive activities, including matching exercises, multiple-choice items, and fill-in-the-blank tasks. Additional elements, such as colorful graphics, sound effects, and customizable avatars, were incorporated to increase student motivation and participation. Participants were encouraged to answer questions both accurately and promptly to maintain their position on the leaderboard. Quizizz also generates comprehensive performance analytics that enable instructors to monitor learners' vocabulary development systematically. Through these data reports, the researchers were able to track progress within the treatment group and contrast it with the control group's outcomes both before and after the intervention.

2.4. Target Vocabulary

The target vocabulary for the intervention was drawn from the seventh unit of the eleventh-grade EFL curriculum. The original list contained 100 words, and previously learned items from earlier units were excluded in consultation with the teacher. During the six-week intervention, participants were introduced to 60 target words, with 10 words covered each week. The experimental group practiced these words using Quizizz, engaging in activities such as multiple-choice questions, matching exercises (picture-word), and cloze tasks (see Figure 1).

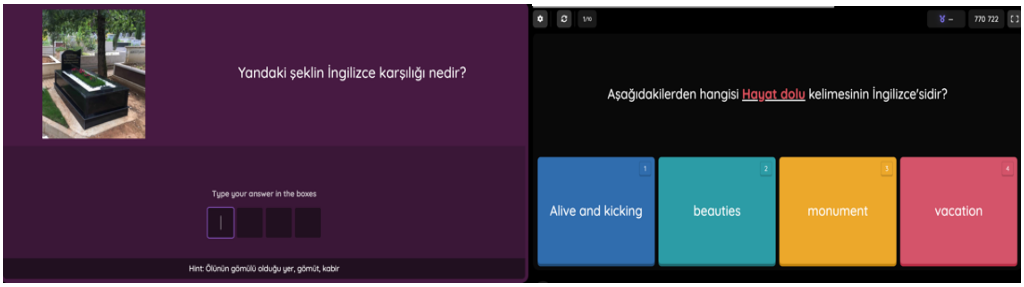


Figure 1. Screen views of the vocabulary exercises applied to the experimental group via quizizz

2.5. Procedure

Before the intervention began, both the treatment and control groups were thoroughly briefed on the study's objectives, procedures, and ethical considerations to ensure confidentiality and voluntary participation. During the first week, a 60-item multiple-choice vocabulary pre-test was administered to determine participants' initial knowledge of the target words, which had been carefully selected from the official EFL curriculum. Following the pre-test, the experimental group received an orientation session introducing them to the Quizizz platform, including guidance on how to download, register, and access the assigned learning materials. Participants were then enrolled in an online Quizizz course that integrated vocabulary sets drawn from the prescribed textbook and workbook. The intervention was carried out over six weeks, encompassing twelve sessions in total. At the beginning of each session, the teacher presented ten new vocabulary items, resulting in 60 target words across the entire treatment period. Learners in the experimental group practiced these items through Quizizz-based tasks—such as multiple-choice, matching, and fill-in-the-blank activities—both during class and independently outside the classroom. In contrast, the control group studied the same items using conventional instruction methods, including teacher-led explanations and board-based exercises. Following the intervention, both groups completed a post-test to measure their vocabulary gains. To further address the third research question, students in the treatment group also completed an online questionnaire designed to capture their perspectives in relation to Quizizz use in vocabulary learning. Additionally, a small number of learners participated in semi-structured interviews, providing qualitative insights into the perceived impact of the application on their learning experience.

2.6. Data Analysis

As this study adopted a mixed-methods design, the quantitative and qualitative data were collected and analyzed separately; however, the results were later integrated to present an in-depth comprehension of the research questions (Creswell, 2012). For the quantitative data, analyses of covariance (ANCOVA) were performed using *Jamovi* software to examine the pre-test and post-test vocabulary scores of both the experimental and control groups. As noted by Pallant (2020), ANCOVA is appropriate for comparing pre-test and post-test differences between groups while controlling for initial variations. In this study, the pre-test served as the covariate. Prior to conducting the analyses, key assumptions—including normality, homogeneity of regression slopes, linearity, reliability of covariates, and correlations among covariates—were tested, and no violations were detected. For the qualitative data, the researchers followed the categorization and coding procedures described by Dörnyei (2007). Participants' responses from the questionnaire and the transcribed interview data were examined to identify recurring themes. These themes were independently coded by the researchers, and the results were then compared and combined to ensure consistency and reliability. The qualitative findings were used to triangulate and enrich the quantitative results, providing deeper insight into the participants' experiences and perceptions.

2.7. Reliability and Validity of the study

To assess item quality, a pilot test with 100 vocabulary items was given to a similar class (n = 60) prior to the main study. After item analysis, each item's discrimination index was determined, and items with low discrimination values or excessive difficulty were eliminated. Strong reliability was indicated by the improved 60-item test's Cronbach's alpha coefficient of α =.919, which also showed good internal consistency. The online survey that was modified from Dizon (2016) was also found to be reliable because its Cronbach's alpha value was higher than the acceptable cutoff .70, indicating adequate internal consistency. Two professors from a Turkish institution examined the questionnaire and attested to its linguistic and contextual suitability to guarantee the authenticity of the Turkish version.

3. FINDINGS

The results of the present study integrate both quantitative and qualitative analyses that address the four research questions formulated earlier. Quantitatively, the results provide insight into learners' readiness levels prior to the intervention, their progress in vocabulary acquisition, and the potential influence of gender on performance outcomes. Qualitatively, students' attitudes and perceptions toward using the Quizizz platform for vocabulary learning in EFL settings were explored in depth.

3.1. Students' Readiness Level

As the first research question focused on evaluating the initial proficiency levels of the participants, it was necessary to determine their readiness before the treatment began. To this end, a 60-item vocabulary test—developed and validated by the researchers—was administered as both a pre-test and a post-test. The results from the pre-test confirmed that students in both the experimental and control groups had comparable English proficiency levels at the outset of the study. To ensure the accuracy of this assumption, the pre-test data from both groups were subjected to statistical analysis. Table 1 and Figure 2 present the participants' pre-test results. The normality of the data distribution was assessed using the Q–Q plot, which indicated that the data were approximately normally distributed.

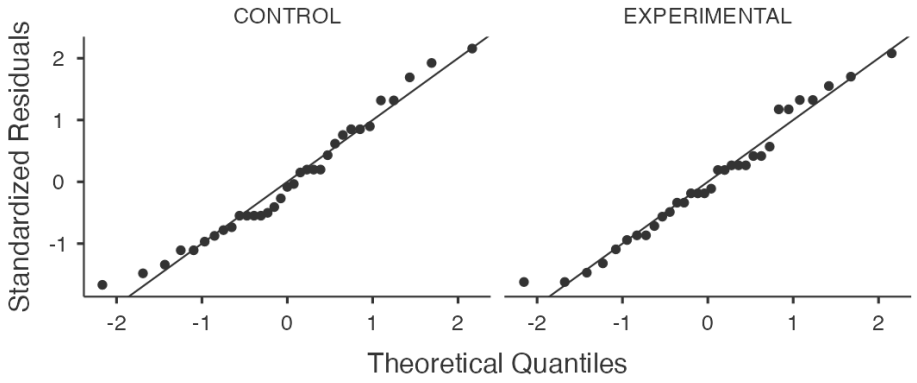


Figure 2. Readiness of control and experimental group

Figure 2 indicates that the results of the pretest in both groups correspond to the readiness level of the participants that was assumed before the start of the study.

Table 1.
Results of the Descriptive Statistics

	Group	***N***	***M***	***SE***	***SD***
Pre-test	Control	32	43.8	3.73	21.4
	Experimental	32	44.5	2.34	13.2

As presented in Table 1, both the experimental and control groups included 32 participants. The mean pre-test score of the control group was 43.8, while that of the experimental group was 44.5. These nearly identical averages suggest that participants in the two groups had comparable levels of English proficiency prior to the intervention. The descriptive statistics therefore confirm that any observable differences in the post-test phase are likely the result of the treatment itself, rather than variations in learners' initial vocabulary knowledge.

3.2. Results Related to the First Research Question

RQ1. To what extent are there significant differences in vocabulary knowledge between the experimental and control groups before and after the intervention?

To address the first research question, the study examined whether there were any statistically significant differences in vocabulary performance between the experimental and control groups following the intervention. Since ANCOVA was applied to account for any potential pre-test variations between groups, it provided a more precise comparison of post-test outcomes. The descriptive statistics for participants' pre- and post-test performance are presented in Table 2 below.

Table 2.
Post-test ANCOVA Statistical Results

	Sum of Squares	***Df***	***Mean Square***	***F***	***p***
Group	1274	1	1274	4.06	0.048
Pre-test	4212	1	4212	13.42	< .001
Residuals	19457	62	314		

As shown in Table 2, the ANCOVA results demonstrated that students in the treatment group gained higher vocabulary scores than those in the control group after the six-week intervention. This suggests that exposure to Quizizz-based vocabulary practice had a measurable and positive impact on learners' vocabulary acquisition. Moreover, the use of ANCOVA strengthened the

statistical validity of the results by controlling for baseline differences and reducing potential error variance. Overall, these findings suggest that incorporating Quizizz into English vocabulary instruction fosters more substantial vocabulary improvement than conventional classroom practices, thereby reinforcing the pedagogical value of MALL tools in EFL settings.

3.3. Results Related to the Second Research Question

RQ2. Does students' vocabulary development vary according to gender?

Regarding the influence of gender on L2 vocabulary growth, a scatter plot was used to illustrate the gender-specific scatter analysis (see Figure 3). An ANCOVA test was also carried out to determine the influence of gender on vocabulary acquisition (see Figure 3).

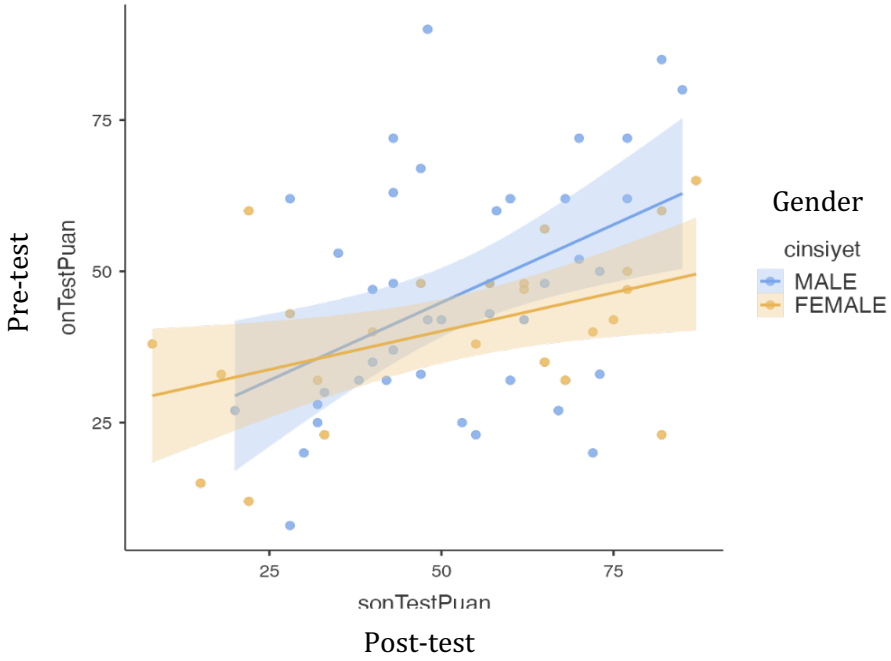


Figure 3. Scatter plot analysis

A scatter plot was utilized to visually examine the relationship among key variables, namely gender, pre-test scores, and post-test scores. As depicted in Figure 3, a slight positive correlation was observed between students' pre- and post-test performances across gender groups. This indicates that while both male and female participants showed improvement following the intervention, the degree of progress remained relatively consistent between the two groups.

Table 3.
Gender ANCOVA Statistical Results

	Sum of Squares	***Df***	***Mean Square***	***F***	***p***
Group	4380.2	1	4380.2	13.147	< .001
Pre-test	73.9	1	73.9	0.222	0.639
Residuals	20656.6	62	333.2		

The outcomes of the ANCOVA analysis, summarized in Table 3, indicated that gender had no significant influence on students' vocabulary gain ($p > .05$). While both genders benefited from the intervention, the differences in their post-test performance were minimal. These findings demonstrate that the Quizizz integrated learning activities were equally effective for learners regardless of gender, highlighting the inclusive potential of mobile-assisted vocabulary teaching in EFL contexts.

3.4. Results Related to the Third Research Question

RQ3. What are participants' perceptions of using Quizizz for vocabulary learning in EFL classes?

To explore how participants in the treatment group perceived the Quizizz intervention, the qualitative data were analyzed in two stages. First, volunteer students participated in individual, semi-structured interviews to share their experiences and attitudes toward using Quizizz. Second, a 12-item questionnaire was administered to all members of the treatment group (n = 32) to further examine their perceptions of the app's usefulness and overall impact on their learning.

3.4.1. Findings of open-ended interviews related to the students' perceptions

The answers of the participants from the treatment group were analyzed through thematic analysis to identify recurring patterns. The analysis revealed four overarching themes—feelings**,** vocabulary learning, intention to use in the future, and problems—along with eight associated subthemes. These themes collectively represent the participants' experiences and attitudes toward the use of Quizizz in English vocabulary acquisition. Figure 4 presents a schematic illustration of the main and subthemes that emerged from the interviews.

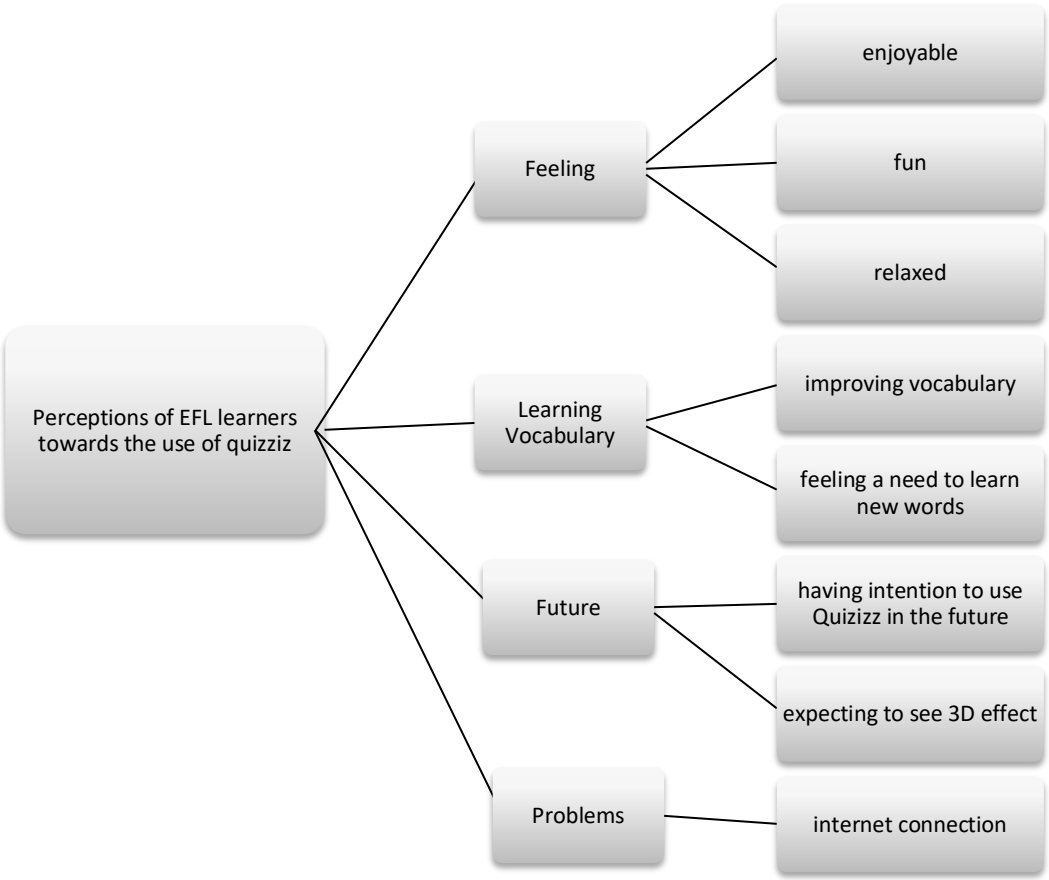


Figure 4. Perceptions of EFL learners towards the use of Quizizz.

The participants in the experimental group were asked to describe their experiences with Quizizz in learning new English words. Table 4 indicates the results of the data obtained from the respondents.

Table 4.
Perceptions of EFL Learners Towards the Use of Quizizz

Learners' attitudes towards Quizizz	***Percent***
Feeling enjoyable	67%
Feeling fun	17%
Feeling relaxed	17%
Learning Vocabulary improving vocabulary	50%
Feeling a need to learn new words	17%
Having intention to use Quizizz in the future	50%
Expecting to see 3D effect	17%
Having problems internet connection	17%

According to Table 4, 67% of learners stated that they enjoyed learning new words with the Quizizz app. In addition, 17% of participants felt fun and relaxed. For instance:

P4: "I really enjoyed the game version of this app."
P1: "I think it was fun to use Quizizz with my smartphone in class."
P5: "It was fun practicing new words and having fun as if I was playing a game. I was relaxed when I saw my level of understanding and my name on the scoreboard among my friends."

Participants found Quizizz easy to use to expand their English vocabulary. 50% of students reported that the Quizizz app improved their L2 vocabulary. 17% of participants stated that they felt the need to learn new words while using the Quizizz app. Quizizz was perceived as a convenient tool to improve English vocabulary. As some of them stated:

P3: "It was a good experience for me because it was easy to use it with my phone. I talked about it with my friends and learned new words, and that made me happy."
P1: "For me, using Quizizz was easy to use Quizizz because I could learn new words so quickly."
P5: "I can say that the Quizizz app has enriched my vocabulary."
P2: "I felt that I needed to learn some new English words. The questions were easy to understand, and I was able to answer them quickly."
According to the respondents' answers to the question "What are the good and bad sides of Quizizz?", 17% of them said that they would like to see a 3D effect in the future, and 17% of them said that they have problems with internet connection.

For example:
P2: "I had a bit of a problem with the internet connection sometimes, but it was easy for me to learn how to use it."
P4: "It was a good experience for me. However, I expect a 3D effect in this app. That might excite me even more."

In the face-to-face interviews, when asked "Would you learn English words with Quizizz if you had the opportunity?", nearly half of the participants declared that they intended to use the platform for vocabulary practice in the future. Sample responses included:
P6: "I will certainly use the Quizizz app in my English classes next year. I will prepare study sets for my friends because we all had fun answering the questions."
P4: "I will use the app in my future English lessons."

3.4.2. Findings of the 12-item questionnaire related to students' perceptions

The perceptions of the treatment group in regard to the usage of the Quizizz app were also examined through a 12-item online questionnaire. The first item asked participants to indicate their preferences when accessing and using Quizizz. This question aimed to identify how students typically engaged with the app (e.g., through smartphones, tablets, or computers) and their general patterns of usage during the study.

Table 5.
Device Preference for Quizizz

Material	***Counts***	***% of Total***	***Cumulative %***
Smart Phone	32	100.0 %	100.0 %

Table 5 summarizes students' device preferences for accessing Quizizz during the study. The results indicate that all participants (100%) reported using their smartphones to complete the activities. This outcome reflects the dominant role of mobile devices in digital learning environments, particularly among technology-oriented and digitally native learners. In the second item, students were asked to specify the amount of time they spent using Quizizz outside the classroom each week. Their responses provided valuable insights into the extent of self-directed engagement with the application. The distribution of these results is displayed in Table 6 below.

Table 6.
Amount of Time Participants Spent on Quizizz Outside the Classroom

Time	***Counts***	***% of Total***	***Cumulative %***
20-40 minutes per week	7	21.9 %	21.9 %
Less than 20 minutes per week	24	75.0 %	96.9 %
Between 40-60 minutes per week	1	3.1 %	100.0 %

As shown in Table 6, the majority of participants (75%) reported spending less than 20 minutes per week using Quizizz outside of class. A smaller portion of participants (21.9%) indicated that they used Quizizz for 20–40 minutes weekly, while only 3.1% of the participants reported spending between 40–60 minutes per week on the app. These findings suggest that although most students engaged with Quizizz beyond classroom hours, the duration of their independent use remained relatively limited.

3.5. Results Related to the Fourth Research Question

RQ4. How does learners' use of Quizizz relate to their behavioral intention (BI), perceived usefulness (PU), and perceived ease of use (PEOU)?

According to the Technology Acceptance Model (TAM), users' perceived usefulness (PU) reflects the belief that utilizing a given system contributes to better learning performance, whereas perceived ease of use (PEOU) represents the perception that the system is straightforward and requires minimal effort to operate (Dizon, 2016). As proposed by Davis (1989), an individual's behavioral intention (BI) to continue using a technological tool is shaped by both PU and PEOU, in addition to contextual factors such as motivation and learning environment. In this study, Pearson correlation coefficients were computed to determine the relationships among BI, PU, and PEOU and to explore how these factors interact in influencing learners' willingness to use Quizizz for vocabulary learning. The outcomes of this correlation analysis are displayed in Table 7 below.

Table 7.
Pearson's r for PU, PEOU and BI

		Behavioral intention		***Perceived ease of use***		***Perceived usefulness***
Behavioral Intention	Pearson's *r*	—				
	p-value	—				
	N	—				
Perceived Ease of Use	Pearson's *r*	0.440	*	—		
	p-value	0.013		—		
	N	32		—		
Perceived Usefulness	Pearson's *r*	0.638	***	0.603	***	—
	p-value	< .001		< .001		—
	N	32		32		—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

The Pearson correlation analysis revealed significant positive relationships among the three constructs of the Technology Acceptance Model (TAM)—Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Behavioral Intention (BI). As summarized in Table 7, both PU and PEOU showed a meaningful association with BI. Specifically, PU demonstrated a stronger correlation, indicating that learners who viewed Quizizz as more effective for enhancing their learning performance were also more inclined to continue using it. Although PEOU presented a slightly weaker, yet still positive correlation with BI, it suggests that students valued the platform's simplicity and accessibility when engaging in vocabulary tasks. Overall, these findings highlight that participants tended to perceive Quizizz as a practical and supportive digital tool for vocabulary learning, contributing positively to their motivation and willingness to integrate it into future language-learning experiences. To gain deeper insight into students' perceptions, the remaining questionnaire items were further analyzed through descriptive statistics, focusing on the mean and standard deviation values of the three constructs (PU, PEOU, and BI). The results of this analysis are displayed in Table 8 below.

Table 8.
PU, PEOU and BI Mean and SD of Participants

Construct	***M***	***SD***
PU	4,56	0,552
PEOU	4,53	0,533
BI	4,35	0,649

Table 8 presents the means and standard deviations of the ten questionnaire items for the three TAM constructs: perceived usefulness (PU)**,** perceived ease of use (PEOU), and behavioral intention (BI)**.** All mean scores exceeded 4 (PU = 4.56, PEOU = 4.53, BI = 4.35), indicating that participants held a generally positive attitude toward Quizizz as a MALL tool in the EFL context.

Among the three constructs, PU emerged as the most prominent (M = 4.56, SD = 0.552). Within this construct, the third item, *"The use of Quizizz made it easier to learn English vocabulary,"* received the highest rating (M = 4.60, SD = 0.502), reflecting participants' perception of the app's practical benefits for vocabulary learning. For PEOU, both the first item, *"It was easy for me to study English vocabulary with Quizizz,"* and the fourth item, *"The Quizizz website and/or mobile app was clear and understandable,"* were rated equally high (M = 4.61), indicating that participants found Quizizz intuitive and user-friendly. Regarding BI, the second item, *"I intend to study English vocabulary with Quizizz in the future,"* had a mean of 4.39 (SD = 0.672), demonstrating that students expressed a clear intention to continue using Quizizz in their EFL learning.

4. RESULTS, DISCUSSION, AND RECOMMENDATIONS

Vocabulary learning has a fundamental role in foreign language acquisition. The objective of the present study was to investigate the impact of Quizizz on Turkish EFL students' vocabulary development, investigate whether gender influenced vocabulary acquisition, and explore learners' perceptions of the Quizizz app. To achieve these aims, the study compared the vocabulary performance of the experimental and control groups before and after the intervention, analyzed the influence of gender on vocabulary growth, and assessed the experimental group's perceptions of using Quizizz as a MALL tool.

The first research question focused on examining the effect of Quizizz on 11th-grade EFL learners' vocabulary development. The results indicated that the Quizizz-based intervention effectively improved the experimental group's vocabulary performance compared to the control group. This finding is consistent with prior research highlighting the effectiveness of MALL tools in facilitating vocabulary acquisition (Başoğlu & Akdemir, 2010; Epp & Phiranage, 2019; Fathi et al., 2018; Saeidi & Mozaheb, 2012; Xodabande et al., 2022). In particular, the present results reinforce earlier evidence that gamified mobile learning environments can enhance vocabulary recall through repetition, interactivity, and immediate feedback. The integration of visual elements, points, and progress tracking likely increased learner attention and retention, transforming vocabulary practice into an enjoyable, goal-oriented process. Furthermore, Quizizz appeared to foster motivation and self-regulation, as students received instant feedback and could monitor their own development throughout the six-week intervention.

However, these findings contrast with those of Bal (2018), who reported no significant differences in vocabulary scores between groups following a Quizizz-based program. One possible explanation for this inconsistency may lie in methodological factors such as the length of the intervention, the frequency of exposure, or the nature of the vocabulary tasks. In the present study, participants engaged in multiple sessions per week and were actively encouraged to interact with the platform both in and outside the classroom. Such regular practice may have contributed to deeper lexical processing and more stable learning outcomes, suggesting that duration and sustained engagement are key determinants of vocabulary growth in MALL-supported environments.

The second research question focused on the possible influence of gender on learners' vocabulary development. The analysis revealed no statistically significant differences in vocabulary performance between male and female participants. This finding is consistent with prior research that reported no gender effect in L2 vocabulary acquisition (Ashiyan & Salehi, 2017; Hassan et al., 2017; Jafari & Chalak, 2016), indicating that both male and female learners can benefit equally from gamified digital learning environments when provided with similar learning opportunities. However, this result diverges from Gu (2002), who found that female students outperformed males in vocabulary learning. These contrasting outcomes highlight the importance of contextual and methodological factors—such as motivation, learning strategies, or cultural attitudes toward technology—that may interact with gender. Therefore, further research is needed to explore gender-related variables in different educational settings and across diverse age groups, as also suggested by Llach and Gallego (2012). Overall, the present study supports the idea that engagement and frequency of practice play a more decisive role than gender in determining learning outcomes in mobile-assisted vocabulary instruction.

The third research question focused on learners' perceptions of Quizizz as a vocabulary learning tool. Both the interview and questionnaire data indicated that participants found Quizizz easy to use, practical, and enjoyable. All participants used their smartphones to access the app and most reported spending additional time practicing outside of class, even though it was not mandatory. These findings are consistent with earlier studies on MALL tools such as Quizlet, which documented positive learner attitudes toward mobile-assisted vocabulary learning (Alavinia & Qoitassi, 2013; Alhadiah, 2020; Dizon, 2016; Hu, 2013; Lam et al., 2018; Lander, 2016; Lu, 2008). Learners in the current study particularly valued the gamified nature of the app, its user-friendly design, and the opportunity to receive immediate feedback. They also expressed greater motivation and willingness to continue using Quizizz in future English courses, suggesting that the app not only facilitates vocabulary learning but also promotes learner autonomy and enhances digital literacy.

Despite these positive findings, the study acknowledges several limitations. First, the intervention lasted only six weeks; therefore, longer-term studies are required to determine whether the observed improvements can be sustained over extended periods. Second, the study was conducted with a relatively small and homogeneous sample, which may restrict the generalizability of the findings to broader populations or varied educational contexts. Future research should involve participants from diverse age groups, proficiency levels, and cultural backgrounds to ensure the robustness and validity of these findings. Third, the present study concentrated exclusively on vocabulary acquisition; however, MALL-based learning has the potential to enhance other language skills. Exploring the transfer effects of vocabulary learning to these broader language competencies would yield a more comprehensive understanding of the pedagogical value of gamified learning environments.

In conclusion, the findings of this study offer empirical evidence supporting the effectiveness of MALL tools in enhancing vocabulary learning in EFL settings. Integrating mobile-assisted applications such as Quizizz can significantly boost learners' engagement, motivation, and sense of autonomy—three key components of successful language learning. The combination of gamification, feedback, and competition in Quizizz appears to promote both cognitive and affective engagement, making vocabulary learning more dynamic and learner-centered. Consequently, educators are encouraged to incorporate such digital platforms strategically into classroom instruction, ensuring alignment with curricular goals and learner needs. Future research

should further investigate how factors such as proficiency level, instructional design, and frequency of use interact to influence learning outcomes. Ultimately, the present study contributes to the growing body of evidence that technology-enhanced, game-based learning can serve as a powerful complement to traditional instruction, promoting sustainable vocabulary development and overall language proficiency among EFL learners.

Research and Publication Ethics Statement

The authors confirm that all procedures performed in this study were in accordance with the ethical standards of institutional and national research committees. Ethical approval for the study was granted by the Ordu University Social and Human Sciences Research Ethics Committee (Session No: 03, Decision No: 2023-67, Approval Date: March 30, 2023).

Contribution Rates of Authors to the Article

The authors state that they have had equal contributions to the present study.

Statement of Interest

The authors declare that they both share no conflict of interest.

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Evaluation of the 2024 Türkiye Century Education Model (TCEM), 2024 Life Studies Curriculum and Life Studies Textbook*

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ABSTRACT

The aim of this study is to determine first-grade teachers' views regarding the 2024 Türkiye Century Education Model (TCEM), the Life Studies curriculum, and textbooks. The study adopted a qualitative research design based on a phenomenological approach. The research was conducted with first-grade teachers working in primary schools in the Üsküdar district of Istanbul. Data were collected through voluntary individual interviews. The number of participants was determined according to the principle of data saturation, and data collection was concluded with 15 participants when responses began to repeat. The interview data were analyzed using content analysis. The findings indicate that teachers considered the in-service training provided during the seminar period to be inadequate, as it did not sufficiently take into account classroom realities such as crowded classrooms and limited instructional resources. Teachers also reported receiving insufficient guidance regarding differentiation, one of the core components of the model, resulting in differentiation practices being largely dependent on individual teacher efforts. In addition, the content of the Education Information Network (EBA) was perceived as not fully aligned with the new curriculum. Criticisms further focused on the limited involvement of teachers in the curriculum development process, the increased content density despite a reduction in learning outcomes, and the growing complexity of assessment and evaluation practices. On the other hand, teachers highlighted several positive aspects, including the improved functionality of textbooks, the support of digital resources in instruction, a stronger emphasis on values education, and increased student participation. Overall, the findings reveal that teachers' curriculum literacy is limited and that instruction remains largely textbook-centered, indicating insufficient familiarity with the guidelines presented in the "Teaching and Learning Practices" section of the curriculum. Based on these findings, it is recommended that the Ministry of National Education develop clear and comprehensive teacher guides to support effective classroom implementation of the curriculum.

Keywords: 2024 Türkiye Century Education Model, 2024 Life Studies Curriculum, Life Studies textbook, primary school, teacher

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1. INTRODUCTION

1.1.The 2024 Türkiye Century Education Model (TCEM)

Every state aims to educate its citizens in line with social developments and scientific advancements through its educational institutions (Satmaz & Yabanova, 2024). Individuals who are educated in a qualified manner contribute to the transformation and development of their countries, thereby creating a mutually reinforcing cycle. In Türkiye, where compulsory education lasts for 12 years, each curriculum reform directly influences the future of both youth and society. Curriculum development is a complex process that incorporates numerous components. The stages of implementation and evaluation, in particular, require the careful use of the nation's limited resources, including energy, labor, time, and financial means. In today's world, characterized by the rapid advancement of science and technology, educating new generations with up-to-date and innovative curricula has become inevitable. Since 1924, Türkiye has accumulated substantial experience in curriculum development. In this context, the Ministry of National Education most recently launched the 2024 TCEM, which began to be gradually implemented in the 2024–2025 academic year as a new step in this ongoing reform process.

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The 2024 TCEM was developed with a holistic perspective (Arslankara & Arslankara, 2024; MoNE, 2024). Within this framework, the primary aim has been to design an indigenous and nationally grounded curriculum based on the K12 Skills Framework (Akpınar & Köksalan, 2024). Prepared with the support of UNICEF and through a commission established within the Ministry of National Education, the program was initially referred to as the "K12 Skills Framework Türkiye Holistic Model" and was later revised and renamed as the "Türkiye Century Education Model" (Yıldırım & Çalışkan, 2024). While sharing many similarities with the 2018 curriculum, the 2024 TCEM provides a more comprehensive and inclusive structure by explicitly addressing interdisciplinary approaches, literacy skills, social-emotional learning, the virtue–value–action framework, concretization, digital content, differentiation, and assessment–evaluation processes in detail (Arslankara & Arslankara, 2024; Bekiroğlu & Güllühan, 2024; MoNE, 2024).

The program's educational philosophy, framed within a holistic approach, encompasses essentialism, perennialism, progressivism, and reconstructionism, and has therefore been described as a "global mixture." While this diversity is argued to provide multidimensionality in instructional practice, it is also seen as potentially leading to inconsistencies among program components such as learning outcomes and assessment processes (Akpınar et al., 2024). Major criticisms include the absence of a needs analysis and pilot implementation (Berk & Özer, 2024; ERG, 2024; Uygun & Akgül, 2024), reliance on a limited group of academics and teachers during development, lack of conceptual coherence (ERG, 2024), insufficient scholarly grounding (Yurdakal, 2024), and the emergence of duality in practice due to the renewal of some subject curricula while others remained unchanged in the weekly timetable set by the Board of Education (Karataş, 2024). Additional criticisms highlight that, despite the reduction in the number of learning outcomes, the inclusion of components such as social-emotional learning, values-action integration, and literacy skills has rendered the program more complex (Karataş, 2024); that the underlying educational philosophies are not clearly defined (Akpınar vd., 2024); and that the official document lacks a reference list (ERG, 2024, 76; Yurdakal, 2024). Views on the 2024 TCEM are generally categorized under two main headings: positive and negative. The concept of *maarif* has been positively evaluated by some for its reference to national consciousness, whereas others have criticized it on the grounds that it is not part of contemporary usage and evokes a sense of regression (Yurdakal, 2024).

Among the positive views of the model are the detailed inclusion of differentiation and extracurricular activities in the program; the adoption of an approach that prioritizes students' discovery of knowledge; the integration of technology into education (Akpınar et al., 2024; Uygun & Akgül, 2024); the explicit emphasis on skills and practice (Akpınar et al., 2024); and the incorporation of nine distinct literacy domains into the curriculum, including financial, informational, technological/digital, sustainability, and data literacy (Karataş, 2024).

Despite these criticisms, the 2024 curriculum also introduces notable innovations compared to previous reforms. While the curricula designed since 2005 have presented a hierarchical structure based on Bloom's taxonomy, the 2024 curriculum introduces a more integrated framework that encompasses disciplinary skills, conceptual skills, social-emotional learning skills, literacy competencies, and the integrity of virtue–value–action. Designed in line with the K-12 Skills Framework, the 2024 program adopts a holistic approach that emphasizes the importance of considering not only cognitive goals but also social and emotional dimensions of development (Aşkar & Altun, 2023). In this respect, it represents a model aimed at preparing students for life in a multifaceted manner.

In the 2024 autumn seminar period, in-service training on the TCEM was provided by mentor/trainer teachers. Common documents were prepared by the Ministry of National Education (MoNE) to ensure the standardization of the materials used in the training across the country. The training was primarily offered to kindergarten, 1st, 5th, and 9th-grade teachers—the levels where the new model would be implemented; however, in institutions with suitable physical conditions, all other class and branch teachers were also allowed to participate. These training sessions were conducted face-to-face during the seminar period. The main goal of the training was to ensure that teachers rapidly adapted to the structural and content changes brought by the new curriculum and acquired the necessary knowledge and skills to effectively implement the program in their classrooms.

1.2.Life Studies Curriculum

The Life Studies course is a core subject taught during the first three years of primary school. Its primary aim is to contribute to students' personal and social development by equipping them with essential life skills and values (Kabapınar, 2012). In this context, the course seeks to help children recognize themselves and the society in which they live, adapt to social life, understand their environment, and acquire the knowledge and skills necessary to become qualified citizens. Life Studies is structured to prepare students for life by teaching them how to cope with challenges they may encounter (Atik & Aykaç, 2019; Kabapınar & Baysal, 2004; Kabapınar, 2012; Şahin, 2009). In this respect, other courses are largely shaped by the themes introduced in Life Studies. It is a comprehensive, multidisciplinary subject that introduces students to themselves, the world, and the universe, and provides a guiding framework for other subjects.

Within the framework of the 2024 Türkiye Century Education Model (TYMM), the Life Studies Curriculum has undergone a notable conceptual and structural transformation compared to the 2018 curriculum. While both curricula share core principles such as interdisciplinarity, constructivism, process-oriented instruction, and student-centered learning, the 2024 curriculum adopts a broader terminology and a more integrated and holistic structure. In addition to maintaining a skills- and competency-

based orientation, the new curriculum introduces key features of the TYMM, including the EDE (erdem-değer- eylem) model, differentiation, school-based planning, learner dispositions, and multiple literacies. Although the general aims of the Life Studies course remain largely similar, the 2024 curriculum expands the scope of specific aims by placing greater emphasis on themes such as family, national consciousness, and valuing science and the arts. Structurally, the curriculum shifts from a unit- and outcome-based model to a cyclical, process-oriented design that integrates learning outputs, process components, teaching–learning experiences, and learning evidence. Despite a numerical reduction in learning outputs, the inclusion of process components results in a comparable level of learning density (Köseoğlu & Şahin, 2024).

The 2024 TCEM adopts an approach that prioritizes skills alongside knowledge acquisition. While students are expected to acquire and articulate relevant rules and information, which corresponds to the cognitive dimension of learning, greater emphasis is placed on transforming this knowledge into applicable skills that can be effectively integrated into daily life. In this context, conceptual skills occupy a central position within the model, as they enable learners to internalize knowledge and apply it meaningfully across real-life situations (Gündoğan-Güngör, 2025, 85).

1.3. 2024 Life Studies Textbook

In Türkiye, the Life Studies course has undergone continuous transformation in response to social changes and educational policies; each curriculum period has reflected the prevailing educational philosophy of its time. This historical trajectory demonstrates that the Turkish education system has remained responsive to both societal and global transformations.

In the 2024–2025 academic year, when the 2024 TCEM began to be implemented, textbooks for preschool, first, fifth, and ninth grades were prepared in alignment with the new curriculum. As one of the most significant instruments for curriculum implementation, textbooks have undergone substantial changes—particularly following the 2005 shift from a behaviorist-based program to a constructivist approach. They became more visually engaging, offered a greater variety of activities, and paid closer attention to children's developmental characteristics. The 2024 Life Studies textbook, in addition to these enhancements, makes the learning process more enjoyable through cut-and-paste activities included at the end of the book and supports technological integration via QR codes, a feature introduced in both the 2018 and 2024 curricula. Furthermore, the Education Information Network (EBA), developed by the Ministry of National Education, provides supplementary digital materials that support teachers at every grade level (https://www.eba.gov.tr/). With the publication of the textbooks in two volumes, the first three learning domains (Self and My School, My Health and Safety, My Family and Community) are included in the first book, while the remaining three (My Environment and My Country, Nature and Environment, Science, Technology, and Art) are placed in the second. This practice not only facilitates ease of carrying for students but also reduces the physical wear of the books. Moreover, the distribution of new volumes in the second semester is expected to help sustain students' curiosity and motivation toward the course.

The 2024 textbook is designed in line with a student-centered understanding that promotes active student engagement and values learners' opinions, positioning the teacher in a guiding role. Accordingly, it is reported that the textbook places greater emphasis on activities aimed at enhancing student practice and skill development (Kalender, 2025).
However, beyond textbooks and EBA-supported materials, the success of the curriculum is closely tied to how teachers—the direct implementers—understand the program and transfer it into classroom practice. Otherwise, the curriculum risks remaining merely on paper or, as in the case of the constructivist approach introduced in 2005, being confined to a superficial "as if" implementation (Berk & Özer, 2024; Karataş, 2024).

1.4. Statement of the Problem

Although a growing number of studies published in 2024 have examined the Life Studies Curriculum within the framework of the Türkiye Century Education Model, most of these studies focus on document analysis, curriculum comparison, or teachers' general perceptions of the model. In contrast, the present study differs from existing research, including Arslan (2025), in several important respects. First, it was conducted during the early implementation phase of the model, approximately three months after schools opened, thereby capturing first-grade teachers' initial classroom experiences with a curriculum that was introduced without prior pilot testing. Second, the study focuses specifically on the Life Studies course and examines the curriculum, classroom practices, and textbooks together, offering a holistic and practice-oriented perspective. Third, by addressing teachers' experiences with differentiation, in-service training, and instructional guidance, the study moves beyond curriculum descriptions to reveal implementation-related challenges and support needs. In this respect, the study contributes original empirical evidence on how the Türkiye Century Education Model is interpreted and enacted in real classroom settings and provides insights that may inform curriculum development and revision processes at different grade levels.

In this context, the following research questions were addressed:

1. How do first-grade teachers evaluate the training they received within the scope of the 2024 TCEM?
2. What are first-grade teachers' overall views regarding the 2024 TCEM?
3. How do first-grade teachers assess the "differentiation" practices included in the 2024 TCEM?
4. What are first-grade teachers' perspectives on the assessment and evaluation process envisaged in the 2024 TCEM?
5. How do first-grade teachers evaluate the 2024 TCEM Life Studies Curriculum?

6. What are first-grade teachers' views concerning the 2024 TCEM Life Studies textbooks?

2. METHODOLOGY

2.1. Research Design

In this study, the 2024 Türkiye Century Education Model, the Life Studies Curriculum, and the 2024 Life Studies textbook were evaluated based on the perspectives of first-grade teachers. To achieve this, a phenomenological design, a powerful qualitative research approach, was employed. Phenomenology focuses on phenomena that are recognized but not yet fully or deeply understood; it provides an appropriate framework for exploring situations whose meanings have not been comprehensively grasped. Interviews serve as the primary data collection tool in phenomenological research (Creswell, 2018; Yıldırım & Şimşek, 2016). Understanding the mental processes of teachers in a study is inherently complex, as decoding a participant's 'mental map' presents significant theoretical and practical challenges (Priestley, Robinson & Biesta, 2011). Consequently, semi-structured interviews were utilized to collect data, thereby enabling the acquisition of profound, in-depth insights into the teachers' lived experiences.

2.2. Study Group

"In qualitative research, sampling is closely related to selecting the most suitable individuals who can respond to the research questions. The guiding principle in determining participants is to obtain qualified data that serve the purpose of the study. Therefore, selecting participants who can provide rich data is of primary importance" (Yıldırım & Şimşek, 2016, p. 354).

In this study, two purposive sampling strategies—convenience sampling and criterion sampling—were employed. Convenience sampling was used in selecting the district in order to minimize the loss of time, cost, and labor, and Üsküdar district was chosen (Büyüköztürk et al., 2018). Criterion sampling was applied in the selection of participants. The criterion was that, since the 2024 TCEM was being implemented for the first time in first grades during the 2024–2025 academic year, the teachers had to be currently teaching first grade.

The participant teachers were selected from four different schools:
1. School: SÖ1, SÖ4, SÖ6, SÖ7, SÖ9, SÖ11
2. School: SÖ2, SÖ3, SÖ5, SÖ8
3. School: SÖ10, SÖ13, SÖ14
4. School: SÖ12, SÖ15

The interviews were conducted on a voluntary basis. In determining the number of participants, the concept of "saturation point" described by Glaser and Strauss (1967) in qualitative research—referring to the stage at which concepts and processes related to the research questions begin to repeat—was taken into consideration (cited in Yıldırım & Şimşek, 2016, p. 125). From the thirteenth participant onward, responses began to show repetition; therefore, the data collection process was concluded with 15 participants.

Table 1.
Study Group

No	Code	Gender	Seniority	Duration (Minutes)
1	SÖ1	F	23	21.57
2	SÖ2	M	31	12.57
3	SÖ3	F	30	14.45
4	SÖ4	M	33	10.20
5	SÖ5	M	36	24.27
6	SÖ6	M	30	21.18
7	SÖ7	F	21	15.53
8	SÖ8	F	28	30.43
9	SÖ9	M	26	18.03
10	SÖ10	F	26	20.15
11	SÖ11	M	17	14.36
12	SÖ12	F	22	29.48
13	SÖ13	F	28	11.36
14	SÖ14	M	28	27.33
15	SÖ15	M	20	19.56

As shown in Table 1, seven of the participants were female and eight are male. The teachers' professional seniority ranged from 17 to 36 years. The duration of the interviews varied between a minimum of 10.20 minutes and a maximum of 30.43 minutes, with an average interview length of approximately 19.1 minutes.

Data were collected through a semi-structured interview form. Initially, the draft form was reviewed by two experts in primary education and one expert in assessment and evaluation, after which some questions were removed in line with their feedback. The final version of the form was then submitted to a Turkısh language expert, and the wording was revised and simplified based on the recommendations received. Following these adjustments, the interview form consisted of 10 questions. This process contributed to establishing both the content and linguistic validity of the form.

The data collection process was conducted in the 2024–2025 academic year, after the completion of the first unit of life study course, with 15 first-grade teachers working at four public primary schools in Üsküdar, Istanbul, under the Ministry of National Education. The interviews were conducted face to face; while 12 participants consented to audio recording, three participants (SÖ10, SÖ11, SÖ12) did not and requested that notes be taken instead. Individual interviews were conducted in teachers' classrooms or in the school library. Interviews with teachers who had free periods were held in the school library, whereas interviews with teachers without free periods were conducted in their classrooms during lunch breaks. In the study, participants were assigned the codes SÖ1, SÖ2, SÖ3, and so forth.

2.3. Data Analysis

The data obtained in the study were analyzed using the content analysis method. Content analysis is a method used to group similar data under specific concepts and themes, and to organize and interpret them in a way that can be clearly understood by the reader (Yıldırım & Şimşek, 2016). The following steps were taken during the analysis process:

1. Audio recordings were transcribed, notes were finalized, and each participants responses were transferred into Word files.
2. Responses to the same questions were organized consecutively under each item.
3. Codes were assigned to participants (SÖ1, SÖ2, SÖ3, …).
4. Sections related to the research questions were read repeatedly, themes and subthemes were identified, and frequencies were calculated for each theme.
5. After the tables were created, teachers' statements related to the research questions were directly quoted and added beneath the relevant tables.

2.4. Validity, Reliability, and Ethics

As part of the validity study, the interview form was revised based on feedback from two subject matter experts, an assessment and measurement expert, and a language expert; suggested revisions were incorporated, and the form was finalized. Following the application, the data obtained were reviewed by an instructor specializing in life skills education, and coding and analysis were performed. Codes were compared and evaluated at both the expression and theme levels, and inter-rater agreement was calculated using the formula proposed by Miles and Huberman (1994).

Reliability = Agreement / (Agreement + Disagreement)

According to this calculation, the reliability coefficient was found to be 86%. This rate indicates an acceptable level of agreement in qualitative research. In cases of disagreement, the coders reconvened to discuss the differences and reached the final decision through consensus.

In order to enhance the reliability of the study, the process was reported in detail, and direct quotations from participant statements were included in the findings section. Suggestions generated by AI-assisted software were used only at the idea level during the interpretation of opinions and the structuring of analysis results; the final coding and interpretations were carried out by the researcher.

At all stages of the research, the principles set forth in the Higher Education Institutions' Directive on Scientific Research and Publication Ethics were strictly observed. Participation in the study was entirely voluntary. Prior to data collection, all participants were informed about the purpose and procedures of the study, and written informed consent was obtained from each participant. During the data collection process, participants were explicitly informed that their identities would be kept confidential, that their names would be referred to with codes such as SÖ1 and SÖ2 within the scope of the research, that audio recordings would not be shared with third parties, that personal conversation content would not be included in the study, and that they would not suffer any harm as a result of their participation. Furthermore, prior to conducting the study, ethical approval was obtained from the Ethics Committee of the Faculty of Educational Sciences at Istanbul Medeniyet University, in accordance with decision number 09.09.2024 dated E-38510686-050.04-2400059183 and recorded in session 2024/7.

3. FINDINGS

In this section, the organized form of the collected data is presented. The findings related to each research question are supported with tables and direct quotations from teachers' statements.

3.1. General Research Questions Regarding The 2024 TCEM

This section presents the findings related to teachers' general views on the 2024 TCEM. The data were obtained through individual interviews and analyzed using thematic analysis. Participants' responses were coded and grouped under common themes reflecting their overall evaluations of the model, including its implementation process, strengths, and challenges encountered in classroom practice.

1.How do first-grade teachers evaluate the training they received within the scope of the 2024 TYMM?

The analysis of teacher interviews regarding the received training yielded the results presented in Table 2.

Table 2.
Participants Views on the Training They Received Regarding the 2024 TCEM

Answer	**f**
Adequate	2
Partially Adequate	3
Inadequate	10

As shown in Table 2, the majority of first-grade teachers (n=10) evaluated the training they received on the 2024 TCEM as inadequate. Three teachers considered the training to be partially adequate, while two teachers found it adequate.

Some of the views expressed by teachers who considered the training inadequate are as follows:

"They mention useful techniques here. However, these techniques can only be implemented in classrooms with a maximum of 15 students. In a class of 40, how can I better maintain students' attention or carry out assessment activities more efficiently? I would like to receive guidance and support that would provide practical solutions to these issues." (SÖ7)

"I am a trainer teacher. They gave me eighteen hours of training. I don't know anything. Nor am I interested." (SÖ11)

"The trainers could not provide clear answers. They were not very competent." (SÖ12)

"It was not sufficient, of course, because I honestly could not fully understand the Maarif Model. What is the goal? What exactly has changed? There is nothing clear—everything is too general. Why was such a change needed? I could not form a clear picture in my mind. I couldn't clearly perceive that the program had changed for a specific reason. I was expecting something more practice-oriented, but it all remained on paper." (SÖ1, SÖ2, SÖ4, SÖ13, SÖ14)

Statements of Teachers Who Found the Training Adequate:

"We were informed about the changes introduced in the regular curriculum, what needed to be done, and how it should be implemented. The training was effective and the instructor was competent. Phonics activities were included, and we were shown how to apply them in practice. The sessions were delivered through games and activities, enabling us to experience the same tasks we would later carry out with our students. Overall, I found the training satisfactory." (SÖ3, SÖ10)

Statements of Teachers Who Found the Training Partially Adequate:

"It was good, but the timing could have been broader. The training was delivered during the seminar period and felt somewhat delayed. It could have been scheduled over a longer period of time. The objectives of the training were explained, along with the main structure and principles of the Maarif Model. The emphasis was mostly on the structure and flow of the program, as well as its application in schools. The colleague who delivered the seminar provided a summary. Overall, it was useful and well-organized. From time to time, these trainings have been beneficial for me, and I apply them in my lessons." (SÖ6)

"It could have been delivered in a different format. For instance, if only first-grade teachers had attended, it would have been more effective; but since the groups were mixed, it became overcrowded, which seemed like a disadvantage. Receiving this training is important because we need to be prepared. It could have been offered gradually, that is what I mean. For last year's second graders, it was not particularly essential. The content was not directly applicable to our lessons; rather, it was mostly about how to write or phrase the learning outcomes, especially in the notebook. Of course, there were some classroom practices shared that could be applied concretely, but as far as I can recall, they were limited and not strongly retained in our minds. It was not a revolutionary change in that sense. This reform can rather be considered as minor adjustments or modifications to what we were already doing. It was not such a significant change that we could say, 'Last year it was like this, but this year it is entirely different.' Instead, some topics changed, and in the notebook the way we recorded them or the writing style was altered. The overarching aim of the Maarif Model—emphasizing values, culture, and similar aspects—is valuable, and these will gradually become embedded. Yet, we had already been incorporating many of these elements in our teaching." (SÖ15)

The majority of teachers considered the training they received to be inadequate. The main reasons for this included the inappropriate timing of the sessions, the excessive number of participants, the involvement of teachers who would not

be implementing the program in the 2024–2025 academic year, the predominantly theoretical nature of the training, and the trainers' insufficient mastery of the model.

The findings related to Research Question 2, 'What are first-grade teachers' overall views regarding the 2024 TYMM?', are presented in Table 3.

Table 3.
Participants Overall Perspectives on the 2024 TCEM

Theme	Sub-Theme	f	T
Negative	No innovation in the program	9	23
	Difficulties in comprehension	3	
	Challenges in the assessment and evaluation process	5	
	Resentment over the lack of consultation with teachers	3	
	Content becoming more in-depth and intensive	1	
	Perception of changes as political or merely symbolic	1	
	Increased need for internet infrastructure	1	
Positive	High quality of textbooks	4	15
	Use of digital materials	3	
	Simplification of content (reduction in the number of learning outcomes)	3	
	Emphasis on values and spirituality	3	
	Interdisciplinary approach	1	
	Increased student participation in lessons	1	

As presented in Table 3, the majority of first-grade teachers' general opinions regarding the 2024 TCEM are negative (n = 23), whereas the number of positive opinions is comparatively lower (n = 15).

Examples of Negative Opinions

"Frankly, there is nothing striking that would make me say, 'Wow, what a major innovation.' We are simply continuing as before." (SÖ1, SÖ13)
"Assessment and evaluation are excessively demanding here. Teachers will get tired and give up. The workload has increased. It needs to be reduced. There are no activities that help children to know themselves. It is always about giving commands—do this, do that. They need to recognize their own selves, their own spirit. Such a structure does not exist." (SÖ12)
"Understanding. The greatest difficulty here was comprehension. We struggled a lot. Since not much has changed, we continued in line with our previous experiences to achieve our routine objectives. The Ministry did not receive sufficient feedback from teachers. There is nothing tangible that we can point to." (SÖ14)
"The resources spent on the launch are not reflected in the content. There is no substantial innovation. The Ministry could not obtain sufficient feedback from teachers because, in fact, there is nothing concrete that we can demonstrate. I do not think the new program has made a difference in classroom practice." (SÖ4)
"Changing names does not change the essence. Only the wording has changed; in fact, the essence is what really matters." (SÖ2, SÖ6)
"There are so many activities… In order to carry them out, class sizes would need to be smaller. To conduct formative assessments, we constantly have to make photocopies. This leads to paper waste. It is an extra burden on teachers—a heavy one indeed. They supposedly lightened the curriculum, but in fact, they deepened the content. This has become exhausting for both teachers and students." (SÖ3)
"We can implement it here since we have internet access. But what about colleagues in places without internet? That remains a question mark." (SÖ9)

Examples of Positive Opinions

"The textbooks are excellent. We do not need to use supplementary materials." (SÖ5, SÖ6)
"The textbook is sufficient. I did not need anything else. If the number of videos could be increased and presented in a musical format, it would be even better." (SÖ9)

"It is a positive change that certain topics were removed from the program. In particular, the decision not to require sentence writing until the second group is a very good choice. Our textbooks are also very well prepared—much more qualified compared to previous years." (SÖ2, SÖ7, SÖ8, SÖ9)
"It is good that some topics were removed from the first-grade curriculum. Especially the removal of clock-related topics from mathematics was a logical decision. The Life Studies topics being more up-to-date and life-oriented is also a positive aspect." (SÖ3)
"It eliminated the obligation to use supplementary resources across schools, thereby ensuring equality of opportunity in education." (SÖ5)
"Digital platforms with QR codes make our work easier. The integration of values into the lessons is also positive." (SÖ6)
"It engages children more actively in the lessons." (SÖ2)

An examination of participants' statements reveals that a considerable number of teachers evaluated the 2024 TCEM negatively. Negative views were primarily concentrated on the absence of innovation in the program, difficulties in comprehension, the intensity of the assessment and evaluation process, the lack of consultation with teachers, the content becoming more complex despite the reduction in learning outcomes, perceptions of political or symbolic changes, and deficiencies in infrastructure. On the other hand, positive views were grouped under the themes of the quality of textbooks, the support of digital materials, the simplification of learning outcomes, the emphasis on values and spirituality, the interdisciplinary approach, and the increase in student participation.

The findings related to Research Question 3, 'How do first-grade teachers assess the "differentiation" practices included in the 2024 TYMM?', are presented in Table 4:

Table 4.
Participants Perspectives on Differentiated Instruction in the 2024 TCEM

Theme	**f**	**T**
Those Implementing Differentiation	3	
Participants Lacking Knowledge of Differentiation	4	15
Those Not Implementing Differentiation	8	

As shown in Table 4, the majority of teachers stated that they either did not implement differentiation at all or did not possess sufficient knowledge in this regard. During the interviews, statements beginning with questions such as 'What do you mean by differentiation?' indicated that the concept was not fully understood by teachers.

Those Implementing Differentiation (f = 3)

"Students' levels are not the same. There are very advanced ones, for whom we prepare enrichment (ZEP) activities. For our inclusion student, we developed an IEP plan. In addition, we organize extra activities for students who can already read and write. Peer teaching has been very beneficial." (SÖ3)
"I use enrichment activities for my students who have started reading. For those who fall behind, I prepare simpler and more concrete tasks." (SÖ6)
"Differentiation is a valuable practice. In the trainings, we were shown that different activities can be designed for advanced students and for those who are lagging behind. However, when time and resources are limited, it becomes difficult to implement this on a regular basis." (SÖ7)

Those Unfamiliar with Differentiation (f = 4)

"What exactly do you mean by differentiation? I have not had the opportunity to engage with this topic." (SÖ1)
"I think it makes sense, but there is not much time. I can only apply it occasionally for low-achieving students." (SÖ5)
"As I understand it, differentiation is about relating content to daily life. However, it is not easy to implement this systematically in the classroom." (SÖ4, SÖ14)

Those Not Implementing Differentiation (f=8)

"We apply it mostly in Turkish. In the Turkish textbook, there is differentiation at the end of each theme, but not in Life Studies. We simply follow whatever is in the textbook." (SÖ2)
"At the moment, I do not know how it should be done in the textbook. I follow my lesson plan. We explain the same thing to all students; there is nothing different." (SÖ9)
"Most teachers already do not implement it. I also do not apply it much in Life Studies, but I try to support students through methods such as drawing and drama without excluding them from the lesson." (SÖ8)
"It is written on paper, but difficult to apply in practice. For example, I created a WhatsApp group with the advanced students and taught them writing. In Life Studies, however, there is not much time left." (SÖ11)
"I try to involve all of them in the lesson, supporting with questions, drama, or hands-on activities. But this is usually not planned differentiation, rather a spontaneous adaptation." (SÖ10)

Teachers' statements point to three critical issues:

1. They had not read the common text of the curriculum and the related programs,
2. In-service trainings did not provide sufficient information on differentiation,
3. Differentiation was not included in the textbooks, which compelled teachers to develop their own activities according to students' individual circumstances.

The findings related to Research Question 4, 'What are first-grade teachers' perspectives on the assessment and evaluation process envisaged in the 2024 TYMM?', are presented in Table 5.

Table 5.
Participants Views on the Assessment and Evaluation Process

Theme	Sub-Theme	f	T
Negative	Paper waste	5	**15**
	Increased workload	5	
	Waste of time	4	
	No difference compared to the previous curriculum	1	
Positive	Contribution to student monitoring and recognition	4	**7**
	Conducting assessments at the end of each topic	3	

As shown in Table 5, teachers' views on the assessment and evaluation process are largely negative (n = 15). The most frequently mentioned problems were paper waste caused by photocopies and printouts, the increase in workload, and loss of time. In addition, some teachers pointed out that the assessment and evaluation practices resembled the intensive applications experienced during the transition to the constructivist curriculum in 2005, noting that such practices were soon abolished and emphasizing that the current process is not sustainable.

Negative Opinions

"We all struggle with the evaluation process. Making photocopies is extremely tiring for us. In fact, if there were an evaluation page at the end of each unit in the textbook… We would not need to prepare additional evaluation scales. This process exhausts us and also results in paper waste." (SÖ3, SÖ7, SÖ8, SÖ12)
"Photocopying and filling out forms take too much time." (SÖ5)
"Are you asking about theme evaluation? They have added an extra burden for us—stationery, printing, keeping files… Although it helps to get to know the student, the workload has increased. In crowded classrooms, we are overwhelmed." (SÖ6, SÖ10, SÖ14)
"I do not think much has actually changed. Too many scales have been added, but they are not feasible. In a class of 41 students, even checking homework is difficult. Such lengthy scales are unnecessary. In the first term, we already address these issues while teaching values. Moreover, even having to demonstrate the activities in the Life Studies textbook creates an additional, unnecessary burden." (SÖ7)

Positive Opinions

"The assessment activities are good. There are worksheets at the end of the textbook. Previously, these were very limited, but now there are more. The use of visuals is extensive." (SÖ11)
"It is not very negative. In other words, it did not seem very different from the previous term." (SÖ2)
"I constantly prepare question–answer activities. The ones in the textbook are not sufficient; they are too few." (SÖ13)
"For first grade, I think it was good and sufficient." (SÖ9, SÖ15)

The majority of teachers perceive the assessment and evaluation process as burdensome, time-consuming, and a practice that leads to paper waste. Nevertheless, some teachers emphasized that the process helps them to get to know students more closely and that end-of-topic assessments are beneficial.

3.2. Research Questions Regarding The Life Studies Curriculum

This section examines first-grade teachers' views on the Life Studies curriculum within the framework of the 2024 TCEM. The findings address teachers' evaluations of the curriculum's implementation, content, assessment practices, and differentiation processes, and are presented in relation to the relevant research questions using tables and direct quotations.
The responses provided by first-grade teachers to Research Question 5, 'How do first-grade teachers evaluate the 2024 TYMM Life Studies Curriculum?', are analyzed and presented in Table 6."

Table 6.
Participants Perspectives on the 2024 TCEM Life Studies Curriculum

Theme	Sub-Theme	Description	Frequency (f)	Total (T)
Positive	Digital Content	Videos	2	**19**
		Visuals	2	
		Use of QR codes	1	
		Integration with EBA	1	
	Student-Centeredness	Student participation	2	
		Learning through activities	1	
		Concretization	1	
	Simplification of Content	Simplification of topics	2	
		Distribution of topics over time	2	
	Differences in Implementation	Changes in instructional practice	1	
		Innovations in teaching style	1	
	Textbooks	Emphasis on visuals	1	
		Simple and colorful content	1	
		Cut-and-paste activities	1	
Negative	Perceived Lack of Change	Content remains the same	6	**18**
		Instructional process remains the same	6	
		Curriculum repeats itself	4	
	Materials	Lack of materials	1	
	Assessment and Evaluation	Confusion in assessment and evaluation	1	

Table 6 presents first-grade teachers' views on the 2024 TCEM Life Studies Curriculum. According to the findings, teachers' statements were grouped under both positive and negative themes. The most frequently repeated negative view was that the program did not contain any substantial changes compared to previous implementations. On the other hand, positive views mainly focused on the dynamism introduced by digital content (videos, QR codes, and EBA integration), the contribution of the student-centered approach and activities to learning, the facilitation of the instructional process through the simplification of content, and the visual richness of the textbooks.

Negative Opinions

"I did not see much change. The topics are the same, and the instructional process is also the same." (SÖ3, SÖ8, SÖ13, SÖ12, SÖ14)

"I apply the same system as before. For instance, we either watch a video or I come to class prepared with the topic." (SÖ1)

"It would have been much better if we had more materials available. If it were more practice-oriented, it would be more effective." (SÖ13)

"The assessment and evaluation process could have been simplified. The textbooks themselves are very good." (SÖ12)

Positive Opinions

"The textbook includes QR codes. At the end of each topic, it provides an activity. This livens up the lesson a bit more. We scan it on the smart board and project it through EBA." (SÖ2)

"There are activities, explanations, storytelling, and videos. These are things children can understand. The videos capture their attention very effectively." (SÖ5)

"Life Studies prepares students for life. The topics are appropriate for their level. The children have something to say about every subject." (SÖ3)

"The topics have been simplified. We now have time in hand." (SÖ13)

"There is no change in terms of topics, but there is a difference in implementation. The content is presented through activities and storytelling." (SÖ5)

"The textbooks include cartoon characters, and the visuals are very appealing." (SÖ6, SÖ9)

As shown in Table 6, teachers' views on the Life Studies curriculum were grouped under both positive and negative themes. The most frequently expressed negative opinion was that the program did not involve any significant change compared to the previous version. Teachers stated that the topics and instructional process largely remained the same and that the course continued in a routine manner. On the other hand, positive views emphasized that digital content (videos, QR codes, and EBA integration) made the lessons more engaging, that student-centeredness and activities brought liveliness to the process, that the simplification of topics saved teachers time, and that the visual richness of the textbooks increased students' interest.

3.3. Research Question On The Life Studies Textbook

This section focuses on first-grade teachers' evaluations of the Life Studies textbook developed within the framework of the 2024 TCEM. The findings are presented in tables and supported by direct quotations from teachers' views.

The responses of first-grade teachers to Research Question 6, 'What are first-grade teachers' views concerning the 2024 TCEM Life Studies textbooks?', are analyzed and presented in Table 7.

Table 7.
Participants Perspectives on the Life Studies Textbook

Theme	Sub-Theme	(f)	T
Insufficient	Lack of teacher's guidebook	15	**38**
	Limited number of activities	5	
	Inadequacy of visuals	4	
	Lack of materials	3	
	General inadequacy of textbooks	2	
	Outdated EBA content	1	
	Limited coloring activities	1	
	Lack of short play scripts	1	
	Limited cartoon content	1	
	Some texts and poems being above grade level	1	
	Lack of posters	1	
	Lack of slogans	1	
	Insufficient video content	1	
	Internet dependency	1	
Sufficient	Cut-and-paste activities	15	**30**
	Quality of visuals	4	
	Integration with EBA	3	
	Use of QR codes	3	
	Actively engaging students	1	

Theme	Sub-Theme	(f)	T
	Appropriateness of content	1	
	Textbooks published in two volumes	1	
	Game-based content	1	
	Support for interdisciplinary teaching	1	

As shown in Table 7, teachers' views on the Life Studies textbook were grouped under two themes: 'insufficient' and 'sufficient.' Teachers who considered the textbook insufficient most frequently emphasized the lack of a teacher's guidebook. They also criticized the limited number of activities, inadequacy of visuals and materials, the outdated nature of EBA content, the absence of motivating elements such as coloring, theater, and cartoon activities, as well as some texts and poems being above grade level. On the other hand, teachers who found the textbook sufficient particularly highlighted that cut-and-paste activities were received with interest by students, that the quality of visuals was appropriate, and that EBA integration and QR code applications enriched the lessons. In addition, the publication of the textbooks in two volumes, the inclusion of game-based content, and the support for interdisciplinary teaching were emphasized as positive aspects.

Negative Opinions

> *"They added one or two activities at the back of the book, but there are not many materials. For example, there could have been posters or slogans. We prepare these ourselves."* (SÖ3)
> *"In one activity, it suggests giving each child a ball. But it is impossible to bring 40 balls to the classroom. There are activities in the textbooks that are difficult to implement."* (SÖ7)
> *"The Life Studies textbook, in particular, should be predominantly visual. Since children do not know how to read and write, they learn by looking at the pictures. Visuals and videos should be increased."* (SÖ9)
> *"Apart from the appendices, there is nothing else in the textbooks."* (SÖ12, SÖ13)
> *"The content is similar, but the activity section is weak. With pictures and materials, the books could have been made more suitable for the six–seven age group."* (SÖ1, SÖ2, SÖ3)

Positive Opinions

> *"It is good that we can use visuals, connect to EBA in the digital environment, and encourage children to speak. However, EBA has not been updated. The directions of letter writing have changed, but in EBA the old versions still remain."* (SÖ6)
> *"Very good and sufficient. The illustrations are nice. Previously, we used supplementary books, but this year we did not. They capture the children's attention."* (SÖ7, SÖ9, SÖ12, SÖ15)
> *"The topics are good, and the explanations are good. It would be better if there were more activities. They especially love the cut-and-paste activities."* (SÖ8, SÖ10)
> *"The textbooks include QR codes; we download the PDFs and open them on the smartboard to carry out the activities. This year's textbooks are more colorful and more engaging. The cut-and-paste activities have been the best part. In addition, publishing the books in two volumes both lightened the students' schoolbags and increased their interest."* (SÖ14)

A common view among teachers was that the Life Studies textbook should be supported with a teacher's guidebook. It was emphasized that such a guidebook would reduce teachers' workload, facilitate lesson planning, and provide a more effective roadmap for implementation.
Positive opinions revealed that the textbooks have become richer in terms of visuals, that activities such as cut-and-paste and QR codes increased students' interest, and that digital integration has given the course a more contemporary structure. Negative opinions, on the other hand, focused on the limited number of activities, the lack of material support, the impracticality of certain content in classroom settings, and particularly the outdated nature of EBA.

4. RESULTS AND DISCUSSION

In this study, the views of first-grade primary school teachers regarding the general structure of the 2024 TCEM, the Life Studies Curriculum, and the Life Studies textbook were examined. The discussion, which was conducted around six research questions, is presented below.

4.1. General Research Questions Regarding The 2024 TCEM

4.1.1. In what ways do first-grade teachers evaluate the training they received on the 2024 TCEM?

The majority of teachers considered the training provided during the fall seminar period to be insufficient. The main reasons cited were the inappropriate timing of the training, the perception of the curriculum as complex, the difficulty of

adapting the suggested activities and assessment processes to crowded classrooms, the overly theoretical nature of the content, the inclusion of teachers who would not be implementing the curriculum (which made the sessions overcrowded), and the trainers' limited command of the model.

The two teachers who found the training sufficient reported that they had been briefed on the Model and had learned practices such as phonics (sound) activities and games; those who described it as 'partly sufficient' indicated that more time was needed in terms of both duration and depth.

As emphasized by Berk and Özer (2024), although the TCEM claims to respond to the requirements of the age, the outcomes of its effective implementation will only become evident over time. The findings indicate that the initial in-service training was inadequate in concretizing the lesson practices expected by the Model.

Although the 2024 TCEM reduces the number of learning outcomes, it presents an intensive program structure that addresses multiple components simultaneously. These components include literacy skills (language and text literacy, digital literacy, media literacy, financial literacy), social-emotional learning (SEL) skills, and the virtue–value–action framework. The content framework forming the basis of the program encompasses categories such as conceptual skills, physical skills, dispositions, and domain-specific skills (MoNE, 2024b; Kadıoğlu-Ateş, 2025). Each category is structured through interconnected subcategories. In this respect, the 2024 TCEM can be described as simplified at the level of learning outcomes, yet intensified in terms of establishing connections among components and aligning activities with these components. Teachers' statements indicate that the program was neither read in detail nor was sufficient guidance provided in the in-service training regarding how the lesson implementation expected by the Model should take place.

4.1.2. What do first-grade teachers think in general about the 2024 TCEM?

The views were grouped under two themes: positive and negative. Among the negative views, the emphasis on the program 'not introducing any innovation' was particularly prominent; teachers stated that the curriculum was difficult to comprehend, that the assessment and evaluation workload had increased, that teachers had not been consulted, that the content had become more in-depth and intensive, that the changes were perceived as political or merely symbolic, and that dependency on internet infrastructure had increased. In contrast, the positive views highlighted the quality of the textbooks, the facilitation of teaching through digital materials, the reduction in the number of learning outcomes, the emphasis on values and spirituality, the interdisciplinary structure, and the increase in student participation.

The literature, in line with the negative evaluations, reports criticisms concerning the absence of an advisory board, the rapid implementation process, the lack of references, and the need for a more fundamental transformation at both the content and methodological levels (Arslankara & Arslankara, 2024; Karataş, 2024; Kurul, 2024; Berk & Özer, 2024; Uygun & Akgül, 2024). On the other hand, positive evaluations point to individual differences, the interdisciplinary approach, the philosophical background, values education, the diversity of activities, and the integration of technology (Berk & Özer, 2024; İlden & Dombaycı, 2024; Uygun & Akgül, 2024).

Initiated by the OECD in 2015, the Education 2030 project seeks to redirect global educational discourse by transitioning the core of education from a knowledge-based to a competency-based framework. This initiative advocates for nations to incorporate not only cognitive skills but also affective and value-laden objectives into their educational systems (OECD, n.d). In this context, the 2024 TCEM represents a significant step towards achieving the programmatic goals outlined by the OECD. However, the findings suggest that the crucial link between theoretical vision and practical implementation remains fragile, as evidenced by teacher statements indicating insufficient information and consultation regarding the model.

4.1.3. How do first-grade teachers implement differentiation within the TCEM?

Although differentiation is identified as one of the distinctive components of the TCEM, the vast majority of teachers reported that they were either unfamiliar with the concept or did not implement it, with only three teachers indicating that they applied it systematically in their classrooms. This finding underscores the inadequacy of in-service training and reveals a critical gap in the transfer of the Model into classroom practice. In line with this, Karataş (2024) anticipates that the intensity of the Model's components may, over time, increase the risk of mere 'symbolic compliance,' while Berk and Özer (2024) caution against potential challenges that are likely to surface during the implementation phase. These concerns resonate with the present findings. Furthermore, the official program document explicitly states that differentiation is not incorporated into the textbook but is expected to be planned by teachers in accordance with students' needs (MoNE TCEM Life Studies Curriculum, 2024, p. 6, art. 11). Collectively, these results point to a clear need for additional resources and systematic guidance to support teachers in translating the Model's principles into practice. Differentiation in education is crucial for meeting students' diverse needs, fostering inclusion, and improving academic performance. System-wide research, teacher training, and resources are essential for cultivating supportive learning environments that unlock each student's individual strengths (Goyibova et al., 2025).

4.1.4. What are first-grade teachers' views on the assessment and evaluation process?

Teachers, recalling similar practices from the 2009–2010 period, predominantly evaluated the current process as leading to paper waste, increased workload, and loss of time. Positive views focused on the benefits of strengthening opportunities to monitor and recognize students and on the advantage of conducting assessments at the end of each topic. However, class size, inequalities in digital infrastructure, and time constraints were identified as factors that weaken the sustainability of the process.

4.2. Research Questions Regarding The Life Studies Curriculum

4.2.1. What are first-grade teachers' views on the Life Studies curriculum?

The views were distributed relatively evenly between positive and negative themes. Within the positive theme, digital content, student-centeredness, the reduction in the number of learning outcomes, new practices, and the quality of the textbooks were emphasized; whereas within the negative theme, the limited perception of change, lack of materials, and issues related to assessment and evaluation were highlighted. In comparison with Arslan (2025), both studies commonly reported student-centeredness and lack of materials. While assessment and evaluation were considered sufficient and creative in Arslan's study, they were described as complex in the present study. Çakır (2025), on the other hand, emphasized that the curriculum should place greater focus on digital skills.

4.3. Research Question On The Life Studies Textbook

4.3.1. What are first-grade teachers' views on the Life Studies textbook?

Although textbooks were frequently cited in the positive evaluations of the Model and the curriculum, they received more criticism when addressed directly. A significant number of teachers considered the textbook inadequate. The main problems highlighted were the absence of a teacher's guidebook, the limited variety and number of activities, the inadequacy of visuals and materials, the outdated nature of EBA, the limited inclusion of coloring, short plays, cartoons, posters, slogans, and video content, some texts and poems being above grade level, and dependency on internet access. On the other hand, teachers who found the textbook sufficient emphasized that cut-and-paste activities increased students' interest, that the visuals were age-appropriate, that QR/EBA integration added dynamism to the lessons, that the questions encouraged student participation, that the two-volume structure provided advantages in terms of portability and motivation, and that the inclusion of games and interdisciplinary elements was a strength. Previous studies have also revealed the necessity of updating textbook content and reorganizing it in line with students' interests (Batmaz, 2022). Furthermore, the problems related to language expression and age appropriateness reported by Gözütok et al. (2015) appear to have been partially addressed in the 2024 curriculum and textbooks, as reflected in teachers' views.

In this study, the views of first-grade primary school teachers on the general structure of the 2024 TCEM, the Life Studies Curriculum, and the textbook were examined. The findings indicate that the majority of teachers considered the in-service training provided during the seminar period to be insufficient, as these sessions were delivered in a way that was disconnected from practice and did not take into account crowded classrooms and material shortages. Moreover, the intensive and complex structure of the curriculum, along with the increased workload, paper waste, and loss of time associated with the assessment and evaluation process, created significant challenges in practice.

In the overall evaluations, the prevailing perception among teachers was that the 2024 TCEM involved only superficial changes and did not introduce genuine innovations. In addition, the fact that the Model was developed without consulting teachers and was implemented rapidly has led to problems of ownership in practice. Nevertheless, positive views were also expressed. Teachers particularly emphasized the improved quality of the textbooks, the support provided by QR codes and digital content, the strengthened emphasis on values and spirituality, and the more student-centered treatment of certain topics as strengths of the program.
With regard to differentiation practices, most teachers stated that they either did not have sufficient knowledge or had no opportunity to implement them. This indicates that, although differentiation is one of the core components of the Model, it was not adequately addressed in the in-service training.

The assessment and evaluation process, on the other hand, was mostly perceived by teachers as burdensome, time-consuming, and unsustainable.

In conclusion, teachers' views indicate that significant challenges are experienced in transferring the TCEM into classroom practice. For the program to achieve its intended impact, it is of critical importance to develop supportive materials such as a teacher's guidebook, to make the assessment and evaluation process more functional, and to ensure that digital content is kept up to date and accessible.

5. RECOMMENDATIONS

Based on the results obtained from the findings of the study, the following recommendations have been developed:

1. The development of mobile/tablet-based observation and marking systems is recommended in order to prevent time loss and waste arising from paper-based practices in the assessment and evaluation process.
2. It is recommended that EBA be updated with more functional content aligned with the 2024 TCEM to support teachers' classroom practices.
3. It is recommended to organize in-service training programs focused on IEP (Individualized Education Program) and EEP (Enriched Education Program) in order to enhance teachers' conceptual knowledge of differentiation and to improve their practice-oriented skills.
4. To support differentiation processes, it is recommended to establish multidisciplinary working teams in each school through the collaboration of classroom teachers, guidance counselors, parents, special education teachers (if available), and Guidance and Research Centers
5. It is recommended to prepare teacher's guidebooks to provide guidance for teachers in the implementation of the programs, and to ensure that the training offered to teachers is more practice-oriented and aligned with classroom realities (e.g., crowded classrooms, lack of materials).

Research and Publication Ethics Statement

The ethics committee approval for this study/researchwas obtained from Istanbul Medeniyet University (E-38510686-050.04-2400059183) on 09.09.2024

Informed Consent

Informed consent was obtained from the participantsin this study.

Contribution Rates of Authors to the Article

This study is single authored.

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The author has no conflict of interest to disclose.

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An Investigation into the Effects of the Quantum Learning Model on Middle School Students' Achievement and Attitudes Towards Music Lessons*

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ABSTRACT

This study investigated the effect of the Quantum Learning Model (QLM) on the academic achievement levels and attitudes toward music lessons among middle school students. In the research, a quantitative method—specifically the *pretest–posttest control group design*—was employed. The implementation process was conducted with two sixth-grade classes in a public middle school located in the Altıeylül district of Balıkesir Province. The classes were randomly assigned to either the experimental or control groups. The quantitative data were coded and analyzed using SPSS 22.0 statistical software. The study's findings revealed that music instruction based on the Quantum Learning Model significantly enhanced students' academic achievement and their attitudes toward music lessons. In light of these results, it is recommended that future research adapt the QLM to other learning domains and outcomes included in the music curriculum. Furthermore, planning school music lessons in accordance with the fundamental implementation steps of the QLM is considered to have the potential to improve the quality and effectiveness of learning processes.

Keywords: Music education, quantum learning model, secondary school, learning model

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1. INTRODUCTION

Music is not merely a form of art; it is also a universal educational tool that supports individuals' emotional, cognitive, and social development in a holistic manner. Music education is a structured and goal-oriented instructional discipline. The primary aim of this discipline is to enable individuals to acquire theoretical knowledge and practical skills related to music, enhance their aesthetic sensitivity, and support their emotional, cognitive, and social development in a multifaceted manner (Zhan, 2025, p. 2). Music is regarded as an art form that has a profound and lasting impact on human life, supporting comprehensive individual development. Particularly during childhood, music serves as an essential tool that strengthens various developmental domains (Yapalı et al., 2025, p. 22). Therefore, music education policies should be designed to ensure effective and lasting learning (Öztuğ, 2012, p. 119).

In music education, it is essential to design a learning environment that extends beyond traditional teaching methods by providing students with interactive and experiential learning opportunities. Considering the lasting and multidimensional effects of music on individuals' cognitive, affective, and social development, integrating the Quantum Learning Model (QLM) with its multidimensional, holistic, and student-centered approach into music education is expected to make learning processes not only academically effective but also more meaningful, motivating, creative, and emotionally engaging.

QLM is recognized as an instructional model that has been implemented in classroom environments and whose effectiveness has been demonstrated. Initially proposed in the 1980s by psychotherapy professor Dr. Georgi Lozanov, the model was later developed by Bobbi DePorter. QLM is a learning model that helps students comprehend instructional materials in the most

* This article is derived from the doctoral thesis titled "The Effect of the Quantum Learning Model on Middle School Students' Achievements and Attitudes Towards Music Courses".

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effective way possible, significantly enhancing their academic achievement. It also provides a comfortable learning environment that can increase students' motivation (DePorter et al., 1999, p. 15).
Quantum learning is defined as the interactions that transform energy into brilliance. At the same time, life consists entirely of energy, and our physical body is composed of matter. The purpose here is to experience light as much as possible through inspiration, connection, and interaction. With this type of energy, a vivid and dynamic form of energy can be produced (DePorter & Hernacki, 1992, p. 18).

QLM incorporates numerous models whose effectiveness has been validated and provides examples of their classroom application. In this respect, it shares methodological similarities with many other instructional models. However, the fundamental distinction of QLM is its openness to all approaches, ensuring mastery learning (Altın, 2018, p. 12).
One of the most essential advantages of QLM in the learning process is that it facilitates instructional activities in a comfortable and enjoyable classroom environment. Such an environment allows students the freedom to gain new experiences and explore throughout the learning process. Meaningful learning experiences support students' academic achievement and the development of their creative potential (Lestari & Rhokhayati, 2024, p. 60).

Structurally, there are significant similarities between QLM and music education. Both adopt dynamic and creative approaches that contribute positively to learning processes. Each discipline fosters innovative thinking and, therefore, plays a crucial role in education. Particularly in music education, creativity is considered the fundamental aim and the desired outcome of all musical activities. Learning the language of music is essential to express our individual creative needs in the best possible way. Creativity is one of the core components of musical experience (Gray, 1960, p. 58).

In a study conducted by Karsono (2016), QLM was chosen as a learning model to create a more enjoyable learning environment in music education. The findings revealed that the application of QLM in music classes provided students with engaging and enjoyable learning experiences. A review of the literature shows that there are insufficient research studies directly examining the relationship between QLM and music education. This indicates that the existing body of knowledge is quite limited. Therefore, this study is considered significant in that it reveals the potential contributions of QLM to music education, examines innovative approaches it may introduce to learning processes, and offers a new perspective that addresses the existing gap in the field. Moreover, the findings are expected to guide both educators and researchers, serving as a foundation for future studies.

Accordingly, this research examines the effects of music lessons taught through QLM on students' academic achievement and attitudes.

From this perspective, the research problem can be expressed as follows:
Does the Quantum Learning Model affect middle school students' music education achievement and their attitudes toward music lessons?

Based on this central research question, the following sub-problems have been formulated:

1. Is there a significant difference between the pre-test achievement score means of the experimental and control groups?
2. Is there a significant difference between the post-test achievement score means of the experimental and control groups?
3. Is there a significant difference between the pre-test and post-test achievement score means of the experimental group?
4. Is there a significant difference between the pre-test and post-test achievement score means of the control group?
5. Is there a significant difference between the pre-test attitude score means of the experimental and control groups?
6. Is there a significant difference between the post-test attitude score means of the experimental and control groups?
7. Is there a significant difference between the pre-test and post-test attitude score means of the experimental group?
8. Is there a significant difference between the pre-test and post-test attitude score means of the control group?

The hypothesis formulated for this study is that when QLM is applied to the experimental group, students' achievement in music lessons will increase, and their attitudes toward music education will improve positively.

2. METHODOLOGY

In this study, an experimental design, a quantitative research method, was employed. In an experimental study, researchers define a sample. They may generalize the results to a population, thereby testing the effect of an experimental intervention by controlling all external factors that may influence the outcome (Creswell, 2017, p. 156). This research was designed using a true-experimental design within the framework of experimental research. Specifically, the pretest-posttest control group randomized design, one of the experimental design types, was utilized.
According to Kerlinger (1973), this design is defined as a structure in which participants are randomly assigned to experimental and control groups, and measurements are taken both before and after the experimental manipulation (X) (Büyüköztürk, 2016, p. 20).

In a pretest-posttest control group randomized design, the inclusion of a control group allows for the prevention of threats to internal validity. Since errors originating from other sources, such as history, maturation, regression to the mean, testing, and

instrumentation, affect the control group to the same extent as the experimental group, their impact on the results obtained from both groups is assumed to be equivalent. Therefore, it becomes possible to attribute the differences between the results of the experimental and control groups to the experimental variable or treatment itself (Kaptan, 1998, p. 83).
The Ethics Committee of Gazi University reviewed and unanimously approved this study during its meeting on June 20, 2023, held under number 12.

2.1. Population and Sample

The population refers to the groups the researcher believes best represent the phenomenon or situation under investigation. It consists of large clusters that contain various elements and a broad data scope (Miles & Huberman, 1994). There are two types of populations: the target population and the accessible population. The target population is the abstract group the researcher aims to reach, though it is often difficult to access. In contrast, the accessible population refers to the realistic and concrete group that the researcher can achieve.

In this study, the accessible population was selected, and schools in the Altıeylül district of Balıkesir Province were determined as the population. The sampling method employed was simple random sampling, a type of probability sampling technique. Simple random sampling involves selecting the required individuals from the population list (Robson, 2015, p. 335).

The sample of the study consists of 46 students from two 6th-grade classes, each with 23 students, at Zağnospaşa Secondary School in the Altıeylül district of Balıkesir Province during the 2023–2024 academic year. Among the classes that returned the parental consent forms, simple random assignment was used to determine the groups: Class 6-G was assigned as the experimental group, and Class 6-D was assigned as the control group.

2.2. Implementation

The experimental phase of the research began on September 27, 2023, and concluded on November 1, 2023. The intervention lasted for 7 weeks, encompassing a total of 14 lesson hours. Each week included one 80-minute session (comprising two 40-minute class periods) for both the experimental and control groups. The researcher personally conducted the music classes. Since classroom teachers typically deliver music lessons at the primary school level, conducting the study at the secondary school level was deemed more appropriate, where music specialists lead lessons. Therefore, 6th-grade students were selected for the implementation process.

The instructor arrived 20 minutes before each lesson in the experimental group to prepare the classroom environment. Fresh flowers were placed in the classroom in advance. The desks were arranged in a U-shape, and relevant materials, including Orff instruments and educational posters, were positioned according to the subject to be taught. The classroom was ventilated before students arrived, and background music was played. Since Zağnospaşa Secondary School did not have a dedicated music room, the instructor brought their electronic keyboard (organ) to each class to establish a productive music-learning environment. The implementation in the experimental group was scheduled during the first two lesson hours of the school day. Due to time constraints, specific activities were completed in the subsequent lesson in some weeks.

The lesson plans were designed based on the “Musical Perception and Cognition” learning domain of the 6th-grade music curriculum. The targeted learning outcomes included: using basic elements of musical notation, recognizing vocal changes during adolescence, and understanding how the human voice is produced. The course content was planned according to the Quantum Learning Cycle, which consists of the following stages: "Enroll, Experience, Label, Demonstrate, Review, and Celebrate." A table was developed to align the Quantum Learning Model (QLM) skills and techniques with the relevant learning outcomes at each stage of the cycle. Based on this alignment, a sample lesson implementation table was created to guide the instruction.

A sample implementation table is presented below.

Music Lesson Plan Aligned with the Quantum Learning Model

Primary Education – 6th Grade

Learning Domain: Musical Perception and Knowledge

Learning Outcome: Uses basic musical notation and elements

Topic: Notes within the low C–high C range

Methods and Techniques: Mirroring, rhythmization, listening, singing, creating

Duration: 40+40 minutes

Table 1.
Sample Application Table of the Quantum Learning Framework

Skills Organization	Enroll	Experience	Label	Demonstate	Review	Celebrate
Quantum Reading						
Quantum Writing						
Speed Writing Technique						
Clustering Technique						
Quantum Memory						
Effective Note-Taking						
8 Keys of Excellence						
Communication Skills				X		
Problem Solving			X	X	X	X
Leadership						
Responsibility				X	X	X
Motivation	X	X				X
Self-Confidence	X	X		X	X	X
Outdoor Lesson						

Lesson Preparation: The classroom is well-ventilated, and the desks are arranged in a "U" shape, allowing each student to see the teacher easily. Flowers and colorful cushions are placed in the classroom to ensure that students feel safe, comfortable, and at home. Large, colorful cards illustrating the notes within the low C–high C range, which will be taught during the lesson, are prepared in advance and placed on the board.

Enroll: The teacher vocalizes the notes, which are paired with body movements, according to their pitch. Then, the notes associated with the body movements are demonstrated to the class using the mirroring technique, creating an interactive lesson environment.

Low C: stomp the foot/ D**:** tap the knees / **E:** clap at stomach level/ **F**: tap the belly/ **G:** snap fingers /

A: clap at chest level/ B**:** cross arms/ **High C:** raise and lower arms from above

Experience: The teacher draws students' attention to the notes displayed on the board and asks them which notes they already know. Students are then asked to identify and point out the notes they recognize on the prepared cards.

Label: After explaining the functions of the staff, notes, and treble clef displayed on the board, students are asked what they think these elements resemble in real life (e.g., staff as the sea, treble clef as a ship, or other associations such as road, car, cloud, rain, etc.).

Demonstrate: The teacher explains the pitches of the notes in detail, along with their relationships to one another. Then, using the cards displayed on the board as examples, students are invited to come to the board one by one and write the notes requested by the teacher.
Next, the teacher divides the class into groups and gives each group a sheet of paper with a blank staff. The groups are asked to write the notes of their choice on the distributed sheets. At this stage, only quarter notes (1-beat notes) are used for examples, and students are asked to write only eight notes. Afterwards, the notes written by each group are performed together with a school instrument, accompanied by the teacher.

Review: Using the aural/oral teaching method, the "Dumlupınar March," written in the key of C major, is taught to the class. After the entire class has learned the song, the notes are written on the board. Discussions and a question-and-answer session are conducted about the notes, and then the music is performed again, incorporating the notes as discussed.

Celebrate: The teacher divides the class into four groups and asks each group to create different body movements to accompany the song they have learned. Groups take turns coming to the board to perform the song with their assigned movements. Afterwards, the entire class applauds each group, celebrating their performances and learning achievements.

2.3. Data Collection Tools

2.3.1. Music Knowledge Achievement Test for 6th Grade Music Course

As one of the data collection tools in the study, the "6th Grade Music Knowledge Achievement Test" developed by Öztürk and Kalyoncu (2020) was utilized. The test initially consisted of a 25-item multiple-choice question pool, created based on predefined content areas. Expert review ensured content validity, and revisions were made accordingly to form a draft version. Following item analysis conducted using responses from 220 students via Excel, five items were removed, resulting in a final version of 20 items. The test demonstrated acceptable reliability, with a KR-20 coefficient of 0.77, a mean difficulty index of 0.57, and a mean discrimination index of 0.44.

Construct validity was examined to confirm the current validity and reliability of the test used in this study. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were conducted to assess the suitability of the data for factor analysis.

2.3.2. Attitude Scale for Musical Experiences of Children Aged 10 to 13

Another data collection tool used in the study was the "Attitude Scale Towards Musical Experiences of Children Aged 10–13," developed by Okay, Ataman, and Kardeş (2021). The original scale included 13 items. The initial exploratory factor analysis (EFA) set a minimum factor loading threshold of 0.50 to ensure item strength. One item (Item 10) fell below this threshold and was removed. A revised EFA confirmed a three-factor structure explaining 59.84% of the total variance. The final 12-item scale demonstrated high internal consistency, with a Cronbach's Alpha coefficient of 0.860.

To reaffirm the scale's validity and reliability for this study, construct validity was re-evaluated. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity were conducted to assess the suitability of the data for factor analysis.

2.4. Data Analysis

The collected data were coded and analyzed using IBM SPSS 22.0 (The Statistical Package for the Social Sciences) software. In the study, tests were conducted to determine whether there were significant differences in the achievement and attitude scores of 6th-grade students between the pre-test and post-test, with a 95% confidence interval and a p-value of 0.05.
Normality tests were conducted to determine which statistical tests to use for comparing achievement and attitude scores. According to Mayers (2013), if the sample size is n ≥ 50, the Kolmogorov-Smirnov test is used for normality testing; if n <50, the Shapiro-Wilk test is preferred. Since the study had 46 participants, the Shapiro-Wilk normality test was used to assess the normality of the distribution.

Parametric tests were employed for comparisons within the study design framework and sub-problems. The Independent Samples t-test was used for between-group comparisons, and the Paired Samples t-test was applied for within-group comparisons. Using the Independent Samples t-test, the mean scores of the experimental and control groups on their pre-tests and post-tests were compared to determine whether there was a significant difference between the two groups. The Paired Samples t-test was used to compare the mean scores of the pre-test and post-test within the experimental and control groups separately, to assess whether significant differences existed within each group over time.

3. FINDINGS

The findings related to the study's sub-problems are presented below.

3.1. Findings Regarding the Difference Between the Achievement Scores and the Mean Achievement Scores of the Experimental and Control Groups

Table 2.
Independent Samples t-Test Results for Pre-Test Achievement Scores of Experimental and Control Groups

	Group	n	x̄	ss	sd	t	*p*
Pre-Test Achievement Scores	Experimental	23	.4348	.14494	44	-.940	.352
	Control	23	.4761	.15290			

According to Table 2, when the arithmetic mean scores of the 23 students in the Experimental group and the 23 students in the Control group were compared in the pre-test achievement test, no statistically significant difference was found [t(44) = -0.940, p = 0.352 > .05]. The arithmetic mean score of the Experimental group was ($\bar{x}$ = 0.4348), while the Control group's arithmetic mean score was ($\bar{x}$ = 0.4761).

3.2. Findings Regarding the Difference Between the Post-Test Achievement Scores and Mean Achievement Scores of the Experimental and Control Groups

Table 3.
Independent Samples t-Test Results for Post-Test Achievement Scores of Experimental and Control Groups

	Group	n	x̄	ss	sd	t	*p*
Post-Test Achievement Scores	Experimental	23	.5527	.21946	44	1.340	.187
	Control	23	.4717	.18939			

According to Table 3, when examining the arithmetic mean scores of the post-test achievement test for the Experimental group (n = 23) and the Control group (n = 23), no statistically significant difference was found [t(44) = 1.340, p = .187 > .05]. However, when comparing the arithmetic mean scores of both groups, the Experimental group's mean score ($\bar{x}$ = .5527) was observed to be higher than that of the Control group ($\bar{x}$ = .4717).

3.3. Findings Regarding the Difference Between the Pre-Test and Post-Test Achievement Scores and Mean Achievement Scores of the Experimental Group

Table 4.
Paired Samples t-Test Results for Pre-Test and Post-Test Achievement Scores of the Experimental Group

	Test	N	x̄	ss	sd	t	*p*
Experimental Group Achievement Test Pre-Test and Post-Test	Pre-test	23	.4348	.14494	22	-3.239	.004*
	Post-test	23	.5527	.21946			

*p<.05

According to Table 4, when examining the arithmetic mean scores of the pre-test and post-test achievement tests for the experimental group consisting of 23 participants, a statistically significant difference was observed [t(22) = -3.239, p = .004 < .05]. The arithmetic mean score of the experimental group in the pre-test was x¯=0.4348\bar{x} = 0.4348x¯=0.4348, while the arithmetic mean score in the post-test increased to x¯=0.5527\bar{x} = 0.5527x¯=0.5527.

3.4. Findings Regarding the Difference Between the Pre-Test and Post-Test Achievement Scores and Mean Achievement Scores of the Control Group

Table 5
Paired Sample t-Test Results for the Difference in Pre-Test and Post-Test Achievement Scores of the Control Group

	Test	N	x̄	ss	sd	t	*p*
Control Group Achievement Test Pre-Test and Post-Test	Pre-test	23	.4761	.15290	22	.118	.907
	Post-test	23	.4717	.18939			

According to Table 5, when examining the arithmetic mean scores of the pre-test and post-test achievement tests for the control group, consisting of 23 participants, no statistically significant difference was observed [t(22) = 0.118, p = 0.907, p> .05]. The arithmetic mean score of the control group in the pre-test was x¯=0.4761\bar{x} = 0.4761x¯=0.4761, which is close to the post-test arithmetic mean score of x¯=0.4717\bar{x} = 0.4717x¯=0.4717.

3.5. Findings Regarding the Difference Between the Pre-Test Attitude Levels and Mean Attitudes Toward Musical Experience of the Experimental and Control Groups

Table 6.
Independent Samples t-Test Results for the Difference in Pre-Test Attitudes of the Experimental and Control Groups

Attitude	Group	n	x̄	Ss	sd	t	p

	Experimental	23	2.2899	.27279	44	.916	.365
	Control	23	2.1884	.45589			

According to Table 6, when examining the pre-test attitude score means of the experimental group, consisting of 23 participants, and the control group, composed of 23 participants, the arithmetic mean value of the experimental group was $\bar{x}$=2.2899\bar{x} = 2.2899$\bar{x}$=2.2899, and that of the control group was $\bar{x}$=2.1884\bar{x} = 2.1884$\bar{x}$=2.1884. No statistically significant difference was found between the pre-test attitude score means [t(44) = 0.916, p = 0.365 > .05].

3.6. Findings Regarding the Difference Between the Post-Test Attitude Levels and Mean Attitudes Toward Musical Experience of the Experimental and Control Groups

Table 7.
Independent Samples t-Test Results for the Difference in Post-Test Attitudes of the Experimental and Control Groups

	Group	n	x̄	ss	Sd	t	p
Attitude	Experimental	23	2.5362	.31565	44	2.556	.014*
	Control	23	2.2717	.38289			

*p<.05

According to Table 7, when examining the differences in post-test attitude score means between the experimental group, consisting of 23 participants, and the control group, composed of 23 participants, the arithmetic mean of the experimental group was $\bar{x}$=2.5362\bar{x} = 2.5362. In contrast, that of the control group was $\bar{x}$=2.2717\bar{x} = 2.2717$\bar{x}$=2.2717. A statistically significant difference was found between the post-test attitude score means [t(44) = 2.556, p = .014 < .05].

3.7. Findings Regarding the Difference Between the Pre-Test and Post-Test Attitude Levels and Mean Attitudes Toward Musical Experience of the Experimental Group

Table 8.
Paired Samples t-Test Results for the Difference in Pre-Test and Post-Test Attitudes of the Experimental Group

	Test	n	x̄	ss	sd	t	*p*
Experimental Group Pre-Test – Post-Tes	Pre-Test	23	2.2899	.27279	22	-2.828	.010*
	Post Test	23	2.5362	.31565			

*p<.05

According to Table 8, when examining the difference in mean scores between the pre-test and post-test of the experimental group, which consisted of 23 participants, the arithmetic mean of the pre-test was $\bar{x}$=2.2899\bar{x} = 2.2899. In contrast, the post-test mean was $\bar{x}$=2.5362\bar{x} = 2.5362$\bar{x}$=2.5362. A statistically significant difference was found between the pre-test and post-test attitude score means [t(22) = -2.828, p = .010 < .05].

3.8. Findings Regarding the Difference Between the Pre-Test and Post-Test Attitude Levels and Mean Attitudes Toward Musical Experience of the Control Group

Table 9.
Paired Samples t-Test Results for the Difference in Pre-Test and Post-Test Attitudes of the Control Group

	Test	n	x̄	ss	sd	t	*p*
Control Group Pre-test – Post-test	Pre-Test	23	2.1884	.45589	22	-.671	.509
	Post-Test	23	2.2717	.38289			

According to Table 9, when examining the difference between the pre-test and post-test mean scores of the control group consisting of 23 participants, it is observed that the arithmetic mean of the pre-test is x̄ = 2.1884, while the post-test mean is x̄ = 2.2717. The analysis indicates that there is no statistically significant difference between the pre-test and post-test attitude scores [t(22) = -0.671, p = .509 > .05].

4. RESULTS, DISCUSSION, AND RECOMMENDATIONS

This study investigated the impact of the Quantum Learning Model (QLM) on the academic achievement and attitudes of middle school students in music classes. The results, discussion, and recommendations based on the findings are presented below.

- As a result of the research, it was concluded that music lessons conducted using the QLM positively impacted students' academic achievement.

Upon reviewing the literature, it becomes apparent that numerous studies have been conducted on the QLM and its applications in various disciplines. In Yıldız's (2024) master's thesis titled *"The Effect of the Quantum Learning Model on Students' Academic Achievement in 5th Grade Social Studies Course,"* it was found that QLM improved students' academic achievement. Similarly, in another master's thesis titled *"The Effect of Science Education Based on the Quantum Learning Model on the Academic Achievement and Scientific Process Skills of 5th Grade Students"* by Erkoç (2019), it was concluded that QLM-based instruction had a positive effect on students' academic achievement and scientific process skills in science lessons.

In the study by Azzahra et al. (2025), titled *"The Effect of the Quantum Learning Model on Social Studies Learning Outcomes of Grade V Elementary School Students,"* the effectiveness of QLM in enhancing achievement in social studies was attributed to the model's ability to engage all the students' senses and create an interactive and enjoyable learning environment. Additionally, the use of positive reinforcement and motivational components within the model was found to have beneficial effects on student motivation and academic success.

This research aligns with findings from studies in other disciplines, collectively indicating that the QLM contributes to improved student achievement.

In various other studies in the literature, Lestari and Rhokhayati (2024), in their research titled *"Application of the Quantum Learning Model Assisted with Audio Visual Media to Improve Tembang Dolanan's Singing Skills of Students at SD Negeri 1 Sukomangu,"* concluded that the QLM can effectively enhance students' singing skills. In another study titled *"The Application of Quantum Computing in Music Composition,"* Lee and Yang (2024) found that quantum algorithmic composition integrates music, art, and technology, offering new theoretical and practical approaches to music composition.

In this context, the current research findings and existing literature support the conclusion that music lessons conducted using the Quantum Learning Model have a positive impact on student achievement.

The Quantum Learning Model is a holistic approach that addresses learning through cognitive, affective, psychomotor, and social dimensions. The model increases student engagement and intrinsic motivation by emphasizing meaningful learning experiences and active participation. It supports learning retention and is an effective tool for academic success among contemporary educational approaches.

- It was found that music lessons conducted using the QLM positively affect students' attitudes.

When reviewing other studies in the literature, Şimşek (2016), in his master's thesis titled *"The Effect of the Quantum Learning Model on Academic Achievement, Attitude Towards Science and Technology Course, Motivation, and Knowledge Retention,"* concluded that QLM had a positive impact on academic achievement, attitude, motivation, and knowledge retention in science and technology classes. Wahyudi et al. (2019), in their article *"The Effectiveness of Information Service with Quantum Learning Models Using Music to Improve Student Learning,"* reported that QLM incorporating music effectively enhanced students' learning motivation. In Akman Mağaracı's (2025) doctoral dissertation titled *"The Effect of Quantum Learning-Based English Teaching on Academic Achievement and Foreign Language Learning Anxiety,"* it was determined that providing students with freedom of movement within the learning environment, facilitating effective communication, easy access to materials, group work, and artistic and autonomy-supportive applications such as background music contributed to psychological comfort during the teaching process. This indicates that the QLM is not limited to a specific subject or content but is similarly effective across various disciplines.

Within this scope, attention is drawn to the positive effects of QLM on music and science, foreign language learning, and other disciplines, including learning attitudes, motivation, and achievement. Therefore, these findings, which demonstrate the interdisciplinary applicability of QLM and the effectiveness of student-centered teaching approaches, are consistent with the current study and support the conclusion that music lessons conducted using the QLM positively influence students' attitudes.

It has become increasingly challenging to capture students' interest and maintain their motivation towards lessons using traditional teaching methods. Therefore, it is essential for teachers to stay current with new programs and training, and to implement various teaching methods beyond the conventional approach, making their lessons more effective and lasting. In Classroom Management (KÖM), the preparation of the environment and atmosphere, such as bringing live plants to the lesson, using colorful cushions in the classroom, airing the classroom before students arrive, playing Baroque music, and posting materials related to the lesson topics on the board beforehand, holds significant importance in organizing the lesson setting and design. Incorporating this entire lesson design into the learning process positively affects students' comfort within the school environment and their learning outcomes. Designing student environments constitutes a crucial dimension of learning that enhances students' motivation towards the lesson, positively influences their attitudes towards the course, and improves their academic success. Based on this information, it is likely that students who develop a positive attitude towards a lesson will also achieve success in it. In the study titled "The Effect of Attitude towards Social Studies Course on Achievement" by Tay and Akyürek Tay (2006), research on attitudes revealed a significant relationship between students' school achievement and their attitudes. Similarly, in the study "The Effect of Classroom Climate and Attitude on English Course Achievement" by Candan Hamurcu and Orman (2023), attitude towards the course was a significant predictor of success. Upon reviewing the above studies, it is evident that students' attitudes towards the course and their academic success demonstrate a parallel relationship. In this regard, the research findings are consistent with each other.

Classroom Management QLM, with its profound philosophical foundation, offers a multifaceted and development-oriented learning environment that values individuality and enables learners to enjoy the learning process while achieving lasting results. Preparing lesson plans through implementing KÖM and designing lessons with careful attention to the environment, atmosphere, and layout will enhance students' perspectives toward the course and positively impact their academic achievement.

Based on the research findings, the following recommendations have been proposed:

1. It has been observed that music lessons conducted using Classroom Management QLM positively affect students' achievement and attitudes in music courses.
- In this context, it is recommended that the instructional process of music lessons conducted in schools be structured by considering the implementation steps of QLM. Additionally, providing in-service training to teachers on this model may enhance the effectiveness of its application.
2. QLM's importance on the classroom environment, spatial arrangement, and learning atmosphere positively influences students' attitudes toward the lesson.
- Therefore, it is recommended that classroom environments be arranged with aesthetic, colorful, and attention-grabbing materials (e.g., live plants, music listening corners, bright cushions, instrument corners, etc.) to capture students' interest and make them feel valued. Additionally, audiovisual materials that increase student participation should also be supported.
3. No significant changes in students' achievement levels and attitudes have been observed in music lessons taught using traditional methods.
- This indicates that memorization-based and teacher-centered approaches limit students' learning motivation and interest in the lesson. Therefore, especially in teaching theoretical subjects such as "musical perception and awareness" in music lessons, supporting instruction with interactive, practical, and contemporary methods can enhance students' academic success and foster positive attitudes towards the subject. Additionally, it is recommended that internationally recognized music teaching models (e.g., Orff, Kodály, Dalcroze) be integrated with QLM.
4. The study is limited to the learning outcomes within the domain of "musical perception and awareness," which include using basic music notation and elements, understanding the formation of the human voice, and recognizing the voice change characteristics during adolescence.
- In future studies, the effects of QLM should also be examined on other learning areas and outcomes included in the music curriculum, and how the model performs across different content areas should be investigated.
5. The study was conducted exclusively with 6th-grade students. However, due to its flexible structure and incorporation of multiple learning approaches, KÖM is adaptable to all age groups and educational levels.
- Therefore, the effects of the model should be evaluated by implementing it across different grade levels. Additionally, the model's long-term impact should be examined through extended applications.

Research and Publication Ethics Statement

Throughout the research process, the researchers conformed to all ethical standards. The data collected from the participants have not been used outside the scope of the present study, and the reporting process was also carried out in accordance with the guidelines for research ethics.

The Ethics Committee of Gazi University reviewed this study at its meeting on June 20, 2023, and numbered 12. The committee unanimously approved the conduct of the study.

Contribution Rates of Authors to the Article

The first author was responsible for the study's conceptual framework, data collection, analysis process, and interpretation. The second author contributed to the study design, determination of the overall framework, and final approval of the manuscript.

Statement of Interest

There is no conflict of interest.

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YAYIN İLKELERİ VE YAZIM KURALLARI

1. YAYIN İLKELERİ

Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, yılda dört kez (Ocak, Nisan, Temmuz, Ekim) yayınlanan uluslararası hakemli bir dergidir ve aşağıda belirtilen ilkeler doğrultusunda yayın yapmaktadır:

1. Dergimiz, yayın politikası gereğince, eğitimin tüm alanlarıyla ilgili nicel ve nitel özgün araştırma makaleleri ile derlemelere yer vermektedir.

2. Derginin yayın dili İngilizce'dir.

3. Dergiye gönderilen makalelerin başka bir yerde yayınlanmamış veya yayınlanmak üzere eş zamanlı olarak başka bir dergiye gönderilmemiş olması gerekmektedir. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi yayınlanmak üzere kabul edilen makalelerin tüm yayın haklarına sahiptir.

4. Dergiye gönderilecek makalelerin https://dergipark.org.tr/ adresinden yüklenmesi gerekmektedir. Baş Editöre, Yayın Kurulu üyelerine veya dergi iletişim e-posta adresine gönderilen makaleler resmi başvuru olarak kabul edilmemektedir.

5. Dergiye gönderilen makaleler ilk olarak şekil incelemesinden geçirilir. Dergi şablonuna uygun olarak hazırlanan makaleler daha sonra Baş Editöre gönderilir. Baş Editör ve Yayın Kurulu tarafından derginin yayın ilkelerine uygunluğu incelenir ve uygun görülen makaleler alan editörlerine atanır. Alan editörleri makaleleri alanın var olan bilgi birikimine katkısı yönünden inceler ve uygun görürlerse makaleyi hakemlere gönderirler. Ön inceleme aşamalarında aşağıdaki noktalar göz önünde bulundurulur:

a) Yayın etiğine uygunluğu
b) Dergi yayın ilkelerine uygunluğu
c) Çalışmanın konusunun bilimsel açıdan özgünlüğü ve güncelliği
d) Çalışma konusunun eğitime katkısı
e) Yazım kurallarına ve makale yazım şablonuna uygunluğu

6. Ön incelemeler sonucunda uygun olduğuna karar verilen çalışmalar bilimsel açıdan değerlendirilmesi için hakemlere gönderilir. Hakem raporlarına dayalı olarak makalelerin yayınlanıp yayınlanmayacağına Baş Editör ve alan editörleri karar verir. Gerek duyulması durumunda çalışmalar, hakemlerden gelen eleştiri ve öneriler doğrultusunda, gözden geçirilmesi veya önerilen düzeltmelerin yapılması için yazarlara geri gönderilir.

7. Yazar(lar)la hakemler arasındaki iletişimi sadece Baş Editör ve alan editörleri sağlar. Dergide makalelerin değerlendirilmesi sürecinde çift taraflı kör hakemlik sistemi uygulanmaktadır.

8. Yayına kabul edilen makalelerin basılması için, yazar(lar) tarafından yükümlülük formunun imzalanması ve dergiye iletilmesi gerekmektedir. Ayrıca, yazar(lar)dan makaleyi bir intihal kontrol programı ile taramaları ve intihal kontrol programının ürettiği en çok % 10 benzerlik oranının olduğunu belgeleyen bir program çıktısını, garanti ve yükümlülük formuyla beraber göndermeleri istenir.

9. Hakemlerden gelen dönütler ve Baş Editör ile alan editörlerin kararına bağlı olarak dergiye gönderilen makalelerin ilk tur hakem değerlendirme süreçlerinin yaklaşık olarak 6-8 hafta sürmesi öngörülmektedir. Ancak bu süre alandan alana değişebilir. Değerlendirme yapmayı kabul etmeyen hakem olması durumunda süre uzayabilmektedir.

10. Yayına kabul edilen ve son biçimi verilen makaleler üzerinde yazar(lar) değişiklik yapamaz.

11. Yayınlanan makalenin içeriğinden (kaynakların ve alıntıların doğruluğundan, ileri sürülen görüşlerden ve telif hakkı olan çizelge, resim ve diğer görsellerden) yazar(lar) sorumludur.

12. Gelecek sayılarda basılmak üzere doi numarası verilen makaleler, **doi numarası sırasına veya kabul tarihine göre değil** makalelerin konuları ve alanları temel alınarak basılmaktadır. Her bir sayıda basılacak olan makaleler eğitimin farklı alanları dikkate alınarak Baş Editör tarafından belirlenmektedir.

13. Yayına kabul edilen makaleler için yazar(lar)a ve hakemlere ücret ödenmez.

14. Açık erişim politikası gereğince, dergi sayıları ve makaleler derginin web sayfasında yer alır ve makalelerin tam metinlerine pdf dosyası olarak erişilebilir.

15. ULAKBİM TR Dizin kuralları gereği makalelerde yer alan tüm yazarların ORCID numaralarının makalenin son şekline eklenerek gönderilmesi gerekmektedir. ORCID numarası eksik yazarlara ait makalelere doi numarası verilmez ve erken görünüm olarak yayına açılmaz.

2. YAZIM KURALLARI

2.1. BAŞLIK VE DİPNOTLAR

Makale başlığı iki yana yaslı, 12 punto, koyu ve Cambria yazı tipinde, en çok 15 sözcük, bağlaçlar hariç her sözcüğün ilk harfi büyük olarak yazılmalıdır. Türkçe yazılmış makalelerde makalenin İngilizce başlığına da aynı biçim kullanılarak yer verilmelidir. Makale ile ilgili olarak, tezden üretilme, bir konferansta sunulma veya proje kapsamında yapılma gibi özel durumlar varsa (*) ile başlayan bir dipnot ile yazılmalıdır. Bu ekleme makale kabul edildikten sonra gerçekleştirilecektir. Yazar kimliklerinin tahmin edilmesine neden olabileceği için, yazarların makale gönderimi sırasında böyle bir dipnota yer vermemeleri gerekmektedir. Makale geliş, kabul, erken görünüm ve basım tarihlerinin eklenmesi ve makalenin APA 7 referans verme stiline göre Türkçe ve İngilizce kaynak gösterimleri, kabul süreci sonrasında editörlerce yapılacaktır. Bu nedenle ilk aşamada bu alanların şablondaki gibi bırakılması gerekmektedir.

Çalışma kabul edildikten sonra çalışmanın yazar(lar)ının adı soyadı ortalı, koyu, 11 punto, Cambria yazı tipinde, soyadı büyük harflerle ve ortalanmış olarak, yazar sayısı birden fazla ise yazarlar tarafından belirlenen sırayla yazılacaktır. Yazar(lar)ın unvanıyla birlikte, çalıştığı yerin açık adı, şehir-ülke bilgisi, e-posta adresi ve ORCID numarası, başlığın altındaki yazar ismi ya da isimleriyle eşleştirilmiş dipnotlarla (*) belirtilmeli ve makalenin ilk sayfasının altındaki dipnotta yer almalıdır. Bu ekleme makale kabul edildikten sonra gerçekleştirilecektir. Yazar kimliklerinin tahmin edilmesine neden olabileceği için, yazarların makale gönderimi sırasında böyle bir dipnota yer vermemeleri gerekmektedir.

Dipnotlar için ek açıklama: Çalışma herhangi bir bilimsel etkinlikte bildiri olarak sunulmuş ise, makalenin başlığına dipnot simgesi (*) konularak, makalenin ilk sayfasının altında etkinliğin adı, yeri ve tarihi belirtilmelidir. Çalışma herhangi bir araştırma kurumu ya da fonu tarafından desteklenmiş ise, makalenin başlığına dipnot simgesi (*) konularak, desteği sağlayan kuruluşun adı, projenin numarası ve tamamlandığı tarih ilk sayfanın altında belirtilmelidir. Çalışma lisansüstü tezlerden üretilmiş ise, makalenin başlığına dipnot simgesi (*) konularak, tezin adı, danışmanın adı ve tamamlandığı tarih ilk sayfanın altında belirtilmelidir. Dipnotlardaki tüm bilgiler Palatino Linotype yazı tipinde, girintisiz ve 10 punto olmalıdır.

2.2. MAKALE DİLİ VE ÖZET

Makaleler İngilizce dilinde hazırlanıp gönderilecektir. İngilizce kısa özet, Cambria yazı tipinde, 9 punto ve 300 sözcüğü geçmeyecek şekilde tek sütun ve iki yana yaslı olarak şablonda belirtilen alana yazılmalıdır. Kısa özet içinde kaynak verilmemelidir. Her kısa özetin altında, çalışmayı betimleyen 2-5 anahtar sözcük bulunmalıdır.

3. BÖLÜMLER VE ALT BÖLÜMLER

Çalışmalarda ana bölüm başlıkları (birinci düzey başlıklar) Arabik rakamlarla numaralandırılarak Cambria yazı tipinde, 11 punto, koyu, sola yaslı ve tümü büyük harf biçiminde yazılmalıdır. Alt bölüm başlıkları (ikinci düzey başlıklar) Cambria yazı tipinde, 11 punto, koyu, sola yaslı, her sözcüğün ilk harfi büyük olarak yazılmalıdır. Üçüncü

düzey başlıklar ise Cambria, 11 punto, koyu, italik, sola yaslı, yalnızca ilk sözcüğün ilk harfi büyük olacak biçimde yazılmalıdır.

Metin içindeki paragraflar en az üç cümleden oluşmalı ve paragraflar arasında bir satır boşluğu bırakılmalıdır. Aynı şekilde başlıkların öncesinde ve sonrasında da bir satır boşluk verilmelidir. Makalenin tamamında girintiye yer verilmemeli, paragraflar arasında önce ve sonra aralık değerleri 0 olmalıdır. Metin içi atıfların yazımında, tablolarda, şekillerde ve kaynakça yazımında APA 7 yazım stili kullanılmalıdır.

Çalışmalarda ana bölümler sırasıyla;

- GİRİŞ
- YÖNTEM
  - Evren ve örneklem/Çalışma Grubu/Katılımcılar/Denekler (bunlardan sadece biri)
  - Veri toplama yöntem(ler)i/teknikleri/araçları
  - Verilerin analizi
- BULGULAR
- TARTIŞMA, SONUÇ VE ÖNERİLER
- KAYNAKLAR

gibi temel bölümlerinden oluşmalıdır. Bununla birlikte çalışmalarda kullanılan yönteme göre yazarlar ilave bölüm veya alt bölümler oluşturabilirler.

Ana metine "1. GİRİŞ" alt başlığı yazılarak başlanmalıdır. YÖNTEM, BULGULAR ve TARTIŞMA, SONUÇ VE ÖNERİLER bölümlerine yeni sayfadan başlanmamalı, bir bölüm bittikten sonra, aynı sayfada diğeri onu izlemelidir. Sıklıkla kullanılan istatistiksel tekniklerin sunulmasında APA 7 yazım stili temel alınarak, istatistisel değerlere cümleler içerisinde yer verilmelidir. Bununla birlikte, uygun yerlerde yazar(lar) tablolar ve şekillerden faydalanabilirler. Makale metninin tamamının yazımında APA 7 yazım stili kullanılmalıdır.

4. ŞEKİLLER

Şekiller yazım alanından taşmayacak şekilde makale içinde uygun görülen yerlere ortalı olacak şekilde yerleştirilebilir. Ana metinden şekle atıfta bulunulmalı ve mümkünse şekil açıklamalıdır. Her bir şeklin altında Arabik rakamlarla numaralandırılmış bir şekil başlığı yerleştirilmeli, makale boyunca aynı numaralandırma devam etmeli ve APA 7 yazım stiline uygun olarak yazılmalıdır. Şekil başlıkları biçim olarak Cambria yazı tipinde, 10 punto, sola yaslı, yalnızca ilk sözcüğün ilk harfi büyük olacak şekilde yazılmalıdır. Şekil başlığında kaynak kullanılmış ise parantez içinde kaynak bilgisi eklenmelidir. Eğer şekil içinde yazılar varsa, 9veya 10 punto olacak şekilde Cambria yazı tipiyle yazılabilir.

5. TABLOLAR

Tablolar sola dayalı olacak şekilde ve tamamında Cambria yazı tipi kullanılarak hazırlanmalıdır. Tablo başlığı, 10 punto ile yazılmalı, başlığın her kelimesinin sadece ilk harfi büyük olmalı ve başlık, tablo sayısının altında verilmelidir. Tablolarda APA 7 yazım stili kullanılmalıdır. Tablolara metin içinde tablo sayısı belirtilerek atıfta bulunulmalı ve tablo bittikten sonra yorumlanmalıdır. Tablolar, metin içinde kullanıldıkları yerde veya izleyen sayfada yer almalıdır. İlgili not ve kaynaklar, tablonun altında, "*Not*:" veya "*Kaynak*:" ifadelerinden sonra belirtilebilir.

6. KAYNAKLARIN BELİRTİLMESİ

Makalenin sonunda, varsa ek(ler)den önce kaynaklar, APA 7 yazım stiline uygun olarak verilmelidir. Kaynakların tamamı, 10 punto ile ve her bir kaynağın arasında 1 satır boşluk verilerek, Cambria yazı tipinde ve iki yana yaslı, tek satır aralığında, önce ve sonra paragraf değerleri 0 olacak şekilde, girintiye yer vermeden yazılmalıdır. Kaynakçada yer alan her kaynağa metin içinden atıfta bulunulduğundan, yine aynı şekilde metin içinde kullanılan her bir kaynağa da kaynakçada yer verildiğinden emin olunmalıdır.

7. EKLER

Yazar(lar) ihtiyaç duyarlarsa kaynakçadan sonra ve geniş özetten önce, Ekler bölümü oluşturabilirler. Bu kısımda verilecek eklere makale içinden mutlaka atıfta bulunulmalıdır. Birden fazla ek kullanılacaksa numaralandırılabilir.

Yazarların eklere koyacakları eklentilerin makale içinde verilmesi durumunda bütünlüğü bozacak biçimde olması gerekmektedir. Makale içinde tablo veya şekil ile verilebilecek unsurlara Ekler'de yer verilmemelidir.

8. MAKALE ŞABLONU

Bir makale çalışmasıyla ilgili bütün ayrıntılara "Yazım Kuralları"nda burada belirtilmemiş olabilir. Biçimlendirmeyle ilgili daha ayrıntılı bilgi, dergiye yollanacak çalışmalar için kullanılması gereken şablon dosyada bulunmaktadır. Burada verilen bilgilerle şablon dosyadaki bilgilerin çelişmesi durumunda şablon dosyası temel alınmalıdır.

Çalışmaların derginin yazım kurallarına uygun hazırlanabilmesi için şablon dosyanın kullanılması gerekmektedir. Eğer yazım işlemi başka bir dosyada yapılmışsa ilgili dosyanın içeriğinin şablon dosyaya aktarılması önerilmektedir. Şablona uygun olarak hazırlanmayan makaleler şekil kontrolü aşamasında yazarlara iade edilecektir.

9. DÜZELTME ÇİZELGESİ

Makaleye ilişkin düzeltme önerileri almış olan yazar(lar), "Düzeltme Çizelgesi" üzerinde, her hakemin istemiş olduğu düzeltme/değişiklik önerilerine dayalı olarak yapılan işlemi sayfa numarası belirterek çizelgede belirtmelidir.

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PUBLICATION POLICIES AND AUTHOR GUIDELINES

1. PUBLICATION POLICIES

Hacettepe University Journal of Education is an international, peer-reviewed journal that is published four times a year (January, April, July, October) and publishes in accordance with the following principles:

1. In accordance with its publication policy, our journal includes original quantitative and qualitative research articles and reviews in all areas of education.

2. The language of the journal is English.

3. Articles that are submitted to the journal should not have been published elsewhere or submitted to another journal for review. Hacettepe University Journal of Education claims all the rights of the articles that are accepted for publication.

4. Articles to be submitted to the journal should only be uploaded at https://dergipark.org.tr/**.** Articles sent to Editor-in-Chief, Editorial Board members or journal contact e-mail addresses are not considered as official submissions.

5. Articles submitted to the journal are first subjected to formal review. Then, the articles prepared according to the journal template are sent to the Editor-in-Chief. Editor-in-Chief and the Editorial Board examine the compliance with the journal's publication principles and appropriate articles are assigned to field editors. Field editors examine articles in terms of their contribution to the existing knowledge of the field and, if they deem appropriate, they initiate the blind review process. The following points are taken into account during the preliminary examination:

a) Compliance with publication ethics
b) Compliance with publication principles
c) Scientific originality and significance of the subject of the study
d) Contribution of the subject study to the field of education
e) Compliance with spelling rules and journal manuscript template

6. The studies that are found to be suitable as result of preliminary examinations are sent to the referees for scientific evaluation through blind review. Editor-in-Chief and field editors decide whether the articles will be published based on the reviewer reports. If deemed necessary, the works are sent back to the authors for review or for proposed corrections in accordance with the criticisms and suggestions from the referees.

7. Only Editor-in-Chief and field editors provide communication between the author(s) and the referees. In the evaluation of the articles in the journal, a double-blind review system is strictly applied.

8. In order to publish accepted articles, author responsibilities form must be signed by the author(s) and submitted to the journal. In addition, the author(s) are required to scan the article with a plagiarism control program and submit the program output documenting that the plagiarism control program has a maximum similarity rate of 10%, together with the guarantee and liability form.

9. Depending on the feedback from the reviewers and the decisions of the Editor-in-Chief and field editors, the first round of peer review process of the articles is expected to take approximately 6-8 weeks. However, this period may vary from field to field. The period may be extended if a need to replace a reviewer emerges.

10. The author (s) cannot make any changes on the accepted and finalized articles.

11. The author(s) is responsible for the content of the published article (the accuracy of the references and citations, the arguments and copyrighted tables, pictures and other images).

12. Articles that are given a doi number to be published in future issues are printed on the basis of the subjects and fields of the articles, **not on the order of the doi number or the date of acceptance.** The articles to be published in each issue are determined by the Editor-in-Chief considering the different fields of education.

13. No fee is paid to the author(s) and reviewers for the articles accepted for publication.

14. In accordance with the open access policy, the number of journals and articles are available on the journal's web page and full texts can be accessed as a pdf file.

15. According to the index rules of ULAKBİM TR, the ORCID numbers of all the authors in the articles must be submitted with the final form of the article. Authors whose ORCID number is missing are not given a doi number and the article is not published as online first.

2. AUTHOR GUIDELINES

2.1. TITLE AND FOOTNOTES

The title of the article should be justified, 12 point, bold, Cambria font, maximum 15 words, and the first letter of each word should be capitalized except for the conjunctions. In the articles written in Turkish, the English title of the article should be written in the same format. If there are special cases related to the article, such as being produced from the thesis, presented at a conference or produced within the scope of a project, it should be written with a footnote starting with (*). This will be done after the article is accepted. Authors should not include such a footnote at the time of submission, as this may lead to an estimate of their identity. Article arrival, acceptance, online first and publication dates will be added and Turkish and English references will be revised according to the APA 7 conventions by the editors after the acceptance process. Therefore, in the first stage, these fields should be left empty in the template.

After the acceptance of the study, the author (s) name of the study should be written in centered, bold, 11 point, Cambria font, surname in capital letters and centered. If the number of authors is more than one, they will be written in the order specified by the authors. Along with the title (s) of the author (s), full name of the place of work, city-country information, e-mail address and ORCID number, should be indicated with footnotes (*) paired with the author's name or names under the title and should be included in the footnote at the bottom of the first page of the article. This addition will be done after the article is accepted. Authors should not include such a footnote at the time of submission, as this may lead to an estimate of their identity.

Annotations for footnotes: If the study has been presented as a paper in any scientific activity, the footnote icon (*) should be placed in the title of the article, and the name, place and date of the activity should be indicated at the bottom of the first page of the article. If the study has been supported by any research institution or fund, the footnote symbol (*) should be placed in the title of the article, and the name of the sponsor, the number of the project and the date of completion should be indicated at the bottom of the first page. If the study has been produced from graduate theses, then the title of the thesis, the name of the supervisor and the date of the completion should be placed at the bottom of the first page by placing a footnote symbol (*) in the title of the article. All information in the footnotes should be in Palatino Linotype font, non-typed and 10 font size.

2.2. ARTICLE LANGUAGE AND ABSTRACT

Studies should be prepared and sent in English. Abstract should be written in Cambria font, 9 font size and written in single column and justified in the field specified in the template, not exceeding 300 words. References should not be included in the abstract. Below each abstract, there should be 2-5 keywords that describe the study.

3. SECTIONS AND SUBSECTIONS

Main section titles (first level titles) should be numbered with Arabic numerals and written in Cambria font, 11 font size, bold, left justified and all must be in capital letters. Subheadings (second level headings) should be written in Cambria font, 11 font size, bold, left justified, and the first letter of each word should be capitalized. The third level

headings should be written in Cambria, 11 font size, bold, italic, left justified and only the first letter of the first word should be capitalized.

The paragraphs in the text should include at least three sentences and one line space should be left between the paragraphs. Likewise, one line space should be given before and after the headings. There should be no indentation throughout the article, and the spacing values before and after the paragraphs should be 0. APA 7 writing style should be used for in-text citations, tables, figures and bibliography.

The main sections in the manuscript should be:

- INTRODUCTION
- METHOD
  - Universe and sample / Working Group / Participants / Subjects (only one of them)
  - Data collection method (s) / techniques / tools
  - Analysis of data
- RESULTS
- DISCUSSION, CONCLUSIONS AND SUGGESTIONS
- REFERENCES

However, according to the methodology used in the studies, authors can create additional sections or sub-sections.

Main text should start with "1. INTRODUCTION". METHOD, FINDINGS AND DISCUSSION, CONCLUSION AND SUGGESTION parts should not be started on a new page, but should be the subsequent part of the main text. In presenting frequently used statistical techniques, statistical values should be included in the sentences based on APA 7 guidelines. Additionally, author (s) may make use of the tables and figures where appropriate. The whole manuscript should be written according to APA 7 writing style.

4. FIGURES

Figures can be placed as centered, where appropriate, and they should not exceed the margins for written parts. In-text references should be made to the figure and, where possible, the figure should be explained. A figure title with Arabic numerals should be placed under each figure; the same numbering should continue throughout the article and be written in accordance with the APA 7 writing style. Figure captions should be written in Cambria font style, 10 font size, left-aligned, and the first letter of the first word should be capitalized. If a source is used in figure title, the source information should be added in parentheses. If the figure includes text, it can be written in Cambria font style and 9/10 font size.

5. TABLES

Tables should be left aligned and all the text in the tables should be written in Cambria font style. The title of the table should be in 10 font size and below the table number; and only the first letter of every word should be capitalized. APA 7 writing style should be used for the tables. Tables should be cited by specifying the number of tables in the text and they should be interpreted after the table. Tables should be placed in the text where they are used or on the following page. Related notes and references can be indicated at the bottom of the table after the “Note:” or “Source:" indicators.

6. REFERENCING

At the end of the article, references should be given according to APA 7 writing style before any appendices. All references should be written by using Cambria font style, 10 font size, before and after the paragraph values of "0", justified, single line spacing, with no indentation. There should be a single line spacing between each reference. It should be ensured that each reference in the references part is referred from the text, and that every reference used in the text is also included in the reference part.

7. APPENDICES

If the author(s) need it, they can create an appendices section after the bibliography and before the extended abstract. The appendices to be given in this section must be cited within the article. If more than one appendix is used, it can be numbered. The attachments to be included in the appendices should be in a way not to disrupt the integrity if they are given in the article. The elements that can be given in tables or figures should not be included in the Appendices.

8. ARTICLE TEMPLATE

Not all details about an article work are specified here in the "Author Guidelines". More information about formatting is included in the template file, which should be used for studies to be submitted to the journal. If the information given here contradicts the information in the template file, it should be based on the template file.

In order to prepare the works according to the spelling rules of the journal, the template file should be used. If writing is completed in another file, it is recommended to transfer the contents of the file to the template file. Manuscripts that are not prepared in accordance with the template will be returned to the authors during the stylistic control stage.

9. REVISION CHECKLIST

The author(s) who have received reviewer comments for the article should state the page number on the "Revision Checklist" sent together with the reviewer reports, specifying the page number based on the change requested by each reviewer.

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