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Shedding Light on Pre-Service Science Teachers' Instructional Preferences and Hurdles in Teaching Phases of the Moon

Öğretmen Adaylarının Ay'ın Evreleri Konusundaki Öğretim Tercihleri ve Karşılaştıkları Zorluklara Işık Tutmak

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Abstract

Purpose: This study aimed to investigate the instructional methods employed by pre-service science teachers and explore the difficulties they encountered while teaching the concept of moon phases.

Design/Methodology/Approach: The present study employed a qualitative research approach using case study methodology to explore the experiences of eight pre-service science teachers. Data were collected through observation of instruction, examination of lesson plans, and semi-structured interviews to gain insights into their instructional practices and challenges. Specifically, the study aimed to understand the difficulties encountered by these pre-service teachers when teaching the phases of the moon. This approach allowed for a rich and in-depth understanding of the complex nature of teaching science to pre-service teachers.

Findings: Analysis revealed that pre-service science teachers predominantly favored physical models and simulations for teaching moon phases. However, the study also identified challenges faced by these teachers in implementing topic-specific teaching strategies.

Highlights: These issues highlight the importance of equipping pre-service science teachers with adequate preparation and resources to effectively teach the phases of the moon. Addressing these concerns may involve providing accurate models, instructing on proper terminology, and offering activities that foster spatial awareness to enhance their understanding and teaching abilities.

Öz

Çalışmanın amacı: Bu çalışma, fen bilgisi öğretmen adaylarının ayın evreleri kavramının öğretiminde kullandıkları öğretim yöntemlerini araştırmayı ve karşılaştıkları zorlukları keşfetmeyi amaçlamıştır.

Materyal ve Yöntem: Mevcut çalışmada sekiz fen bilgisi öğretmeni adayının deneyimlerini keşfetmek için vaka çalışması yöntemini kullanan nitel bir araştırma yaklaşımı kullanılmıştır. Veriler, öğretim uygulamaları ve zorlukları hakkında fikir edinmek için öğretimin gözlemlenmesi, ders planlarının incelenmesi ve yarı yapılandırılmış görüşmeler yoluyla toplanmıştır. Çalışma özellikle bu öğretmen adaylarının ayın evrelerini öğretirken karşılaştıkları zorlukları anlamayı amaçlamıştır. Bu yaklaşım, öğretmen adaylarına fen bilgisi öğretmenin karmaşık doğasının zengin ve derinlemesine anlaşılmasını sağlamıştır.

Bulgular: Yapılan analizlerde fen bilgisi öğretmen adaylarının ağırlıklı olarak ayın evrelerini öğretmek için fiziksel modelleri ve simülasyonları tercih ettiği tespit edilmiştir. Ancak, öğretmen adaylarının konuya özgü öğretim stratejilerini uygulamada zorluklarla karşılaştıkları da görülmüştür.

Önemli Vurgular: Bu bulgular, ayın evrelerini etkili bir şekilde öğretmek için fen bilimleri öğretmen adaylarını yeterli hazırlık ve kaynaklarla donatmanın önemini vurgulamaktadır. Öğretmen adaylarına doğru modeller sağlamak, uygun terminoloji konusunda bilgi vermek, uzamsal yeteneklerini artıracak aktiviteler sunmak gibi öğeleri içermelidir.

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INTRODUCTION

Our knowledge of how we observe the moon with its different phases is one of the oldest pieces of information considering the history of science. It was recorded that Anaxagoras proposed the first scientific explanation of the moon's phases in the fifth century BC (Heath, 1931, as cited in Subramaniam & Padalkar, 2009). In other words, we have known the reasons behind observing different moon phases for over 2500 years. However, comprehending why we observe different shapes of the moon from Earth remains a challenging phenomenon for both students and adults. From the initial research conducted in the 1950s to the present, numerous studies have revealed a deficiency in understanding moon phases (Cohen & Kagan, 1979; Haupt, 1950; Jones & Lynch, 1987). The reasons for this are generally attributed to deficiencies in observations required to comprehend the complex systems among the sun, Earth, and moon (Gazit et al., 2005), teachers' insufficient conceptual understanding, and shortcomings in teacher education programs (Hemenway, 2009), as well as individual's lack of spatial reasoning abilities (Black, 2005; Cole et al., 2015; Wilhelm, 2009). Various teaching methods and techniques have been tested to address these issues and enhance individuals' understanding of the moon's phases. While instructing, multiple instructional strategies are often employed concurrently. For instance, students may observe the moon's phases with the naked eye, record their observations, discuss patterns detected through observation, and develop a model to explain the moon's phases (Abell et al., 2002; Ogan-Bekiroglu, 2007). Moreover, studies have focused on employing group discussion, drawing, and the presentation of three-dimensional models as additional teaching methods (Wilhelm et al., 2007).

Results of previous studies have shown that model-based education (Galperin & Raviolo, 2019), simulations (Kiroğlu et al., 2021; Ucar, 2014), planetariums (Hobson et al., 2010), visual representations (Parnafes, 2012), group discussions (Abell et al., 2001), didactic games (Susman & Pavlin, 2020) and historical moon stories (Abell et al., 2002) are effective methods for teaching phases of the moon. Given the existing literature, it is reasonable to assert that we understand the factors that inhibit the comprehension of lunar phases and how to address these deficiencies. However, there is limited knowledge about pre-service science teachers' instructional capabilities and the challenges they face while teaching about the moon's phases. Consequently, this study focuses on examining senior pre-service science teachers' instruction on the moon's phases. Identifying pre-service science teachers' instructional approaches is significant, as it provides insight into the future teachers' methods of teaching lunar phases. The primary objective of this study is to identify the obstacles encountered by pre-service science teachers while instructing on the moon's phases.

Examining teachers' instructional knowledge of the moon's phases is not only worthwhile but also essential, given the complexity of the concept. To capture students' interest and facilitate their understanding, pre-service science teachers must possess the necessary teaching skills to effectively convey such a challenging topic. The way pre-service teachers employ their knowledge in teaching practice is a clear indicator of their potential success in engaging students. Consequently, this study focuses on exploring pedagogical content knowledge to uncover potential shortcomings in their instruction. The findings of the current study will be beneficial for teacher educators in enhancing the quality of teacher training programs, ensuring that future science teachers are better equipped to teach complex concepts, such as the moon's phases, to their students.

Research questions

1.) What are the pre-service science teachers' instructional knowledge on phases of the moon?

2.) How do pre-service science teachers instruct on phases of the moon?

3.) In what ways do the challenges experienced by Pre-Service Teachers when teaching phases of the moon?

This study was conducted to investigate the challenges that pre-service science teachers experienced while instructing on phases of the moon. Regrettably, previous research on astronomy education has primarily focused on teachers' conceptual understanding difficulties, overlooking potential issues that may arise during instruction on lunar phases. It is reasonable to assume that, given the complexity of conceptualizing moon phases, pre-service science teachers may face challenges while teaching this subject. To effectively teach the moon's phases, teachers should possess sophisticated instructional knowledge and be equipped with a repertoire of appropriate techniques and methods that address students' difficulties (Broadfoot & Ginns, 2009; Marks, 1990; Shulman, 1987). Throughout their teacher education, pre-service science teachers acquire proficiency in diverse teaching methodologies and approaches, yet exceptional educators are frequently characterized by their content-specific pedagogical expertise (Geddis, 1993). The decisions teachers make in selecting and implementing teaching strategies can either facilitate or hinder students' understanding of lunar phases. Consequently, the current study examined pre-service science teachers' knowledge of topic-specific instructional strategies for teaching the moon's phases. By identifying areas of improvement, this research aims to contribute to the development of more engaging and effective instructional approaches that will ultimately enhance students' comprehension of this fascinating yet complex subject.

Teaching phases of the moon

Astronomy topics are an integral part of the science education curricula worldwide. Curriculum developers from various countries incorporate astronomy issues into their science education programs, recognizing the benefits of teaching astronomy (Bailey & Slater, 2004; Pasachoff & Percy, 2009). Consequently, teaching astronomy, including moon phases, provides practical advantages for students. Astronomy issues serve as a context for teaching concepts in physics and mathematics. To cite an

example, heat and energy concepts can be introduced through climate discussions, while Earth's interior heat and gravity concepts may be taught using tides and Kepler's laws (Plotnick et al., 2009). Additionally, astronomy fosters connections with mathematics and enhances students' attitudes towards the subject (Ros, 2009). Trigonometry, logarithms, and calculus can be taught through astronomy topics. Moreover, astronomy serves as an effective vehicle for teaching the history of science and the nature of science (Percy, 2009). Students may observe and record the moon's phases, reflecting the empirical nature of science. They may also share their explanations of the moon's phases, demonstrating the socially embedded nature of science (Abell et al., 2001). Furthermore, historical moon stories depicting perspectives from ancient Egypt, China, India, and Greece can be used to help students understand the tentative nature of science (Abell et al., 2002).

While astronomy topics offer numerous advantages, teachers often face challenges when instructing students on the moon's phases. These complex concepts can be difficult to explain, and various obstacles hinder effective teaching and learning. The inherent nature of astronomy contributes to these difficulties (Pasachoff & Percy, 2009). Teaching astronomy through hands-on activities often necessitates students being outdoors at night. Since stars and many planets are primarily visible during nighttime hours, providing suitable conditions for student observation presents a significant challenge for educators. Moreover, although telescopes are essential tools for astronomy, schools and families may lack the financial resources to acquire them in many situations. Spatial reasoning abilities are also critical for understanding the moon's phases adequately. Studies (e.g., Cole et al., 2015) have reported that low spatial abilities impede comprehension of lunar phases. To grasp the moon's phases, individuals must switch their reference points between Earth and space perspectives (Plummer, 2014), and mentally visualize and rotate the sun-Earth-moon system (Wilhelm et al., 2013).

Research findings (e.g., Chastenay, 2016; Ucar, 2014) showed that understanding moon phases is not an easy task. Therefore, teachers must transform this topic into more accessible forms for their students. In other words, teachers should convert their knowledge into teachable formats for teaching moon phases. In the literature, these characteristics are referred to as pedagogical content knowledge. The term "pedagogical content knowledge" was introduced by Shulman (1987) and identified as a unique form of teachers' professional knowledge encompassing both pedagogy and content. Teachers make a subject more comprehensible and intelligible for others through pedagogical content knowledge (Shulman, 1986). In other words, pedagogical content knowledge refers to teachers' reorganization of subject matter and related components, considering the abilities and characteristics of learners for instruction (Magnusson et al., 2006). Pedagogical content knowledge consists of the knowledge of curriculum, students' difficulties, assessment, and instructional strategies (Tamir, 1988). One component of pedagogical content knowledge is the knowledge of instructional strategies, including subject-specific and topic-specific strategies (Magnusson et al., 2006). Subject-specific refers to general approaches to teaching science topics, while topic-specific instructional strategy corresponds to specific activities and representations related to a particular science topic. By honing their pedagogical content knowledge, teachers can more effectively present complex subjects like moon phases to their students. This, in turn, can help facilitate deeper understanding and appreciation for the topic, ultimately contributing to a more enriching educational experience.

In literature, few studies investigate in-service or pre-service teachers' knowledge of instruction regarding astronomy topics. One study found that urban school teachers prefer class discussions as a primary teaching method, while employing laboratory experiments and simulations for astronomy instruction (Miranda, 2010). Similarly, teachers regarded experiments and observations (Kahraman, 2006), 6-sigma method (Sontay & Karamustafaoğlu, 2019) as the effective methods for teaching astronomy content. In a more recent study conducted by Tascan and Unal (2020), teachers reported employing videos and animations, and models in the instruction of lunar related topics. In the same study, Merve and Unal emphasized that methodologies employed by teachers exhibit a considerable degree of uniformity, potentially indicating inadequacy in realizing the targeted educational objectives. In addition to studies conducted with in-service teachers, Lee (2011) examined pre-service elementary teachers' perceptions of their ability to teach the topic of moon phases. Pre-service science teachers participated in inquiry-based instruction to learn about moon phases and then discussed patterns and reasons for moon phases with elementary students via an internet messaging system. Lee reached the conclusion that pre-service science teachers perceived an improvement in their abilities to instruct on moon phases. In light of earlier research, it becomes apparent that there has been limited study into the instructional practices of teachers or teacher candidates. These studies generally focus on astronomy subjects and subject-specific strategies rather than topic-specific strategies for moon phases. In summary, the present study aims to examine pre-service science teachers' specific knowledge of instruction regarding moon phases. We also intend to highlight the challenges pre-service science teachers face while instructing on moon phases.

METHOD

Research design

This investigation employed a qualitative approach using case study design, which involves examining one or more cases to gain a comprehensive understanding of a subject matter (Creswell, 2007). Case studies explore various aspects of a real-life setting and provide an in-depth insight into the issue at hand within predetermined boundaries, considering the whole context (Merriam, 2009). This method aims to offer a holistic view of the topic under study (Stake, 2005). Upon careful consideration, the case study was determined to be the most appropriate approach for identifying pre-service science teachers' instructional preferences and the challenges they encountered. Furthermore, by employing a case study approach, we were able to conduct a thorough analysis

of the pre-service science teachers' instruction, interviews, and lesson plans of the participants, which served as valuable data sources for our research. Incorporating multiple data sources in case studies is essential for enhancing the credibility of the findings (Yin, 2003).

Participants and setting

The study was conducted in the fall semester of the academic year 2022-2023 at a public university, and the process of collecting data extended over a period of four months. The participants in the current study were eight pre-service science teachers enrolled in a "school experience" course. This course aimed to provide opportunities for pre-service teachers to instruct their classmates and middle school students, as well as observe and evaluate instruction on various science topics. Accordingly, the pre-service teachers delivered instruction at middle school and during class meetings. In response to feasibility concerns, the study's focus was refined to exclusively examine phases of the moon instruction within the context of class meetings. During these sessions, eight pre-service science teachers voluntarily engaged in microteaching, delivering instruction on lunar phases to their classmates. Importantly, this study solely concentrated on the instructional interactions among pre-service science teachers themselves, rather than extending to middle school students. It is also noteworthy that pre-service teachers had no prior experience teaching moon phases and had completed a one-semester astronomy course covering basic principles. Pseudonyms were assigned to the participants of the study to ensure anonymity and maintain confidentiality throughout the research process.

The study's currentness is noteworthy as it provides valuable insights into the phases of the moon, a topic that still remains integral to the subject matter of science education. Since the challenges in comprehending and instructing the phases of the moon stem from its inherent complexity, researchers should continually explore innovative pedagogical approaches and assess the effectiveness of the current techniques.

Data sources

Instruction: The primary data sources for the present study were the instructional sessions conducted by pre-service science teachers on the topic of moon's phases. The pre-service science teachers were instructed to teach their classmates the concepts of moon phases, using any teaching methodology or technique of their choice. The instruction sessions were recorded on video and lasted approximately forty minutes each. The videotaped sessions were analyzed to extract relevant data for the study. Moreover, the pre-service science teachers were provided with a format for the lesson plan, and they were asked to explain the details of their instruction. The researcher of the current study provided guidance on how to prepare lesson plans, which included four main parts: the intention or objectives of the instruction, difficulties and limitations connected with teaching phases of the moon, teaching procedures, including the rationale for using specific techniques and instructional materials, and evaluation.

In addition to the instructional sessions and lesson plans, semi-structured interviews were employed as supplementary data sources to provide a more comprehensive understanding of the pre-service science teachers' knowledge and instructional strategies related to phases of the moon. Specifically, semi-structured interviews were conducted after the instructional sessions to explore the teachers' topic-specific instructional knowledge. The interview questions aimed to elicit information about the teachers' preparation for instructing on phases of the moon, their rationale for choosing specific teaching methods, their knowledge of alternative methods, their understanding of the sun/moon/earth system, and their reflections on how to improve their instruction. The interview questions were presented in Table 1.

Table 1. Interview questions

Questions
How did you prepare for instructing on phases of the moon?
Why did you choose …… method for your instruction?
What are the alternatives methods for instructing on phases of the moon?
To what extent do your models reflect the nature of the sun/moon/earth system?
How would you improve your instruction if you taught it again?

Data analysis

The data sources for this study, including instructional records, interview transcripts, and lesson plans, were analyzed using qualitative methods. A holistic approach was adopted to ensure that all relevant information was considered during the analysis. The study drew inferences from the pre-service science teachers' instruction, their lesson plans, and their responses to the interview questions. To obtain accurate interpretations regarding the obstacles that pre-service science teachers face and their preferences for instructional strategies, the theoretical construct of topic-specific strategies and the scientific mechanism of phases of the moon were defined. This helped to ensure that the analysis was grounded in relevant theoretical frameworks and that the findings were consistent with established scientific knowledge.

In the realm of topic-specific pedagogical strategies, knowledge can be bifurcated into two primary components: knowledge of activities and knowledge of representations. Knowledge of activities encompasses the various activities and instructional techniques employed to impart specific scientific information, while knowledge of representations pertains to the use of drawings, analogies, figures, models, simulations, and visualizations (Magnusson et al., 2006). Within this context, the term "strategy" denotes the teaching techniques implemented during the instruction of a given topic. Although the terms "teaching technique" and "teaching method" are frequently utilized interchangeably, they possess subtle differences in meaning. A teaching method,

such as learning cycles, problem-based learning, or expository teaching, is a systematic, step-by-step instructional process designed to cover the instruction of a topic over the course of one or multiple class sessions (Anthony, 1963). In contrast, teaching techniques, which may include the use of analogies, demonstrations, simulations, or questioning, are specific instructional processes tailored to address particular challenges associated with a specific concept. These techniques serve to support an instructional method during the teaching process and typically require only a few minutes to execute (Anthony, 1963). The primary focus of this study was to examine the efficacy of pre-service science teachers in properly utilizing teaching techniques while engaging in the interpretation of scientific concepts.

In addition to the clarification of teaching strategies in the context of this study, it is essential to explore the scientific normative explanation of the moon's phases. The varying appearances of the moon result from the interactions within the sun-earth-moon system. A comprehensive scientific explanation of the moon's phases typically incorporates several mechanisms. Primarily, the moon orbits almost around the Earth. As the moon is spherical, only half of it is illuminated by the sun at any given time, and consequently, only half of the moon can be observed from Earth. The phases of the moon arise from the varying perspectives of the illuminated side of the moon as viewed from Earth while it orbits around our planet. For instance, when the moon is positioned between the sun and Earth, the illuminated half of the moon is not visible from Earth. In contrast, when Earth is situated between the moon and the sun, an observer on Earth can see the entire illuminated half of the moon. This specific phase is referred to as the full moon.

Trustworthiness

This qualitative study heavily relies on the researcher's interpretations; however, several measures were taken to ensure the trustworthiness of the research. It is important to note that the researcher's interpretations were not based on a single data source. Instead, pre-service science teachers' instructional plans, interviews, and instructions were triangulated to corroborate assertions. This helped to ensure that the findings were grounded in multiple sources of data, and not solely reliant on the researcher's interpretation of a single data source. Furthermore, the researcher is also a lecturer of the course from which the data was collected, having interacted with the participants for several months. This established rapport between the instructor and pre-service science teachers allowed the latter to focus on their instruction of the moon's phases without concern for academic or social perception. This rapport contributed to the acquisition of rich and reliable data from the pre-service science teachers' engagement with the topic of the moon's phases. In addition, researchers in qualitative studies must preserve the natural environment and characteristics of an issue while collecting data (Bogdan & Biklen, 1992). As the researcher in this study is also the course instructor, the participants' natural environment was not disrupted by an external party, thus preventing any potential unusual reflections from the participants. This helped to ensure that the pre-service science teachers' reflections were not influenced by external factors, which could have potentially led to unusual responses.

Limitations

The research is constrained by three limitations. One limitation inherent in this research is the restricted timeframe allotted for data collection, specifically 40 minutes per pre-service teacher. This time restriction might have limited participants from providing more topic-specific strategies with an extended duration. The short data collection period could have influenced breadth of the information gathered, potentially limiting the richness of the finding. Furthermore, it should be noted that no financial support was provided to the pre-service science teachers. The instructional setting consisted solely of one computer and a connected projection device, and all other tools and materials were acquired by the teacher candidates through their own financial means. The absence of any financial assistance or material support from institutions may have imposed constraints on their choices of teaching methods and techniques. The final limitation relates to the absence of a measurement to assess the conceptual understanding of pre-service science teachers concerning the phases of the moon. Consequently, the research lacks the capacity to explore the potential correlation between the pre-service science teachers' understanding of lunar phases and their instructional decision-making processes. This gap restricts the thorough examination of the relationship between conceptual understanding and instructional choices of pre-service science teachers.

FINDINGS

Techniques for instructing on phases of the moon

In the present study, all participating pre-service science teachers crafted instructional designs adhering to student-centered pedagogical approaches. They incorporated various activities and representations into their lesson plans. These pre-service science educators employed three distinct methods for teaching the topic of lunar phases: the learning cycle, role-playing, and argumentation. An analysis of the implemented teaching practices revealed that all pre-service science teachers employed questioning and lecturing at various stages of their instructional designs. In addition to these prevalent teaching techniques, the pre-service educators supplemented their instruction with eight alternative techniques. Table 1 enumerates the instructional techniques utilized by the pre-service science teachers in this study.

Table 2. Pre-service science teachers' techniques to teach lunar phases

Name	Activities and Representations
Amber	Modelling, Discussion
Aria	Simulation, Visual Demonstration
Zephyr	Modelling, Simulation
Lark	Modelling, Video
Nova	Discussion, Simulation
Orion	Modelling, Simulation, Worksheet
Basil	Discussion, Drawing, Game,
Frost	Modelling, Drawing, Analogy

The participants in the study showed a variety of preferences for instructional techniques. Modelling was the most preferred technique, with five out of eight participants indicating a preference for it. Simulation was also a popular choice, being chosen by four participants. Discussion was chosen by three participants, while drawing was chosen by two participants. These results suggest that participants may prefer instructional techniques that allow them to actively engage with the material, such as modelling and simulation, as well as techniques that encourage discussion. In the following section, how pre-service science teachers utilized instructional practices were explained respectively.

Modeling the phases of the moon

In current research, it has been demonstrated that pre-service science teachers predominantly favor the utilization of physical models as an instructional approach for elucidating the phases of the moon to students. Three distinct modeling techniques for teaching the lunar phases have been identified. Zephyr, Frost and Lark utilized almost the same physical models. They selected their two of their classmates to illustrate the appearance of the phases of the moon. While one pre-service teacher, who is a classmate of the instructing pre-service teachers, stands and holds a light source, another pre-service science teacher, also a classmate, manipulates a Styrofoam ball and rotates it. In this way, light illuminates different parts of the Styrofoam ball and pre-service science teachers can observe changes of the illuminated portion of the Styrofoam ball as seen Figure 1. Pre-service science teachers briefly instructed how to perform these modeling activities. At the end of the activities, pre-service science drew and discussed their observation.

Figure 1. Classmates' performance with models in the instruction by pre-service science teachers

Amber preferred approach involved creating a self-made model to illustrate lunar phases. This model was constructed using a cardboard base with eight Styrofoam balls affixed to it and a hole in the center. One edge of the cardboard was designated as the point where sunlight would enter, and half of the Styrofoam balls, specifically the side not facing this edge, were painted black. As depicted in Figure 1, Amber' classmates rotated their heads to observe the changes in lunar phases. In contrast to Amber's technique, Orion employed a group activity utilizing playdough. Initially, he distributed a sheet featuring images of four distinct lunar phases. Subsequently, he instructed his classmates to create a model of the sun-earth-moon system using playdough, with each component corresponding to a particular moon appearance. The groups subsequently presented their models and, with the aid of the simulation, engaged in a discussion to verify the accuracy of their representations. Upon comparison, it was evident that Orion's model did not effectively demonstrate the process of moon illumination. He acknowledged that his model's absence of a light source rendered it incapable of visualizing the process. Consequently, the model only depicted the positions corresponding to specific lunar phases, limiting its overall effectiveness in teaching the concept comprehensively.

Pre-service science teachers' preference for physical models can be attributed to the effectiveness of these models in addressing misconceptions commonly associated with lunar phases. They believe that teachers can effectively facilitate students' comprehension of the phenomenon by employing physical models. This approach emphasizes that the varying lunar appearances result from the moon's illuminated portion as it orbits Earth, rather than being a direct consequence of Earth's shadow on the moon. For example, Amber states:

> There was a misconception about the Earth's shadow falling on the moon. It's a pretty common misconception, even present in the classroom. To show that this isn't the case, the sun's rays hit one side of the moon. From Earth, we see it like this. I wanted to explain this concretely. They had already learned that it was illuminated. When the light hits, it brightens up. That's why I made that part of the model white. The other side is dark.

In interviews conducted with pre-service science teachers, they also expressed their belief that the models they use also effectively represent the moon's rotation and revolution movements. They think that these physical representations not only help students understand the lunar phases but also provide a comprehensive understanding of the moon's movements in relation to the Earth. By utilizing these models, teachers can visually demonstrate the complex processes behind the moon's orbit, enhancing students' grasp of fundamental astronomical concepts and fostering a deeper appreciation for the intricacies of our natural satellite's behavior.

Simulation

Four pre-service science teachers employed various lunar phase simulations, which shared similar characteristics. Each simulation's screen comprised two frames: one displaying the moon's orbit around the earth, and the other illustrating the changing appearance of the moon during its orbit. The simulations used by Nova and Orion also included a third frame, showcasing the orientation of the moon and sun in the sky. Three pre-service science teachers, Aria, Zephyr, and Orion did not allow their peers to modify the simulation conditions. Instead, they set up the simulation, and their classmates observed the changes. Conversely, Nova provided computers and simulations setups for each group of classmates, who subsequently utilized the simulation to derive conclusions regarding the moon's phases.

Aria employed the simulation to elucidate the mechanism of lunar phases, explaining the occurrence of each phase and demonstrating it through the simulation. Zephyr utilized the simulation to reveal that the moon is visible during the daytime, while Orion integrated the simulation to verify whether the pre-service science teachers' models accurately represented specific lunar phases. Additionally, Nova incorporated the simulation into an argumentation activity to display earth-based and space-based perspectives of the sun-earth-moon system.

Frost expressed her thoughts on the potential incorporation of simulations in her instruction of the lunar phases, especially if given the chance to refine her teaching methodology. S/he explained the limitations of her current method, stating, "After all, we are in a classroom setting. I only have a plastic ball in my hand, which might not be sufficient to visualize the concept for the students." Recognizing that today's students are accustomed to using computers and tablets, she suggested that simulations could be more effective for engaging them. Frost further elaborated, "Simulations involve numerous parameters, which indicate their basis in a scientific framework. This aspect could make them particularly appealing to students." By incorporating simulations into her lessons, Frost aims to enhance the learning experience, leveraging technology to foster a deeper understanding of complex astronomical concepts in a manner that resonates with contemporary students.

Video

Lark was the only pre-service science teacher who incorporated a video related to lunar phases into her instruction. She utilized a video titled "Outer Space Time to Shine: The Moon Song by StoryBots" at the beginning of her lesson. The video featured a song and visual demonstration of the sun-earth-moon system. Lark employed this video as a warm-up activity, with the aim of reminding pre-service science teachers about the moon's rotation and revolution, as well as the shapes of the earth, sun, and moon. After watching the 2-minute-long video, Lark provided a summary of the concepts presented within it.

Figure 2. Video demonstration

Game

Basil opted to engage her classmates in a game while teaching the phases of the moon. In this activity, students would throw a ball to another student and ask a question related to the sun-earth-moon system. The game continued with the ball being thrown and questions being asked among the students. Basil began her instruction with this game to activate the students' prior knowledge. The questions, predetermined by Basil, encompassed topics such as "naming a lunar phase," "describing the shape of the moon," "drawing a lunar phase," and "demonstrating their movements."

Drawings, visual demonstrations, and worksheets

Drawings and visual demonstrations were common techniques employed by most of the pre-service science teachers. They utilized smartboards or worksheets for visual representation and drawings. For example, Orion distributed a worksheet displaying the appearance of the four lunar phases. He asked the students to draw the positions of the sun, earth, and moon to illustrate these lunar phases. Frost preferred drawing the phases of the moon on the board while explaining why we observe lunar phases. She sketched eight orbital positions of the moon while the sun illuminated it. Then, she demonstrated how a person on earth would observe the moon from those positions, as shown in Figure 3.

Figure 3. Drawing lunar phases on the whiteboard

Aria incorporated photos into her presentation with the aim of showing that the moon is visible during the daytime. Consequently, the images depicted some of the moon phases observable in the daytime. The image utilized by Aria is presented in Figure 4.

Figure 4. Visual demonstration

Discussion

Nova, Amber, and Basil chose to incorporate group discussions into their instruction on the phases of the moon. Each of these discussion activities had distinct characteristics and purposes. Both Basil and Nova aimed to facilitate a deeper understanding of lunar phases among pre-service science teachers by exploring their ideas on the topic. Meanwhile, Amber's objective was to teach the reasons behind lunar phases through discussion.

Basil presented four national flags and asked students to identify differences and similarities of the moon depicted on these flags. She also asked students to consider the geographic locations of the countries. Following the discussion, Basil explained that the moon's orientation can change depending on one's location. In Amber's instruction, the classmates discussed the reasons behind the observation of different lunar phases. She incorporated the discussion segment after the model demonstration. The students observed various lunar phases through the model and then discussed the rationale behind them. On the other hand, Nova provided three graphs displaying the appearance of the sun and the moon in the sky. The positions of the moon and the sun, as well as the phases of the moon, differed in all three graphs. Nova asked students to examine which of the scenarios would be impossible to observe from the earth. Students discussed the problem within their groups and attempted to find a logical answer.

During their instruction on lunar phases, pre-service science teachers often utilize the questioning technique as a means to engage students and encourage critical thinking. By posing thought-provoking questions, teachers can effectively stimulate discussions and encourage students to actively participate in the learning process. For example, Frost employed this technique by asking her classmates whether they believed the moon was not a source of light. This question not only encouraged students to consider the nature of the moon's illumination but also provided an opportunity for Frost to address potential misconceptions, clarify the role of the sun as the primary light source, and ultimately deepen her classmates' understanding of the underlying mechanisms responsible for the moon's various phases.

Among the pre-service science teachers, Nova expressed her intention to revise and integrate the questioning technique into her lessons if given the opportunity. She believes that employing this approach would enhance her instruction on the phases of the moon. Specifically, Nova mentioned that she would pose questions to the students about the stages in which solar and lunar eclipses occur during the moon's cycle. By incorporating questioning into her teaching, Nova aims to deepen her students' understanding of the complex interplay between the sun, the moon, and the Earth that gives rise to these fascinating astronomical phenomena.

Story

Only one pre-service science teacher, Aria., shared a story with her classmates. She incorporated a brief narrative related to the evolution of our understanding of lunar phases. The story, which is included in the lesson plan, is outlined in the following excerpt.

> Ancient Greeks believed that their Goddess Selene's shiny crown illuminated the moon, and they used the phases of the moon as a measure of time. In fact, they considered the period from one full moon to the next as one month. The teacher continued, explaining that many ancient people believed the moon had its own light. However, the Greek philosopher Anaxagoras posited that the moon was a rocky body, reflected sunlight. In 1065, Chinese philosopher Shen Kuo observed and deduced that the shape of the moon was spherical. He also explained the reasons for the moon's phases. Furthermore, with the advancement of technology and the invention of the telescope, the moon was observed in greater detail.

Aria included this story in her instruction to emphasize the tentative and empirical-based nature of science. By highlighting the historical development of our understanding of lunar phases, she aimed to demonstrate how scientific knowledge evolves over time through observation, experimentation, and the refinement of ideas. This approach helps students appreciate the ever-changing and progressive nature of scientific inquiry, as well as the importance of advancing our comprehension of natural phenomena.

Analogy

Among the pre-service science teachers, it was observed that only Frost employed the analogy technique in the lesson on the phases of the moon. At the beginning of her explanation, Frost posed a question regarding how an apple is illuminated by a candle. As seen in Figure 5, she drew a comparison between the apple and the moon, illustrating that just as the candle illuminates the apple, the sun similarly illuminates the moon. By utilizing this analogy, Frost aimed to facilitate the classmates' understanding of the relationship between the sun and the moon, and how their interaction results in the observable lunar phases.
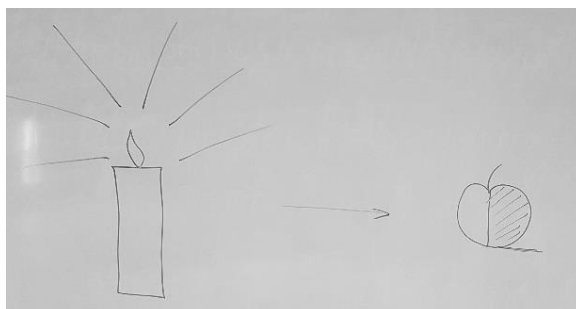
Figure 5. Moon's illumination analogy

Challenges of Pre-service Science Teachers' Instruction on Phases of the Moon

Shadows Falling on the Face

The infrequency of solar and lunar eclipses can be attributed to the approximately 5-degree inclination of the moon's orbit relative to Earth's orbital plane. This inherent tilt results in the moon generally being positioned above or below the ecliptic during the new and full moon phases, which are essential for eclipses to occur. In various model demonstrations conducted by pre-service teachers, it has been observed that the lunar models were not held at an appropriate angle to accurately represent the actual inclination. Consequently, instead of effectively illustrating the new and full moon phases, the demonstrations inadvertently depicted solar and lunar eclipse events, as shown in Figure 6. This highlights the importance of precise model manipulation and a thorough understanding of celestial mechanics to ensure accurate representation and comprehension of astronomical phenomena in educational settings.
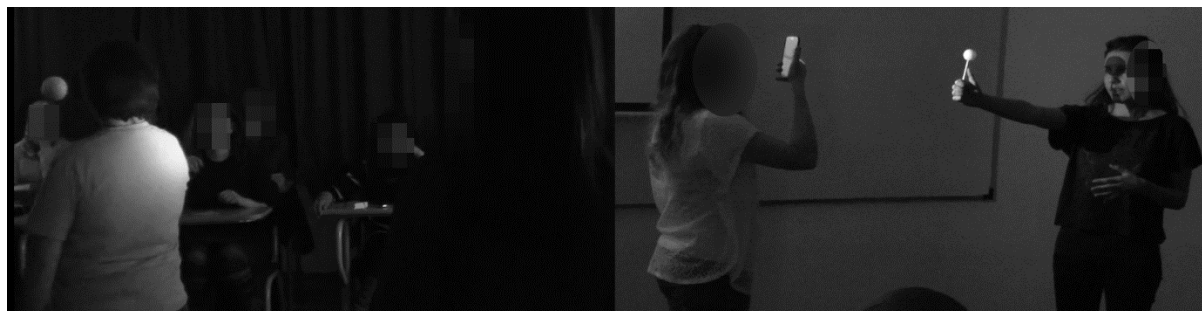
Figure 6. Shadow problems in model usage

As illustrated in Figure 6, during the full moon phase, the student's shadow falls onto the ball, while in the new moon phase, the ball's shadow is cast onto the student's face. This highlights the importance of precise model manipulation and a thorough

understanding of celestial mechanics to ensure accurate representation and comprehension of astronomical phenomena in educational settings. The aforementioned discrepancy in the pre-service science teachers' model demonstrations underscores a potential gap in their awareness of the intricacies involved in accurately representing astronomical phenomena.

Lunar Phase Representations

In the research, it was observed that pre-service science teachers employed a variety of activities to instruct on the phases of the moon. Some opted for three-dimensional models and drawings as tools to facilitate understanding of the reasons behind the appearance of lunar phases. However, these pre-service science teachers encountered challenges in translating their observations from three-dimensional models to two-dimensional representations. Notably, difficulties arose when attempting to accurately depict the shapes and positions of the waxing and waning gibbous and crescent moons in their drawings. This finding underscores the complexities involved in the process of transferring knowledge between different representational formats within the context of teaching lunar phases. For example, as seen in Figure 7, Lark was unable to accurately draw the positions and shapes of the crescent phases in the lunar phases diagram, which was created together with the students after the model demonstration.
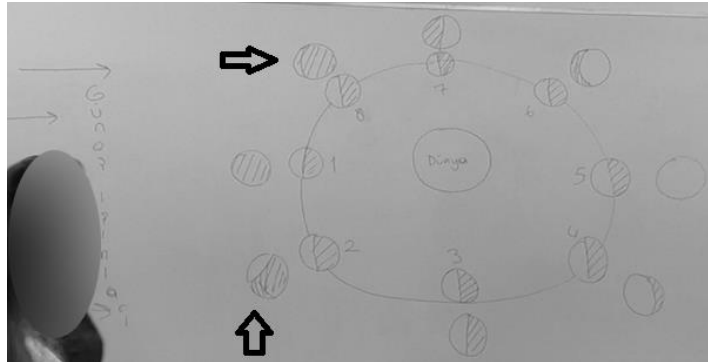
Figure 7. Lark's inaccurate crescent depiction

Space-based and earth-based awareness

It has been observed that some pre-service science teachers lack an awareness of the distinguishing characteristics between the Earth-based and space-based appearances of the moon. For instance, Aria confused the moon's appearance from space and its view from Earth. This issue is evident in both her verbal explanation and her demonstration of lunar phases using a simulation. Aria tried to explain the phases of the moon; however, their explanations and demonstrations made understanding the idea challenging. While showcasing the lunar phases via simulation, Aria stated, "Following the new moon, we see the crescent moon, where the moon's edge is facing the sun." It is important to note that the moon's edge is not actually facing the sun; rather, half of the moon is always illuminated by the sun. Her statement and demonstration during the interview underscore the confusion arising from differentiating between space-based and Earth-based perspectives of the lunar phases, which is seen in Figure 8.
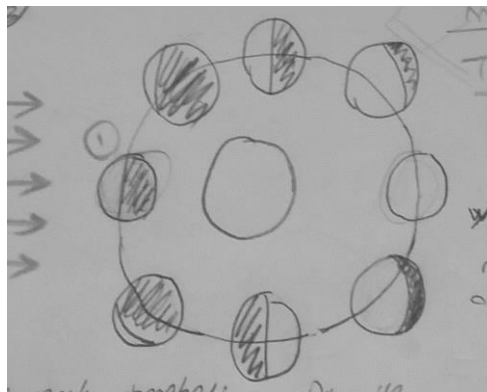
Figure 8. Space-based and earth-based awareness

Half Moon Fallacy

There are some pre-service science teachers to refer to the first and last quarters of the moon as a "half-moon," rather than using the appropriate terminology. While looking at the first and last quarter moon, it is perceived that we observe half of the moon. Therefore, pre-service science teachers describe the first and last quarter moon as a half-moon. However, we observe a quarter of the moon in these phases. In the interview, Amber stressed that memorizing the moon's name was difficult for her. More specifically, she underlined the difficulty of determining the appropriate name of the phases considering their apparent parts from the earth.

Daytime Lunar Visibility

The moon is visible during the daytime due to its position in relation to the Earth and the sun, which allows it to reflect sunlight towards the observer on Earth. The visibility of the moon during daytime is contingent upon its various phases. For instance, during the waning gibbous phase, the moon can be observed during late morning and afternoon hours. The limited observable knowledge of pre-service science teachers regarding the moon has led to difficulties in explaining the moon's daytime appearance to their classmates.

Addressing daytime lunar visibility, Zephyr encounters difficulties while explaining lunar phases using a simulation, as her beliefs about when the moon becomes visible conflict with the scenarios presented in the simulation. Zephyr believes that during daytime, the moon only becomes visible when the sun is close to setting. While explaining the lunar phases with a simulation, she states, "As the sky darkens, we start to see the moon." However, during the simulation, a scene appears where the moon is visible at daytime while the sun is at its zenith, prompting one of the pre-service teachers to point out the inconsistency with Zephyr's statement. After a moment of consideration, Zephyr claims that the simulation presents an idealized image and that such a situation is not possible in real life.

In contrast to Zephyr's case, Aria approached the topic of daytime lunar visibility differently, focusing on students' understanding of the moon's phases and using photographs to illustrate her points. Aria asked students whether we observe the moon during daytime to elaborate on students' understanding of lunar phases. However, after the students' responses, she demonstrated photographs showing the moon's appearance during the daytime and explained.

> First, to see the moon during the day, the moon must be at a certain height. Depending on its position, it should receive sufficient light from the sun. When these conditions are satisfied, we can observe the moon in the daytime.

Aria's explanation aligns with the real situation to some extent. The visibility of the moon during daytime does indeed depend on the moon's position in the sky and the amount of sunlight it receives. However, the key factor influencing daytime visibility is the moon's current phase. Similar to Zephyr, Aria lacks sufficient lunar observation experience, which prevented her from adequately presenting the relationship between the moon's phases and visibility to her peers. An effective teaching technique could have involved providing information about the moon's phases and discussing whether they are visible during the day, as well as the specific time intervals during which they can be observed.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The focus of the study was to examine pre-service science teachers' instruction on phases of the moon. Specifically, the current study aimed to identify the teaching techniques that are favored by pre-service science teachers, as well as the challenges they encounter when implementing these techniques. The result of the study revealed that pre-service science teachers instructed adopted a student-centered perspective and integrate several teaching techniques into their lessons when instructing on the phases of the moon. However, despite their efforts, pre-service science teachers encountered various challenges during the instructional process.

Modeling is one of the most frequently used and effective techniques in the teaching of the moon phases and supports students to acquire an appropriate conceptual understanding (Mills et al., 2016). Profound conceptual development occurs during the process of converting information to physical models when the students are actively involved in the modelling process (Shen & Confrey, 2007). However, previous studies emphasized that failure to achieve the desired effect with the model might be attributed to the lack of adequate control of the scientifically accuracy of the model (Mills et al., 2016) A total number of five pre-service science teachers utilized physical models. This is a rational decision, as explaining the movement of the moon is difficult using only two-dimensional diagrams (Mulholland & Ginns, 2008). It was underlined that there were many mistakes in the models made by the teachers and that the teachers were in a dilemma as to whether the models should reflect the image of the earth from the moon or the image of the moon from space. The evidence suggests that pre-service science teachers lack sufficient knowledge in constructing models related to the different phases of the moon and in evaluating the models created by their students. This finding highlights the need for further education and training for these teachers in the realm of scientific modelling.

It is necessary to be able to visualize objects from different angles and to be able to follow the movement of objects in three-dimensional space to have a comprehensive understanding of phases of the moon. The ability to imagine and visualize is important when studying the complexities of space and related phenomena (Plummer et al., 2016). The findings of the present study indicated that pre-service science teachers might encounter difficulties in their teaching practices that are related to their spatial abilities. These challenges could be related to visualizing or understanding spatial relationships, which could impact their ability to effectively teach certain concepts or subjects (Sagdic & Sahin, 2023). Pre-service science teachers with inadequate spatial skills may struggle to effectively visualize the complex three-dimensional relationships between the moon, Earth, and the sun (Black, 2005; Cole et al., 2015; Plummer, 2014). As illustrated in Cole et al. (2022) study, spatial ability of teachers is linked to their students' success in grasping the phases of the moon. In other words, it is crucial that their teachers have an adequate proficiency in spatial reasoning in order for students to acquire a thorough understanding of lunar phases. In the current study, it is posited that the challenges experienced by pre-service teachers while teaching lunar phases might be potentially linked to their spatial abilities. For instance, pre-service teachers faced challenges when attempting to convert the three-dimensional concept of lunar phases into a two-dimensional representation, and then accurately portraying them on a model. In light of the challenges

identified, integration of spatial ability assessments and targeted training within teacher education programs is recommended to better prepare educators for addressing the complexities associated with teaching subjects that demand advanced spatial skills.

Pre-service science teachers often encounter difficulties memorizing the names of lunar phases, with some preferring to use "half-moon" instead of the more accurate terms "first quarter" and "last quarter." This confusion may arise from the inconsistency between the names of the phases and their appearances, as some lunar phases are named based on a space-based perspective, while others originate from an Earth-based perspective. Previous studies (e.g., Dove, 2002; Parker & Heywood, 1998) have also identified that terminology might be a problem in understanding the phases of the moon. To cite an example, the term "full moon" is used even though only half of the moon is visible from Earth. When viewed from an Earth-based perspective, the entire visible surface of the moon appears illuminated by the sun. However, the term "first quarter" refers to a quarter of the moon being illuminated by the sun, a description consistent with a space-based perspective, rather than an Earth-based perspective. To minimize confusion while instructing lunar phases, it is essential to enhance pre-service science teachers' understanding and awareness of the various names associated with lunar phases and the perspectives they represent.

Astronomy topics can be challenging to understand and teach due to their complex nature. To achieve a thorough understanding of celestial bodies, it is imperative for students to engage in sky observations (Mant & Summers, 1993). Nevertheless, observations alone are inadequate for cultivating a comprehensive grasp of the subject matter. It is essential that students develop the ability to visualize celestial bodies in three dimensions and conceptualize their spatial movements (Wilhelm et al., 2018). Similar to various scientific fields, astronomy greatly benefits from advancements in technology and communication for its ongoing progress. These developments play a vital role in enhancing the learning and instruction of astronomy-related subjects. A diverse array of new technology-based techniques has been specifically designed to support learning of astronomy issues. Studies showed that these techniques (Beltozar-Clemente et al., 2022) contributed to understanding of individuals. In the current research, four pre-service science teachers utilized simulation as a teaching technique for the phases of the moon. Interestingly, none of the pre-service teachers employed more recent technology-supported approaches, such as mobile applications or augmented reality. In Tascan and Unal (2020) study involving teachers, a similar trend emerged, indicating that among the 26 participating teachers, only one individual reported using augmented reality applications. These findings align with broader research (e.g., Alkhattabi, 2017; Perifanou et al., 2022), which demonstrated that obstacles hindering the use of augmented reality in classrooms include the absence of essential support systems, insufficient tools for content creation, and teachers' limited knowledge of augmented reality. It is probable that the prospective teachers participating in this study might not have utilized technologies such as augmented reality in their classes due to a lack of knowledge about these new technologies or the unavailability of suitable instructional materials. Therefore, it is crucial to explore and promote the use of innovative technology-supported teaching methods in astronomy education, as they have the potential to significantly enhance students' understanding and learning experience.

Ethics Committee Approval Information

All ethical rules were strictly followed during the stages of data collection and analysis. Additionally, ethical approval was obtained from Kafkas University Social and Humanities Research and Publication Ethics Committee, with the approval document dated 06.04.22 and assigned the permission number 33, ensuring that the research adhered to ethical standards.

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Statements of publication ethics

I hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

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An Examination of the Preservice Teachers' Personal Practical Theories

Öğretmen Adayların Uygulamaya Dayalı Bireysel Teorilerine İlişkin Bir İnceleme

Emel Bayrak Özmutlu [1]

Abstract

Purpose: The aim of this study is to examine the contents and sources of preservice teachers' personal practical theories (PPTs) and the relationship between the contents and sources.

Design/Methodology/Approach: The study was carried out using a basic qualitative research design. The study group of the research was determined by criterion sampling, one of the purposive sampling methods. The data collection instrument was developed by the researcher. This instrument was developed with an understanding that allowed preservice teachers to externalize their PPTs, reason about the professional behaviors that their PPTs would result in, identify the sources of their PPTs, and recall the relevant memories that their PPTs originated from. Fifty-one preservice teachers studying in the eighth semester of the classroom teaching program were included in the study group of the research. Analyses were based on PPT statements labeled with 489 in vivo codes. The research data were obtained within the scope of a study titled "Personal practice-based theory construction" conducted with the participants for three weeks.

Findings: Preservice teachers' PPTs were analyzed under the themes of teacher, students, instruction, curriculum, classroom, and socio-cultural context of education. It was observed that the teacher candidates' PPTs were mainly constructed on the teacher theme, through which the characteristics of high-quality teachers were explained. It was seen that about half of the teacher candidates' PPTs were sourced from their experiences before they came to the faculty of education, while the lowest percentage of PTTs stemmed from the theoretical dimension of teacher education.

Highlights: The most prominent of these is that teacher candidates constructed their PPTs predominantly on ideal teacher characteristics, while they paid less attention to the curriculum and socio-cultural context. An idealistic approach that placed too much emphasis on values was identified in the contents of the candidates' PPTs. Although the candidates' PPTs were largely compatible with the accepted theories, they need to be developed to transfer them into practice in a real classroom context.

Öz

Çalışmanın amacı: Bu araştırmanın amacı öğretmen adaylarının bireysel uygulamaya dayalı teorilerinin içeriklerini, kaynaklarını ve içerik ile kaynakları arasındaki bağlantıyı incelemektir.

Materyal ve Yöntem: Araştırma temel nitel araştırma deseni ile gerçekleştirilmiştir. Araştırmanın çalışma grubu amaçlı örnekleme yöntemlerinden ölçüt örnekleme yöntemi ile belirlenmiştir. Veri toplama aracı araştırmacı tarafından geliştirilmiştir. Bu araç adayların bireysel uygulamaya dayalı teorilerini dışsallaştırmalarına, onların sebep olacağı profesyonel davranışlar üzerinde akıl yürütmelerine, bireysel uygulamaya dayalı teorilerinin kaynaklarını belirlemelerine ve onlara kaynaklık eden ilgili anıyı hatırlamalarına imkân veren bir anlayış içinde geliştirilmiştir. Araştırmanın çalışma grubuna sınıf öğretmenliği programının sekizinci döneminde öğrenim gören 51 öğretmen adayı dâhil edilmiştir. Analizler 489 vivo kod ile etiketlenmiş bireysel uygulamaya dayalı teori ifadesi temelinde yapılmıştır. Araştırma verileri, katılımcılarla üç hafta süre ile yürütülen "Bireysel uygulamaya dayalı teori inşası" isimli bir çalışma kapsamında elde edilmiştir.

Bulgular: Öğretmen adaylarının bireysel uygulamaya dayalı teorileri öğretmen, öğrenci, öğretim, program, sınıf ve eğitimin sosyokültürel bağlamı temaları altında incelenmiştir. Adayların bireysel uygulamaya dayalı teorilerinin ağırlıklı olarak nitelikli öğretmenin özelliklerinin açıklandığı öğretmen teması üzerinden inşa ettikleri gözlenmiştir. Adayların bireysel uygulamaya dayalı teorilerinin yaklaşık yarısına eğitim fakültesine gelmeden önceki deneyimlerinin kaynaklık ettiği, öğretmen eğitiminin teorik boyutunun ise en düşük kaynaklık oranına sahip olduğu görülmüştür.

Önemli Vurgular: Adayların bireysel uygulamaya dayalı teori içeriklerinde değerlere aşırı vurgu yapan idealistik bir yaklaşım tespit edilmiştir. Adayların sahip olduğu bireysel uygulamaya dayalı teoriler büyük oranda kabul gören teoriler ile uyumlu olsa da gerçek sınıf bağlamında uygulamaya dönüşebilmesi için geliştirilmesi gerekmektedir.

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INTRODUCTION

Personal practical theory (PPT) is a concept used to describe the interactions among teachers' knowledge, beliefs and practices. It is defined as a holistic synthesis of experiential, academic and interactive knowledge used by teachers while fulfilling the complex requirements of the profession (Buitink, 2009). PPT is a conceptual whole that corresponds to teachers' cognition and beliefs (Pitkäniemi et al., 2014). Elbaz (2018), who conducted the first studies on this subject, defined this type of knowledge as the sets of understanding that teachers actively use in the process of shaping and directing the task of teaching. PPT, which has been one of the important areas of research in teacher education since then, is also regarded as one of the central goals of teacher education (Buitink, 2009; Pitkäniemi et al., 2014). Considering the power that PPT has over preservice teachers' professional and developmental decisions and practices, such an approach seems reasonable. When the relevant literature is examined, studies are encountered that examine the relationship of PPTs with teachers' professional development (Sweeney et al., 2001), teachers' assessment and evaluation practices (Box et al., 2015), and teachers' actions related to curriculum and instruction (Cornett, 1987). In addition, there are studies that examine the relationship of PPTs with preservice teachers' theory and practice (Feryok, 2005), interactional decision-making processes (Tsang, 2004), and idealistic approaches (Maaranen, et al., 2016). It is also possible to see studies in which the content and sources of preservice teachers' PPTs are examined (Ferry et al., 2022; Levin & He, 2008; Pitkäniemi et al., 2014) and in which the longitudinal change in their PPTs is considered (Levin et al., 2013). Moreover, there are studies examining teachers' identities based on PPTs (Stenberg et al., 2014; Stenberg & Maaranen, 2020).

It is possible to mention two main pillars of importance of preservice teachers' PPTs. The first of these is based on accepted theories on cognition and learning. Current cognitive theories regard learning as an active construction process that is strongly influenced by individuals' existing meanings, beliefs, and perceptions (Resnick, 1989). This indicates that PPT is an important determinant of the teacher candidate's learning process for teaching. In fact, PPT corresponds to a synthesis of learnings, assumptions and beliefs derived from personal experience that strongly influence constructivist-based learning. The second factor that makes PPT significant is a situation that can be expressed as the nature of teaching. The unstructured and complex nature of the classroom, which requires rapid decision-making, reveals the importance of PPT in the practice of the teaching profession. In fact, Schön (1983, 1987) discussed in his studies the principle of "reflection-in-action", which implies a constant dialogue with constantly changing situations in the teacher's professional life. For this reason, he states that we should not view teachers as being in a position where they directly apply the theoretical knowledge transferred to them. In this context, it is important to state that in their professional activity, teachers are in a position to create the knowledge they need rather than merely being consumers of others' knowledge (Chaharbashloo et al., 2020). In sum, the nature of learning and the classroom causes teachers' decisions and practices to be guided by their cognitive structures, which are a synthesis of their theoretical knowledge, personal beliefs and experiential knowledge rather than simply their theoretical knowledge. This makes PPT one of the predictors of preservice teachers' professional and developmental decisions and practices.

The aim of teacher education is to develop candidates' thoughts and actions so that they can become high-quality professionals. In this regard, it is considered worthwhile to work on PPT, which is regarded as one of the predictors of their thinking and actions. In the first dimension of the study, the contents of preservice teachers' PPTs are examined. In this way, it will be possible to predict the inclusiveness and quality of teacher candidates' PPTs. These predictions will serve as a guide for teacher educators as to what needs to be done for preservice teachers to develop more developmental and inclusive PPTs (Buitink, 2009). In the second dimension of the study, the percentages of the variables that are the sources of teacher candidates' PPTs will be examined. This examination will undoubtedly answer the question of the extent to which teacher education is the source of teacher candidates' PPTs. In the study, teacher education is examined in two dimensions, which are the theoretical dimension and the observation and practice dimension. In this way, it will also make apparent the extent to which each dimension of teacher education programs is the source. In addition, the characteristics of units with a high effect on PPT sources can provide ways for effective teacher education. In this regard, it can be said that sources of PPTs enable us to make predictions about the indirect or direct role of teacher education in the formation and change of teachers' PPTs. The following research questions are addressed in this study.

What are the contents of preservice teachers' PPTs?

What are the sources of preservice teachers' PPTs?

What is the relationship between the content and sources of preservice teachers' PPTs?

Personal Practical Theory (PPT)

PPT is a concept used to describe the interactions among teachers' knowledge, beliefs and practices (Levin & He, 2008). Furthermore, it is known that concepts such as practical theories (Ferry et al., 2022; Stenberg & Maaranen, 2020; Tiilikainen et al., 2019), teachers' beliefs (Anders & Evans, 2019; Buehl & Beck, 2015; Fives et al., 2015), and teachers' conceptions (Barnes et al., 2017; Boulton-Lewis et al., 2001; Hewson & Hewson, 1987; Teo & Zhou 2017) are also used to explain this relationship. PPT constitutes one of the valuable psychological constructs for understanding the teacher. The reason for this is its relationship with the teacher's cognitive and affective processes. PPT includes all the terms, concepts, perceptions, views and beliefs that the preservice teacher uses when preparing, presenting, evaluating and thinking about instruction. In the words of Elbaz (1981), PPTs are mental representations that include the rules, principles and images that teachers use in their practices. Calderhead (1996)

called PPTs the conceptualized version of teacher cognition. PPT can be considered as an integrated structure consisting of experiential knowledge, formal knowledge and personal beliefs (Van Driel et al., 2001).

Teacher cognition studies strengthen the predictive value of PPT on teachers' professional development and practices. PPT functions as a cognitive filter for individuals to interpret new information, situations and events (Calderhead & Robson, 1991; Levin & He, 2008; Levin et al., 2013; Nespor, 1987). Moreover, by acting as a filter in preservice teachers' acquisition and interpretation of new beliefs, PPT influences what is learned during the teacher education program. Furthermore, PPT is used as a framework for planning, interacting with and communicating instruction (Elbaz, 2018; Levin & He, 2008). Studies (Lotter et al., 2007; Tavakoli & Azad, 2017) reveal the relationship between teachers' beliefs and professional practices. In this regard, it is convenient to study these structures in order to understand the decisions taken and practices performed by teachers in the classroom and the reasons for these (Enyedy et al., 2006). By defining PPT as "beliefs in action", Levin et al. (2013) emphasized the relationship established by PPT with teachers' actions. When the literature is examined, it can be seen that studies focusing on teacher cognition arouse scientific interest in understanding teachers' ways of thinking and planning, and in designing teacher education more effectively (Box, et al., 2015; Buitink, 2009; Maaranen et al., 2016; Maaranen & Stenberg, 2020; Puustinen et al., 2018). As the number of related scientific studies increases, it will be possible to make more accurate decisions in teacher education.

Sources of Personal Practical Theories (PPTs)

In the educational sciences literature, besides the ongoing debate about what preservice teachers' PPTs are, what effects they have on their decisions and practices, and their potential for and pathways of change, another important issue concerns which variables are the sources of PPTs. The reason for this is that studies on the variables that are the sources of PPTs can provide guiding information on the potential for and pathways of change in PPTs. Prominent studies on this subject emphasize that preservice teachers have a relatively structured set of beliefs about learning and instruction before beginning their studies at the education faculty (Calderhead, 1991). In fact, it is common knowledge that preservice teachers' teaching approaches are formed by their observations and experiences of teaching for countless hours as students (Anspal et al., 2012; Calderhead 1996; Kagan, 1992; Pajares, 1992; Zeichner & Tabachnick, 1981). The beliefs that teacher candidates bring with them greatly influence what they learn and may make them less responsive to the theories and approaches in the teacher education process.

Another variable that is a source of preservice teachers' PPTs is the teachers of preservice teachers. Britzman's (1991) case study conducted with two preservice teachers showed that preservice teachers had strong beliefs about both the positive and negative roles they had acquired from teacher role models. Britzman (1991) showed that these beliefs had a profound effect on their classroom behaviors. Knowles (1992), on the other hand, stated that both families and teachers influenced preservice teachers' beliefs about teachers' roles. Similarly, in a case study conducted on the development of preservice teachers' teacher role identities, Crow (1987) found that past teacher role models and early childhood family experiences strongly influenced preservice teachers' professional identities. Another factor that is a source of PPTs is individuals' own teaching experience. Zeichner and Tabachnick (1981) expressed the source effect of the social environment in schools by stating that the preservice teacher, who becomes liberal towards contemporary approaches as long as he/she studies at university, switches to traditional views when beginning his/her teaching experience.

In the literature, studies examining the sources of teacher candidates' beliefs under categories are also worthy of attention. One of the first studies on this subject belongs to Elbaz (1981). She classified the sources of practical knowledge as situational, individual, social, experiential and theoretical. In their study, in which they examined the contents and sources of preservice teachers' PPTs, Levin and He (2008) analyzed the sources of PPTs under the categories of family, experience and teacher education. The categories mentioned in their study are detailed under sub-categories. Mansour (2009) classified sources of beliefs as formal and informal. The formal type of source is provided through formal education. The informal type of source corresponds to units other than this. Pitkäniemi et al. (2014) examined the sources of prospective teachers' PPTs under the themes of experiences as a teacher, teacher education, personal learning experiences and values, and other learning environments. In their study, Ferry et al. (2022) classified sources of PPTs as the subject matter course that preservice teachers were reading, the general education courses that preservice teachers had taken the previous semester, preservice teachers' work experience, and personal experiences and media. In this study, the sources of preservice teachers' PPTs are examined with an empirical approach on the basis of separate categories.

METHOD/MATERIALS

Research Design

Qualitative research, which is derived from constructivism, phenomenology, and symbolic interactionism, is concerned with how people interpret, make sense of, and structure their experiences (Merriam, 2009). The widespread acceptance of the idea, that the ways individuals interpret their experiences have the potential to predict their professional decisions and practices, has increased the importance attached to qualitative studies in teacher education research. Basic qualitative research, which is a qualitative research design, is a type of research that focuses on participants' experiences and the meanings they attribute to these experiences (Worthington, 2013). This study focuses on the content and sources of preservice teachers' PPTs. PPT is defined

as a holistic synthesis of an individual's experiential, academic and interactional knowledge. In this respect, the contents of PPTs are inherently suitable for examination with a qualitative research paradigm. The study also examines the sources of PPTs. In fact, thanks to the opportunities provided by qualitative research, the memories that were the sources of PPTs were accessed in this study. All the steps followed in the study comply with the qualitative research principle of examining experience and the meanings ascribed to experience.

Participants

The criterion sampling method of purposive sampling was used in the study. Purposive sampling is used to select the participants most likely to provide relevant and useful information. Criterion sampling, one of the purposive sampling methods, is the study of all cases that meet a set of predetermined criteria. The criterion is either set by the researcher, or else a previously prepared list of criteria can be used (Marshall & Rossman, 2014). The study was conducted in the education faculty of a university in Turkey. The participants of the study are enrolled in the Primary Education Department, Classroom Teaching Program. As criteria for inclusion in the study, studying in the fourth grade of the classroom education program and participating in the study named "Construction of PPT" were determined as criteria. Since the departments in which preservice teachers' study are decisive in the formation of their PPT contents, data were collected from a single department. The students included in the study were studying in their 8th semester and had completed a total of 210 ECTS credits. A total of 51 preservice teachers, 9 of whom were male and 42 of whom were female, participated in the study. Ethics committee approval for this study was obtained from Ordu University Social and Human Sciences Research Ethics Committee (dated 05.06.2020 and numbered 66417432-050.01.04).

Data Collection Tools

The data collection instrument was developed by the researcher. This instrument was developed with an understanding that allowed preservice teachers' to externalize their PPTs, reason about the professional behaviors their PPTs would result in, identify the sources of their PPTs, and recall the relevant memories that were the source of their PPTs. In the process of developing the inventory, firstly, studies carried out for similar purposes and the measurement instruments used in those studies were examined (Ferry et al., 2022; Levin & He, 2008, Pitkäniemi et al., 2014). Then, the data collection instrument was developed on the basis of a four-stage directive, as detailed below, in accordance with the purposes of the study. The draft was then sent to an expert for review. The necessary revisions were made based on face-to-face interviews held with the expert. The data collection instrument consisted of four parts. The first section contained an open-ended instruction that allowed teacher candidates to make their PPTs explicit. The second part included an instruction that directed candidates to make assumptions about the professional behaviors that would result from the PPTs they had written. This instruction allowed the researcher to understand the PPTs without error. In addition, with this instruction, the aim was to enable teacher candidates to mentally construct the intellectual and operational unison of PPTs. The third part of the instrument was designed as a multiple-choice structure that enabled the preservice teacher to choose the variables that were the source of their PPTs from among the options given to them. In this context, 12 structured options were given to the teacher candidates. The 13th item was an open-ended item that allowed candidates to write any source that was not included among the options. Finally, the candidates were asked to write their memories about the variable they selected as a source. In this way, the aim was to ensure that the variable that was the source of the PPT was correctly understood by the candidate. Moreover, the aim was also to enable the researcher to understand the variable that was the source of the PPT without error. In the inventory, candidates were asked to state 7-13 PPTs. A sample data collection instrument is shown below.

Table 1. Sample Data Collection Instrument

Write below one of your thoughts that you believe to be true, important and necessary in the teaching-learning process and at school.		
How does this thought direct you to act as a teacher?		
What is the source of your thought? **(Let's just choose one)** *Example: My chosen source is my teachers*		**Write a memory about your chosen source** *Example: My primary school teacher was very fair.*
What is the source of your thought? (Let's just choose one)	Teaching Practicum	
	School Observations (Observations made in primary schools as part of the course)	
	School Practices (Practices made in primary schools for the teaching course)	
	Theoretical Courses I Have Taken at the Faculty of Education	
	My Theoretical Readings (Articles, theses, academic books…)	
	My philosophy of life, religion and values	

Write below one of your thoughts that you believe to be true, important and necessary in the teaching-learning process and at school.

	My home upbringing
	My learning experiences as a student (from primary school to university)
	My teachers (from primary school to university)
	Social Media, YouTube, Instagram, Pinterest
	Books Outside the Pedagogical Subject Area
	Experiences Not Directly Related to Teaching
	Other (Please state)…

Data Collection

The research data were obtained within the scope of a three-week study entitled "Construction of PPT" with the participants. The aims of this study were as follows: To make students' implicit PPTs explicit, to allow them to consider different perspectives of their PPTs, and to provide space for them to reflect on and question why they thought and acted in a certain way. The research data were obtained within the scope of a study with such aims. The construction of PPTs first began with a process whereby teacher candidates made their PPTs explicit. The instrument, which made it possible to examine the PPTs developed within the scope of the study on the basis of four instructions, fulfilled this purpose. The subsequent processes of the study were carried out in an open discussion environment in which the preservice teachers shared their specified PPTs, in which these were interpreted by the other participants, and in which their relationship with the literature was examined. This process was conducted within the framework of a course led by the researcher. Discussions took place with the entire class. Prior to the data collection process, the candidates were informed about the concept of PPT, and the analyses of scientific studies conducted on this subject were shared. The relationship of PPTs with the candidates' intellectual and operational processes was explained on the basis of scientific studies. Finally, sample PPT statements were shown to the candidates. Once it was established that the candidates had sufficient knowledge about the concept of PPTs, the data collection instrument was shared with the candidates.

Data Analysis

Stage 1: Coding of PPT contents: In determining the contents of PPTs in the study, besides the PPTs written by the teacher candidates, the behaviors to which the PPTs would lead the candidates and the memories that were the source of the PTTs were carefully read. In this way, an attempt was made to interpret the PPT contents with as few errors as possible. Following this interpretation, each PPT was coded with the vivo code that was considered to best define its scope. As a result of this process, a total of 489 PPT statements were coded in vivo.

Stage 2: Classification of coded PPTs based on the theme they belong to: The theme system used in the studies by Levin and He (2008) and Pitkäniemi et al. (2014) was interpreted and used within an eclectic approach based on teacher education programs in Turkey. Six themes were used in the analysis. These are teacher, students, instruction, classroom, curriculum, and socio-cultural context of education. The PPTs coded in the study were each placed in one of the themes expressed on the basis of their characteristics. As a result of the analysis, the distribution of PPTs based on the themes is as shown below.

Table 2. Analysis of PPTs based on themes.

Theme	Frequency
Teacher	125
Instruction	80
Student	75
Classroom	60
Curriculum	38
Socio-Cultural Context of Education	11
Total	489

Stage 3: Applying the constant comparison method to PPTs classified on the basis of themes: After the coded PPTs were classified based on themes, each PPT was categorized based on its focus. At this stage, each PPT was classified based on the question "Which subject does the content of this PPT focus on?" These clusters were constantly compared with each other and this process was continued until the clusters became stable. The naming of the clusters was carried out at the end of this process. The categories found in the study and the definitions of these categories are shown below.

Table 3. Units of analysis and definitions of PPT contents

Theme	Category	Definition
Teacher	Boundaries	Characteristics of behaviors required of a teacher in terms of ethics
	Characteristics of a High-Quality Teacher	Pedagogical and personal characteristics that a high-quality teacher should possess
	Role Responsibility	Roles and responsibilities that must be fulfilled by a teacher
	Professional Development	Requirement for and ways of professional development
Instruction	Instructional Approach	Assumptions that will guide the method, the structuring of the content, and the choices regarding the whole learning environment to be created in the classroom in the teaching process
	Ways of Teaching	Principles such as interest, attention, motivation, reinforcement, and humorous elements that should be considered in the implementation of the teaching process
	Inclusivity in Teaching	Statements about how to interpret multiculturalism in the teaching process and what kind of learning environment should be created on this basis
	Differentiation of Instruction	Statements about how to create a learning environment that embraces the differences observed in the classroom on an academic basis
	Instructional Strategies	Strategies, methods and techniques that should be used in creating an effective learning environment in the classroom
Students	Approach to Students	Statements about how students should be approached and what kind of relationship, communication, closeness, distance, etc., there should be with them
	Need for and Ways of Getting to Know Students	Statements about the need for and ways of getting to know students for any decision taken as a teacher.
	Expectations from Students	Statements expressing the relationship between the teacher's belief towards students and students' behaviors
	The Nature of Learning	Implications regarding how permanent and meaningful learning takes place
Classroom	Physical Characteristics of the Classroom	Statements about how the physical characteristics of an effective classroom, seating arrangement and size, etc., should look
	Classroom Management	Statements about the measures to be taken for creating an effective learning environment and enabling participation in the classroom
	Relationships	Statements about the norms that regulate the relationship between the teacher and students, and on how and why rules should be observed
Curriculum	Learning Outcomes	The knowledge and skills believed necessary to be fostered in students by the school
	Structuring of Content	Statements about how the content in the curriculum should be structured
	Planning the Lesson and Implementing the Plan	Statements about how the learning outcomes in the curriculum should be transformed into a learning experience in the classroom, and in this context, what the plan is and how it should be implemented
	Measurement and Evaluation	Statements about how to determine whether the learning outcomes in the curriculum are acquired by students
	Mission of the School	Statements about what the mission of schools is
Socio-Cultural Aspects of Education	Communication with Parents	Statements about parents' influence on students and how communication with parents should be established in the teaching process
	Educational Policy	Statements about how the right to education in the country should be provided to all citizens in an efficient way
	School Culture / School Management	Statements about what the school culture should be and how it should be managed

Analysis of Sources of PPTs: During the research process, the source of each PPT expressed by the teacher candidates was determined with 12 structured options and one open-ended item (See Table 3). In addition, candidates were asked to write down their memories about the sources they declared. The reason for this was to prevent errors that could result from possible misinterpretation of the source code of the PPT by the candidate. Therefore, during the analysis process, the source of the PPT was decided on by considering the conformity between the source indicated and the memory written by the candidate. During the analysis, the source of each PPT was coded as follows: Theme/category/source to which the relevant PPT belongs. This process

was carried out for all 489 PPTs. Following this process, the 489 PPTs were coded and clustered based on 13 sources. Finally, the PPT sources grouped in 13 categories were classified under three themes, namely, the theoretical dimension of teacher education, the observation and practice dimension of teacher education, and personal learning experiences and values.

Trustworthiness

Qualitative research focuses on trustworthiness rather than validity-reliability. Trustworthiness is examined based on the requirements of credibility, dependability, confirmability and transferability (Guba & Lincoln, 1982). In a research study, it is recommended to carry out one or more of these strategies in order to check the accuracy of the findings (Creswell, 2003). Credibility is a concept related to the trustworthiness of the findings. One of the ways to increase credibility is through expert review (Holloway & Wheeler, 1996). In the study, the opinion of an expert was sought during the development of the data collection instrument and the analysis of the data. In order to increase credibility, certain measures were also taken in the data collection instrument. The first of these was that the preservice teachers were asked to explain how the PPT they expressed led them to behave, so that the content of the PPT could be understood by the researcher without error. Secondly, the candidates were asked to write down their memories about the sources of the PPTs they chose. Both instructions ensured that the responses received from the participants were understood without error. For objectivity, which is another requirement, it is necessary to reduce the biases of the researcher. For this purpose, under the heading of "role of the researcher", the researcher's point of view on the subject was shared reflectively with the reader. In addition, in this context, certain measures were taken in the analysis of the research data. These measures are also recommended for the confirmability audit trail. The aim of these measures is to clarify as much as possible the thought process and evidence that leads the researcher to research results (Houser, 2015). In fact, Elo & Kyngäs (2007) state that explaining how the analysis is performed and defining the relationship between the findings and the original data enable the study to be evaluated as trustworthy. In this context, firstly, the analysis of the research data was made using a computer-assisted analysis program. All analyses were performed on in vivo codes. In this way, it was ensured that the most basic unit of analysis was not the abstractions of the researcher, but the verbatim statements of the participants. Moreover, the abstractions (categories) and definitions (inclusion and exclusion criteria) created by the researcher are explained in the data analysis section. In addition, detailed tables on the number of codes found in each category and subcategory are included. For the confirmability of a study, the findings should include participants' own statements rather than the researcher's biases or opinions (Lincoln & Guba, 1985). For this purpose, in vivo codes were used as the analysis unit of the study. Guba and Lincoln (1982) recommend purposive sampling and detailed description to demonstrate transferability. The study was conducted with a diverse group of preservice teachers. The participants of the study were determined by purposive sampling. Within the scope of detailed description, verbatim quotations are included in the findings section. For transferability, it is also stated that the research process should be defined clearly, precisely and in detail. In this regard, the whole research process is expressed clearly, precisely and in detail in the method section of the study.

Role of the Researcher

As a teacher educator, I have always been inquisitive about the mechanisms underlying preservice teachers' decisions and practices. I have observed in theoretical and applied studies aimed at fostering professional competence that the decisions and practices of teacher candidates are quite different from each other. During my studies, I have always questioned the reasons for their preferences. In this process, I first encountered the concept of Personal Practical Theory in the study by Levin and He (2008) in the literature. I thought it was a very promising concept for understanding the mechanisms underlying preservice teachers' decisions and practices. In that study, a means to identify the sources of PPTs was also put forward. This means had the potential to provide original answers to many questions whose answers are sought in teacher education. Following my studies on the concept, I saw that teacher candidates' PPTs were given particular importance in Northern Europe, and that in this regard, there was even a course named "Pedagogical Knowing and Construction of Personal Practical Theory" at the University of Helsinki. I have had the opportunity to review many studies on PPT. How the results of these studies, one of them carried out in the USA and the other in Finland, would appear in Turkey was a matter of great interest for me. In this context, I conducted a three-week study called "Construction of PPT" with fourth graders, modeling this course, which I had seen an example of in a Finnish university. I obtained the research data within the scope of that study, the details of which are explained in the data collection process section. Meanwhile, while meeting with an expert for the data collection instrument, the idea was born to also add memories about sources of PPTs to the data collection instrument. This feature, which did not appear in the previous studies, provided extensive opportunities, which also exceeded my own expectations, to understand teacher candidates' PPTs. During the research, I had the role of a teacher educator who introduced the teacher candidates to the concept of PPTs and revealed the importance of this subject based on the studies in the literature. The way I interpreted the data was influenced by my recognition of certain features that teacher candidates' PPTs should have. I can summarize these features as harmony with accepted theoretical knowledge and a realistic and multifaceted approach appropriate for the nature of teaching. Furthermore, the fact that I studied a similar subject with teachers for my doctoral thesis and that I had read almost every study related to PPT provided me with a strong background during the research process. My research nurtured my awareness of the way preservice teachers interpret their experiences and make professional assumptions and led me on to further research ideas on this subject.

FINDINGS

In the first research question of the study, the contents of the preservice teachers' PPTs were examined. The findings regarding the contents of the participants' PPTs are shown in the table.

Table 4. Contents of preservice teachers' PPTs

Category	Number	Percentage
Teacher	**125**	**32.1**
Boundaries	**26**	**6.7**
The teacher cannot interfere with the student's appearance. A teacher cannot make coercive financial demands on the student. No teacher can make more physical contact than necessary (kissing, hugging, embracing, etc.) with his student.		
Characteristics of a High-Quality Teacher	**62**	**15.9**
The teacher should always be able to stay calm in the face of unexpected new situations. The teacher should be able to intervene immediately in every situation and manage times of crisis well.		
Role Responsibility	**17**	**4.4**
The teacher must do everything for the student's right to education. The teacher is both the mother and the father of the student.		
Professional Development	**20**	**5.1**
As a teacher, it is necessary to keep up with the developments in technology, pedagogy and education and adopt these as a teacher. Considering the changing and developing conditions of the times, it should not be ignored that development is taking place in education just as it is in every field. The teacher should be able to self-criticize. This quality of mine will lead me to carry out research and studies aimed at constantly renewing myself.		
Instruction	**80**	**20,6**
Instructional Approach	**5**	**1.3**
Associations with different disciplines should be made while teaching the lesson. I support the idea that a culture of development-oriented values should be prioritized over a culture of fear-based discipline.		
Ways of Teaching	**22**	**5.7**
I think that doing short exercises before the first lesson in the morning increases children's attention and interest in the lesson. Teaching should be supported with educational games and concrete materials.		
Inclusivity in Teaching	**15**	**3.6**
We should benefit from the multiculturalism of the classroom. By seeing each student as a piece of the puzzle, we must show them that they will achieve the whole. We must create a positive classroom atmosphere.		
Differentiation of Instruction	**19**	**4.9**
Each student should be guided according to his/her own interests and abilities. It should be supportive and complementary. Learning outcomes, approaches and activities appropriate for the student's personal and mental development should be preferred. The teacher must be aware that students have different types of intelligence. He/she should adjust his/her teaching methods and techniques accordingly.		
Instructional Strategies	**19**	**4.9**
Activities in which students will be active in the process should be used. Lessons should be taught with methods and techniques appropriate for the learning outcome. One single method and technique should not be adhered to. Changes must be made. Constantly delivering the lesson in the same way causes students to become bored with the process. This may cause them not to be involved in the process. Considering current learning and teaching theories, methods and techniques should be used in which students are more active and in which they internalize mathematical concepts and generalizations instead of just memorizing them. It should be ensured that they can derive pleasure from the mathematics learning process.		
Students	**75**	**19.3**
Approach to Students	**24**	**6.2**
Teachers should communicate positively with their students. Moreover, I-language should be used instead of you-language. (Mert). The teacher should make the student feel valued. Each student should be treated as unique. He/she should take care not to approach the student with the slightest bias in his/her heart.		
Getting to Know Students	**19**	**4.9**
Special observation forms and portfolios should be prepared for each student and individual monitoring charts should be kept. The teacher should know his/her students' wishes, abilities and personalities. He/she should get to know them well.		
Expectations from Students	**4**	**1.0**
We must believe that students will be successful and make them feel that we believe this. In this way, we can be encouraging and supportive towards learning. The teacher should not give up hope for any student. An appropriate learning environment and type of learning environment should be provided for him/her.		

Category	Number	Percentage
A teacher must believe in his/her students.		
The Nature of Learning	**28**	**7.2**
In order for students to achieve high quality learning, a lesson plan and classroom environment that accords with constructivism and contemporary understanding should be prepared.		
I think that learning is more permanent when students construct knowledge in their own minds through their own efforts.		
Classroom	**60**	**15.4**
Physical Characteristics of the Classroom	**10**	**2.6**
Seating the students by creating a cluster seating arrangement instead of a layout in rows has a positive effect on the interaction between students.		
I want to equip the school and classroom environment with opportunities for students to socialize.		
Classroom Management/Participation	**23**	**5.9**
A preventive model approach should be adopted in the classroom.		
It is very important to make students understand the rules so that there is no chaos in the classroom.		
Boundaries and rules in the classroom should be created together with the students.		
Relationships	**27**	**6.9**
In the name of self-expression, the classroom environment should be as transparent as possible. Students should be able to express their thoughts and ideas directly without any restrictive filter and without being wary of their teacher or friends.		
There should be a positive atmosphere in the classroom. Everyone should respect each other's opinions, and a warm classroom environment should be provided.		
Curriculum	**38**	**9.8**
Learning Outcomes	**26**	**6.7**
Character and values education should be given importance before the basic subjects.		
Opportunities should be provided for students to be self-confident, assertive and creative, and to have strong communication skills.		
Structuring of Content	**2**	**0.5**
The course content should be enriched in a way that will appeal to every student and ensure participation in the course.		
Course contents should be prepared that appeal to more than one of the students' senses.		
Planning the Lesson and Implementing the Plan	**7**	**1.8**
The teacher's planning of the lesson in advance makes the process more productive. A more efficient transfer of information is enabled.		
While planning the lesson, the teacher should plan for every possibility by taking possible problems into account. He/she should put this in writing.		
Measurement and Evaluation	**1**	**0.3**
The teacher should make observations and evaluations on early literacy readiness in the first week of school		
Mission of the School	**2**	**0.5**
Our priority should be the children, not the curriculum. As one of our colleagues said, we should educate students, not the curriculum.		
Schools should prepare students for life.		
Socio-Cultural Aspects of Education	**11**	**2.8**
Educational Policy	**1**	**0.3**
A school should be an institution where there are many activities. Schools in rural areas should be given more support in this regard.		
Communication with Parents	**9**	**2.3**
The teacher should be in constant communication with parents of all students. This is necessary for the student to progress systematically.		
Teacher-parent relations are important for the development and success of students.		
School Culture / School Management	**1**	**0.3**
A school management should definitely communicate correctly with the student. I find it more appropriate to explain the reasons for the rules in accordance with their schemas.		

The contents of the preservice teachers' PPTs were examined under the themes of teacher, students, instruction, curriculum, classroom, and socio-cultural context of education. It was observed that the preservice teachers mostly constructed their PPTs based on the teacher theme, in which the characteristics of a high-quality teacher were explained (32.1%). In this theme, there were PPTs classified under the categories of teacher qualifications, role responsibility, boundaries and professional development. The socio-cultural context of education theme (2.8%) had the lowest percentage among the teacher candidates' PPTs. Almost all of the PPTs in the socio-cultural context of education theme were based on communication with parents. The curriculum theme had the second lowest percentage with less than 10%. This theme was examined under the categories of the mission of the school, learning outcomes, structuring of content, measurement and evaluation, and planning. The classroom theme, which was in third place, was examined under the categories of physical characteristics of the classroom, classroom management, and relationships. Approximately 20% of the teacher candidates' PPTs belonged to the students theme. In this theme, there are categories of

approach to students, expectations from students, ways to get to know students, and the nature of learning. The nature of learning (7%), which included candidates' assumptions about learning, was the category with the second highest percentage. Twenty percent of candidates' PPTs were related to the instruction theme. This theme was examined under the categories of instructional approach, ways of teaching, inclusivity in teaching, differentiation of instruction, and instructional strategies.

In the second research question of the study, the sources of teacher candidates' PPTs were examined. Findings related to the examination are shown in the table.

Table 5. Sources of preservice teachers' PPTs

Theoretical Dimension of Teacher Education	**70**	**18.0**
Theoretical Reading	**19**	**4.9**
According to the results of the studies I have read, learning becomes more permanent when students acquire knowledge by doing-experiencing and through their own efforts.		
Theoretical Courses I Have Taken at the Faculty of Education	**51**	**13.1**
Many courses that I took at the faculty, such as Inclusive Education, Inclusive Language Teaching, Special Education, and Individualization and Adaptation of Instruction, made me realize the necessity of organizing teaching according to the student.		
Observation and Practice Dimension of Teacher Education	**146**	**37.5**
School Practices	**15**	**3.9**
During my internship, I forgot the rule that I wanted to be observed in the classroom and exhibited a behavior outside the rule. And I was warned harshly and severely by my student.		
School Observations	**27**	**6.9**
I had the opportunity to observe different teachers at the school I attended. I realized that teachers who could not impose their authority had difficulties in classroom management. I observed that teachers who were able to impose their authority had better control of the classroom.		
Teaching Practicum	**104**	**26.7**
When students do not sense your authority in the classroom, they try to assume control themselves.		
Personal Learning Experiences and Values	**183**	**47**
Independent Learning	**17**	**4.4**
Social Media, YouTube, Instagram, Pinterest	**8**	**2.1**
There are many teachers that I have followed on social media. When I looked at the images shared by some teachers in the classroom, they created a seating arrangement in the classroom where the students could see each other. I saw that it would be easier to establish communication and carry out activities among students in such a classroom. In this way, the methods and techniques to be applied will yield more efficient results.		
Experiences Not Directly Related to Teaching	**5**	**1.3**
When my cousin was attending the first grade, they collected a sum of money and bought a gold bracelet for the class teacher on Teachers' Day.		
When a neighbor of ours, who is a history professor, came to chat with us in the apartment, he always enlightened us like the sun with the information he gave. He never neglected to give us life lessons based on the events he experienced.		
Books Outside the Pedagogical Subject Area	**2**	**0.5**
Project training	**2**	**0.5**
As part of a TÜBİTAK project I participated in in Samsun, I learned how permanent and effective it is to learn in contact with nature in a Forest School. I saw that this is an effective way for students to become individuals who are sensitive to life, the environment and the world.		
My philosophy of life, religion and values	**20**	**5.1**
For me, being able to listen to people, and to approach every idea with tolerance and learn new things from those ideas is a philosophy of life.		
My home upbringing	**15**	**3.9**
I was always able to express myself comfortably at home. When there was an issue at home, our opinions were obtained and we would wait for our conversation to end. Afterwards, comments were made.		
My learning experiences as a student	**46**	**11.8**
In the courses I have taken during my student life, I have always been more interested and enthusiastic towards courses in which I could express myself and my ideas freely.		
My Teachers	**85**	**21.9**
One of my friend's teachers cut my friend's hair with scissors, saying it was too long. Afterwards, the boy had to have his hair cut very short.		

The sources of preservice teachers' PPTs were examined under three themes. One of these is the theme of personal learning experiences and values, formed by preservice teachers' experiences prior to and independent from the education faculty. This theme consists of the categories of my teachers, my learning experiences as a student, my home upbringing, my philosophy of life, religion and values, and independent learning. As can be seen from the table, about half of the candidates' PPTs originated from the theme of personal learning experiences and values. Teacher education, on the other hand, is divided into two categories

in the study, namely the theoretical dimension of teacher education, and the observation and practice dimension of teacher education. It was seen that the observation and practice dimension of teacher education was the source of 37.5% of the teacher candidates' PPTs. The lowest percentage of sources of teacher candidates' PPTs was in the theoretical dimension of teacher education with 18%.

In the third research question of the study, the source percentages of PTT contents for each source theme were examined. The findings for this research question are shown in the figures below.

	Theoretical Dimension of Teacher Education	Observation and Practice Dimension of Teacher Education	Personal Learning Experiences and Values
Educational Policy	0%	0%	9,1%
Communacition with Parents	0%	36,4%	45,5%
School Culture / Management	0%	0%	9,1%
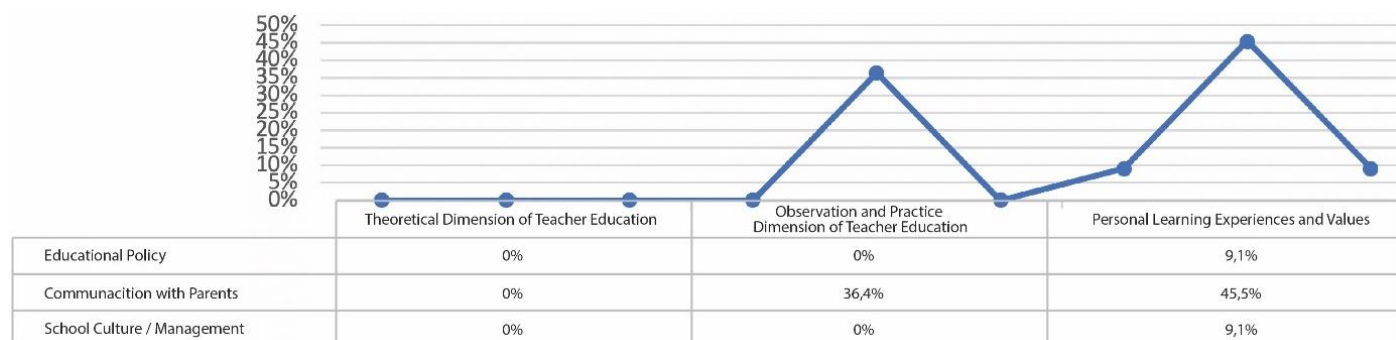
Figure 1. Distribution of PPTs in Theme of Socio-Cultural Context of Education According to Sources

Preservice teachers' PPTs related to the socio-cultural context of education mainly stemmed from experiences outside the faculty of education (63.7%). It can be seen that the theoretical dimension of teacher education did not originate any of the PPTs within the socio-cultural context of education.

	Theoretical Dimension of Teacher Education	Observation and Practice Dimension of Teacher Education	Personal Learning Experiences and Values
Mission of the School	0%	5,3%	0%
Learning Outcomes	5,3%	18,4%	42,1%
Structuring of Content	0%	0%	5,3%
Measurement and Evaluation	2,6%	0%	0%
Plannig the Lesson and Implementing the Plan	7,9%	7,9%	5,3%

Figure 2. Distribution of PPTs in Curriculum Theme According to Sources

It was observed that more than half of the PPTs in the curriculum theme were sourced from units outside the education faculty. In particular, almost all of the PPTs about what students should learn at school were derived from the theme of personal learning experiences and values. All of the PPTs related to the mission of the school originated from the observation and practice dimension of teacher education. On the other hand, none of the PPTs related to the structuring of content stemmed from teacher education. The lowest percentage of PPTs related to the curriculum were sourced from the theoretical dimension of education.

	Theoretical Dimension of Teacher Education	Observation and Practice Dimension of Teacher Education	Personal Learning Experiences and Values
Physical Characteristics of the Classroom	0%	8,3%	8,3%
Relationships	5%	13,3%	25%
Classroom Management / Participation	11,7%	20%	8,3%
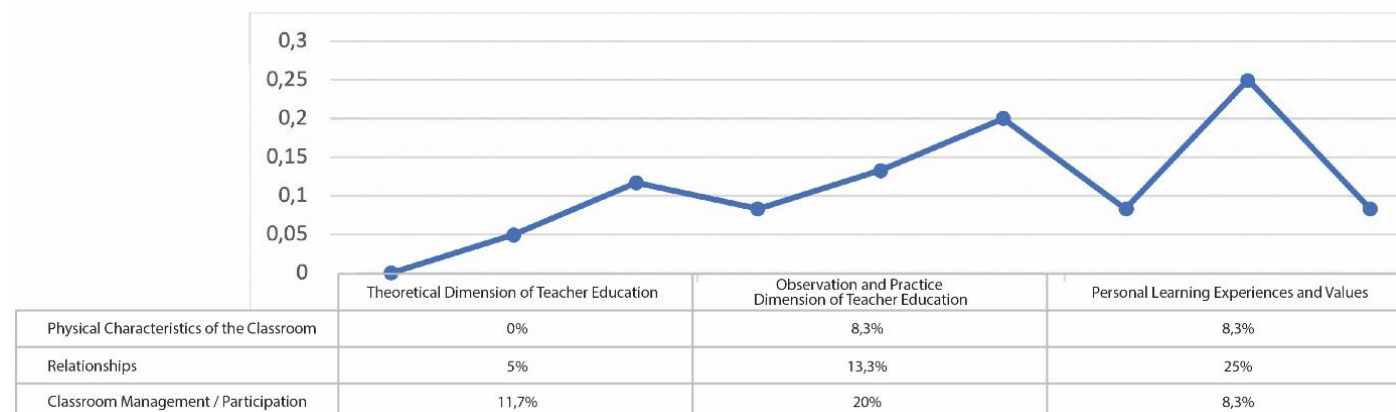
Figure 3. Distribution of PPTs in Classroom Theme According to Sources

PPTs in the classroom theme were equally sourced from the observation and practice dimension of teacher education and personal learning experiences and values. The lowest percentage of PPTs in the classroom theme were derived from the theoretical dimension of teacher education. PPTs in the relationship category mainly originated from personal learning experiences and values. PPTs in the classroom management theme were largely derived from the observation and practice dimension of teacher education.

	Theoretical Dimension of Teacher Education	Observation and Practice Dimension of Teacher Education	Personal Learning Experiences and Values
Ways of Teaching	3,8%	16,3%	7,5%
Instructional Approach	2,5%	2,5%	1,3%
Instructional Strategies	7,5%	7,5%	8,8%
Differentation of Instruction	8,8%	8,8%	5%
Inclusivitiy in Teaching	7,5%	7,5%	5%
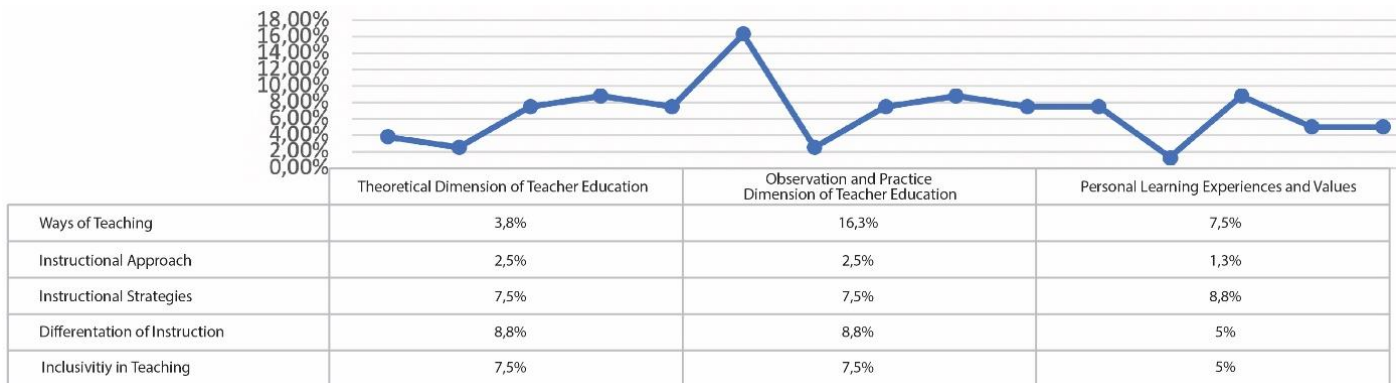
Figure 4. Distribution of PPTs in Instruction Theme According to Sources

The observation and practice dimension of teacher education was the source of almost all PPTs related to ways of teaching. Personal learning experiences and values were the source of PPTs in the category of teaching methods, techniques and strategies at a higher rate than the theoretical dimension of teacher education. The theme that was the greatest source of PPTs in the instruction theme was the observation and practice dimension of teacher education.

	Theoretical Dimension of Teacher Education	Observation and Practice Dimension of Teacher Education	Personal Learning Experiences and Values
Boundaries	0%	2,4%	15,2%
Role and Responsibility	1,6%	4%	7,2%
Characteristics of a High-Quality Teacher	3,9%	17,6%	31,2%
Professional Development	4%	6,4%	5,6%
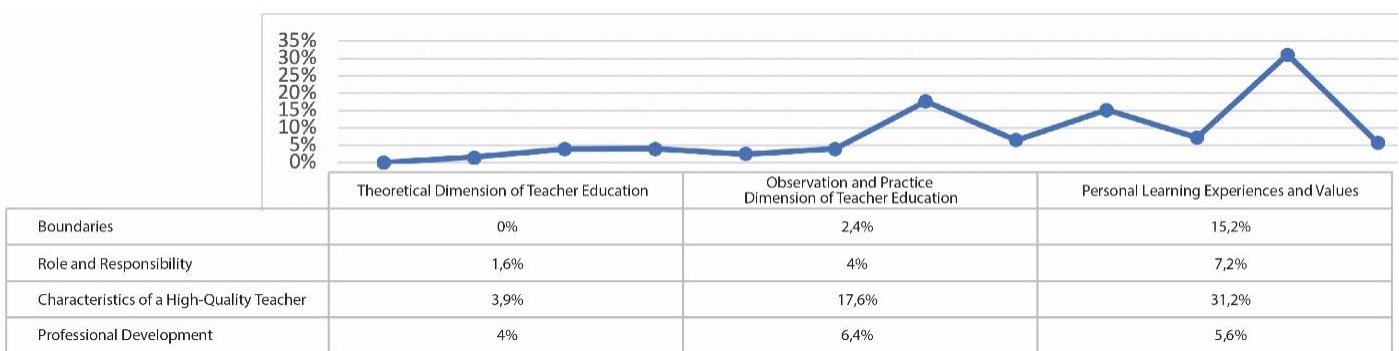
Figure 5. Distribution of PPTs in Teacher Theme According to Sources

Over half of the PPTs in the teacher theme originated from personal learning experiences and values. It can be seen that the majority of teacher candidates decided on how a teacher should be when they were students. The lowest percentage of PPTs in the teacher theme stemmed from the theoretical dimension of teacher education.

	Theoretical Dimension of Teacher Education	Observation and Practice Dimension of Teacher Education	Personal Learning Experiences and Values
Expectations from Students	0%	1,3%	6,7%
Getting the Know Students	9,3%	10,7%	5,3%
The Nautral of Learning	6,7%	16%	13,3%
Approach the Students	4%	10,7%	16%

Figure 6. Distribution of PPTs in Students Theme According to Sources

PPTs in the student theme were mostly derived from personal learning experiences and values. PPTs in the category of approach to students mostly stemmed from candidates' own student experiences. The observation and practice dimension of teacher education was the main source of PPTs related to the nature of learning and getting to know students.

DISCUSSION

In this study, the contents and sources of preservice teachers' PPTs were examined. The study shows that the preservice teachers structured their PPTs mostly on the basis of teacher characteristics. A similar study (Pitkäniemi et al., 2014) supports this finding. The theme with the second highest percentage of PPTs in the study is instruction. However, in studies conducted with a similar approach (Ferry et al., 2022; Levin & He, 2008; Maaranen et al., 2016), it can be seen that the instruction theme comes in first place. The findings of similar studies, including those of this study, show that the contents of preservice teachers' PPTs are teacher- and instruction-oriented. A comparable finding is also observed in studies examining the identities of teacher candidates on the basis of PPTs (Stenberg & Maaren, 2020). Similar to the findings of this study, the student theme is ranked third in the studies by Pitkäniemi et al. (2014) and Ferry et al. (2022). However, in the study by Levin and He (2008), student contact has the lowest percentage of PPTs. In this study, the classroom theme has a percentage of 15.4%. While this percentage is 29% in the study by Levin and He (2008), it is 29.9-25.9% in the study by Pitkäniemi et al. (2014). Although the category systems used in the studies are similar to each other, the difference between the percentages is worth examining. On the other hand, in the study by Ferry et al. (2022), the classroom theme has a percentage of 14.6%, which is close to the findings of this study. In the study, 9.8% of preservice teachers' PPTs belonged to the curriculum theme. This theme, which is encountered only in the study by Ferry et al. (2022), has a percentage of 6.3% in that study. Only 2.8% of the PPTs examined in the study were related to the socio-cultural context of education. This finding is consistent with that of the study by Pitkäniemi et al. (2014). Similar findings also appear in the studies by Stenberg et al. (2014) and Stenberg and Maaranen (2020). In both studies, this theme, which is discussed under the name "context", also has the lowest percentage.

In the second sub-problem of the study, the sources of preservice teachers' PPTs were examined under three themes. The theme of personal learning experiences and values was the source of nearly half (47%) of the teacher candidates' PPTs. This rate is 35% in Levin and He (2008), 32.4% in Pitkäniemi et al. (2014), and 31% in Ferry et al. (2022). In the study, teacher education was examined in two categories, namely, the theoretical dimension of teacher education and the observation and practice dimension of teacher education. The observation and practice dimension of teacher education was the source of 37.5% of the teacher candidates' PPTs. This rate is 35% in the study by Levin and He (2008) and 34% in the study by Pitkäniemi et al. (2014). It was observed that 82% of preservice teachers' PPTs were derived from observations and experiences, while 18% stemmed from the theoretical dimension of teacher education. The theoretical dimension of teacher education has a percentage of 31% in the study by Levin and He (2008) and 25.3% in the study by Pitkäniemi et al. (2014). Compared to other studies, the theoretical dimension of teacher education has the lowest percentage of sources in this study.

In the third sub-problem of the study, the source percentages of PPT contents for each source theme were examined. The theoretical dimension of teacher education had the lowest source percentage among all themes. This case is not found in the findings of similar studies. PPTs related to the socio-cultural context of education mainly originated from experiences outside of teacher education (63.7%). It was observed that the theoretical dimension of teacher education was not a source of any of the PPTs within 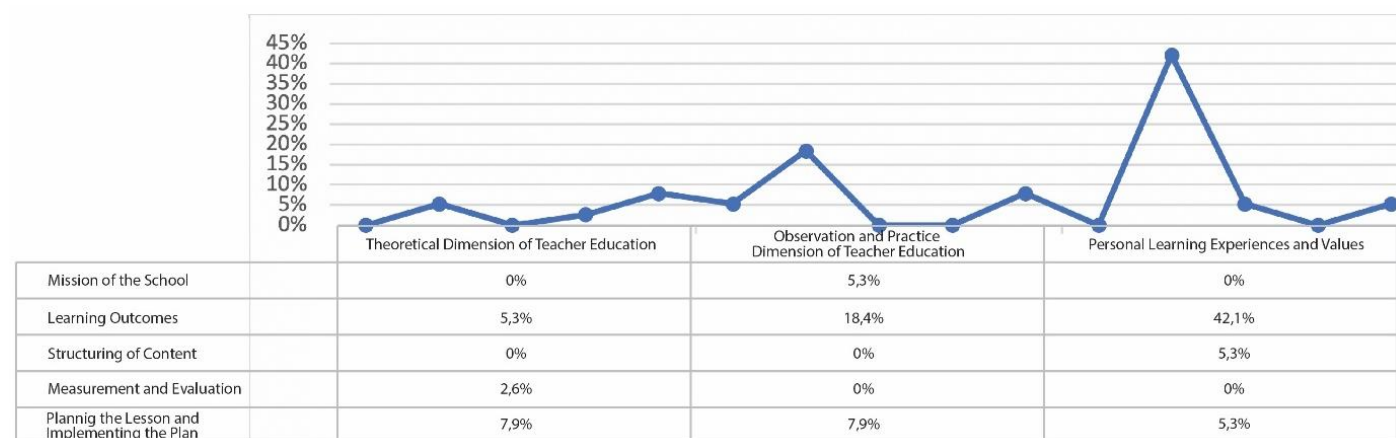the socio-cultural context of education. Over half of the PPTs in the curriculum theme stemmed from units outside of teacher education. PPTs in the classroom theme were equally sourced from personal learning experiences and values and the observation and practice dimension of teacher education. In the study by Pitkäniemi et al. (2014), the classroom theme was mainly derived from personal learning experiences and values. Preservice teachers' PPTs regarding how to establish relationships with students largely stemmed from their experiences before coming to the faculty of education. This finding is consistent with those of the studies by Pitkäniemi et al. (2014) and Levin and He (2008). The classroom management category was largely derived from 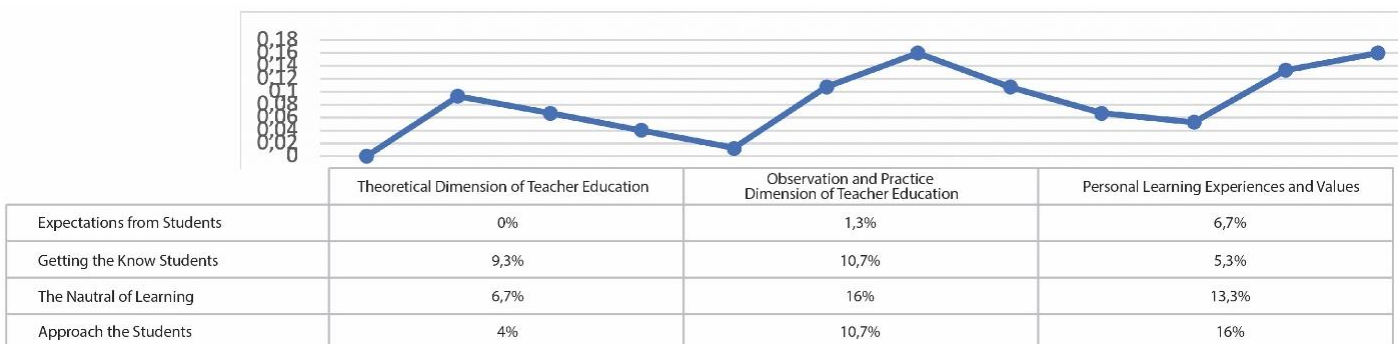the observation and practice dimension of teacher education. The studies by Pitkäniemi et al. (2014) and Levin and He (2008) have similar findings. The instruction theme mainly originated from the observation and practice dimension of teacher education. The differentiation of instruction theme was mainly sourced from teacher education. These findings are consistent with those of the studies by Levin and He (2008) and Pitkäniemi et al. (2014). Over half of the PPTs in the teacher theme were derived from personal learning experiences and values. These findings are in line with those of the studies by Pitkäniemi et al. (2014) and Levin and He (2008). The student theme mostly stemmed from personal learning experiences and values. This case is similar in the study by Pitkäniemi et al. (2014). Teacher candidates' PPTs regarding the student theme largely originated from their own student experiences.

The study shows that preservice teachers mostly structured their PPTs on ideal teacher qualities. When these qualities are examined closely, it can be seen that PPTs were mostly focused on personality traits that highlight the ethical and emotional characteristics of teaching. In their article, in which they examined the PPTs of preservice teachers who were just starting the profession, Maaranen et al. (2016) similarly stated that preservice teachers' statements reflected an idealistic approach to teaching. Stenberg et al. (2014), who reached similar findings in their research, attributed this to the fact that teacher candidates have many personal experiences regarding the moral nature of teaching. In their opinion, candidates (as students) easily fix the image of good teaching in teachers who care about and support students' holistic development. A similar situation was observed in the category of boundaries. It was seen that the preservice teachers' emotional experiences during their student years were the source of PPTs that expressed the ethical boundaries. Here, it would be useful to remember the recommendation made by Levin and He (2008), who emphasized that teacher education should take more responsibility in assisting teacher candidates to express, evaluate and restructure their PPTs. A case study-based professional ethics course will allow candidates to reflect on and

reconstruct their PPTs. These opportunities given to candidates in teacher education will pave the way for them to construct realistic, flexible, and developmental PPTs.

Although awareness of the moral nature of teaching is very important (Stenberg et al., 2014), it is questioned whether being a caring educator risks hindering the perception of the complexity of teaching. Maaranen and Stenberg (2017) acknowledged that it is important to be idealistic, but they underlined that teacher candidates should recognize the everyday reality of their profession. In this case, candidates should be made aware of the strong emphasis on values in their identities (Stenberg et al., 2014). Another thing observed in the PPTs under the teacher theme is that the characteristics of high-quality teachers were rarely expressed on the basis of pedagogical requirements, and that teacher qualities were considered in terms of single rather than interrelated characteristics. It is a requirement of teacher education to focus on the ways in which teacher candidates can consider the characteristics of a high-quality teacher on the basis of the steps and requirements of a pedagogical reasoning process (Shulman, 1987). It should be noted here that it is important for candidates to consider their perspectives with a critical approach. This awareness will enable preservice teachers to create a domain for different characteristics and knowledge related to teaching.

All of the PPTs in the categories of ways of teaching and strategies were compatible with current learning approaches such as learner-centeredness and active participation. It can be thought that this situation arose from the harmony between the teacher candidates' belief system and the current approaches. In fact, preservice teachers' pedagogical beliefs play an important role in how they interpret knowledge and experiences during their teacher education (Stenberg et al., 2014). Similarly, Meschede et al. (2017) argued that teachers can only focus on classroom activities that match with their pedagogical beliefs. In fact, when the memories included in the instruction theme were examined, it was observed that candidates frequently stated that they learned better in peaceful learning environments where they were actively involved in the learning process.

In the teacher candidates' PPTs, the classroom was considered more as a social environment than as a physical environment. Candidates stressed the importance of creating a democratic and free-thinking environment in the classroom. However, it was seen that the candidates overly emphasized the classroom as an ideal environment. In the PPTs, the creation, limitation and direction of dialogues in the teaching process were not emphasized. Although it is important for students to be able to express themselves freely in the classroom environment, situations in which the teacher's intervention may be required, such as alerting students to flaws in their thinking during this process, were not mentioned. Furthermore, explanations about in-class academic dialogues were rarely found in the PPTs. This shows that although the candidates were in harmony with accepted approaches, steps should be taken to ensure that their PPTs meet professional requirements. In this process, as revealed by Griffiths and Tann (1992), importance should be given to teacher candidates' PPTs. Moreover, through various studies, they should be guided towards arriving at their own theories. This process is the uncovering of their implicit theories. In this way, their theories can be examined, questioned, compared to public theories, and then verified or reconstructed.

About half of the PPTs expressed by the teacher candidates were derived from their experiences prior to teacher education. This confirms the argument that when candidates begin teacher education, they have clear perceptions about how high-quality teaching should look based on their previous experiences as students and the way they have been taught (Stenberg, 2011). In this case, it can be clearly seen that teacher education should work on the PPTs that teacher candidates bring with them, because it is possible that some of the candidates' beliefs are not conducive to high-quality teaching. Moreover, these beliefs are powerful assumptions based on emotional experiences. Candidates need to deepen the beliefs they bring with them through a pedagogical filter and based on a realistic and scientific perspective. This is exactly what Korthagen (2001) means when he speaks of realistic teacher education. The powerful PPTs that teachers bring with them are effective pathways into the candidate's mind. Teacher education should assist candidates in connecting their beliefs and values to teaching theory and practice (Maaranen & Stenberg, 2017).

In the study, the theme with the least number of PPTs is the socio-cultural context of education. This finding is consistent with those of the studies by Stenberg (2014) and Pitkäniemi et al. (2014). Many of the problems seen in the classroom occur due to contextual conditions. By virtue of the teacher's awareness of the conditions surrounding education, it will be possible for him/her to understand the problems he/she faces. Schools are not isolated islands, but a part of society. Teachers cannot turn a blind eye to political issues in society that affect daily life in schools (Stenberg et al., 2014). The successful integration of students into the ever-changing world depends on teachers' ability to understand and navigate among social and political structures (Maclellan, 2017). In the study, the candidates were able to extend the socio-cultural context of education to relationships with parents. Numerous theoretical courses taught in faculties of education aim to fulfill this purpose. On the other hand, the source percentages of candidates' PPTs for theoretical courses was remarkably low. It is the task of teacher education to provide teacher candidates with experiences that will enable them to interpret the phenomenon of education on the basis of expanding contexts.

PPTs related to the theoretical dimension of teacher education had the lowest source percentage. In this regard, it would be worthwhile to ask whether teacher education enables candidates to confront their current beliefs critically and whether it provides the right conditions to help them reflect on these and expand their perspectives (Stenberg & Maaranen, 2017). It is clear that measures should be taken to increase the source rate of PPTs in theoretical education. Theoretical education should provide teacher candidates with experiences with strong persuasive power that can compete with the PPTs that they bring with them. The observation and practice dimension of the faculty of education had a source effect more than twice that of the theoretical dimension. This situation provides important insights into how an effective teacher education should be designed. The characteristics of the units that have a strong source effect on candidates' PPTs can provide us with ways for effective teacher

education. For example, half of the PPTs originated from the experiences of preservice teachers as a student and candidate in the classroom. This can be interpreted as the fact that candidates need to spend more time in the classroom.

IMPLICATIONS

The main purpose of teacher education is to equip candidates with the ability to think and act like a teacher. Due to the nature of the teaching profession, candidates are not fed only by teacher training in this regard. Each candidate begins teacher education with a highly structured set of beliefs regarding teaching and professional requirements, based on their long years as students and their personal experiences. These beliefs are likely to contradict accepted theories and/or have an idealistic outlook far from grasping the complex requirements of the teaching profession. This situation is worthy of note for us, because these beliefs of candidates are decisive on the extent to which they benefit from the faculty of education. In fact, because of these beliefs, teacher education is regarded as a weak intervention by a number of researchers. Right at this point, this study presents a model related to the contents and sources of preservice teachers' PPTs. The study made it possible to analyze the contents of PPTs, which are regarded as a strong predictor of preservice teachers' professional decisions and practices, on the basis of categorical structures. In this way, numerous inferences can be made about teacher education programs. The most prominent of these is that teacher candidates constructed their PPTs predominantly on ideal teacher characteristics, while they paid less attention to the curriculum and socio-cultural context. An idealistic approach that placed too much emphasis on values was identified in the contents of the candidates' PPTs. Although the candidates' PPTs were largely compatible with the accepted theories, they need to be developed in order to transfer them into practice in a real classroom context. Otherwise, candidates run the risk of experiencing a "reality shock" when faced with the real situation of today's schools (Stenberg & Maaranen, 2017). In addition to being a profession that requires possession of a number of values, teaching also requires the use of high-level pedagogical knowledge, skills and reasoning processes (Shulman, 1983). In this regard, it should be emphasized how preservice teachers can be supported so that they do not experience burnout at the beginning of their careers in the face of the challenging tasks demanded from the teacher in today's world (Stenberg et al., 2014). The finding that about half of the candidates' PPTs were sourced from their experiences before they came to the education faculty once again clearly shows that teacher education should begin with candidates' beliefs. Another issue that needs to be considered is that the observation and practice dimension of teacher education was the source of approximately twice as many PPTs as the theoretical dimension. Considering that the experiences of the candidates as a student and as a prospective teacher in the classroom were the source of half of their PPTs, it becomes clear how an effective teacher education should be designed. Preservice teachers make assumptions that guide their decisions and practices when they are in real classroom environments. This shows that the amount of observation and practice should be increased in teacher education and that students should spend more time in real classroom contexts. The fact that the theoretical dimension of teacher education was the source of only 18% of the candidates' PPTs clearly shows that consideration should be given to the effectiveness of existing theoretical practices. This finding can be taken as a restatement, from a different angle, of the problem of the gap between theory and practice in teacher education, which has been debated for a century.

LIMITATIONS AND FUTURE STUDIES

This study examines the contents and sources of PTTs of preservice teachers studying in the final semester of teacher education. However, it does not investigate how preservice teachers' PPTs change during the teacher education process. In the future, it is recommended to investigate how PPTs are transformed in the teacher education process. Another limitation is that the candidates' PPTs were collected in writing. None of the candidates were observed in actual practice. For this reason, it is recommended to examine how teacher candidates' PPTs are reflected in their teaching practices. In order to understand how the teacher education program affects teacher candidates' beliefs and their actions in their professional lives, studies in which these teacher candidates are monitored in the field should be designed. Moreover, it will be useful to conduct this study on teacher candidates, teachers and teacher educators from different branches in terms of comparison with the findings obtained in this research.

Declaration of Conflicting Interests

Funding

Statements of publication ethics

I hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

### Ethics Committee Approval Information

Ethics committee approval for this study was obtained from Ordu University Social and Human Sciences Research Ethics Committee (dated 05.06.2020 and numbered 66417432-050.01.04).

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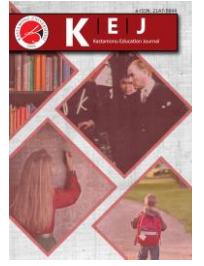
| Research Article / Araştırma Makalesi|

Examination of Distance Education Processes from the Perspective of Science Teachers

Uzaktan Öğretim Süreçlerinin Fen Bilimleri Öğretmenlerinin Bakış Açısına Göre Irdelenmesi[1]

Ersin Karademir[2]**, Kübra Altunsoy**[3]

Abstract

Purpose: The purpose of this study is to examine the opinions of science teachers who teach online about synchronous distance education applications that allow teachers and learners to come together regardless of place and time, and to examine them based on teacher experiences.

Design/Methodology/Approach: This study, which was prepared to determine the views of teachers on distance education, was carried out with the case study model. The study group of the research was carried out with 19 science teachers from different schools and institutions with different years of seniority. A structured interview form was used as a data collection tool. The data has been collected remotely; The research data obtained were analyzed through content analysis.

Findings: Science teachers stated that the transition to distance education completely affects the quality of education negatively. However, it has been stated that distance education and face-to-face education can create beneficial results when used together effectively. In addition, the positive side of distance education is to carry out distance education and to access digital content easily in cases where education stakeholders cannot be together physically.

Öz

Çalışmanın amacı: Bu çalışmanın amacı, çevrimiçi ders veren Fen Bilimleri öğretmenlerinin, yer ve zamandan bağımsız olarak öğretmen ve öğrenenin bir araya gelmesine olanak sağlayan eş zamanlı uzaktan eğitim uygulamalarına ilişkin görüşlerinin incelenmesi ve ve öğretmen deneyimlerine dayalı olarak irdelenmesidir.

Materyal ve Yöntem: Öğretmenlerin uzaktan öğretime Yönelik görüşlerinin tespit edilmek üzere hazırlanan bu çalışma durum çalışması modeliyle yürütülmüştür. Araştırmanın çalışma grubunu farklı okul ve kurumlarda, değişik kıdem yıllarına sahip 19 Fen Bilimleri Öğretmeni ile gerçekleştirilmiştir. Veri toplama aracı olarak yapılandırılmış görüşme formu kullanılmıştır. Verilerin uzaktan yollarla toplanmış olup; elde edilen araştırma verileri içerik analizi yoluyla çözümlenmiştir.

Bulgular: Fen Bilimleri öğretmenleri, tümüyle uzaktan öğretime geçilmesinin eğitim niteliğini olumsuz etkilediğini belirtmişlerdir. Ancak uzaktan eğitim ve yüz yüze eğitim beraber etkili kullanıldığında yararlı sonuçlar oluşturabileceği belirtilmiştir. Ayrıca eğitim paydaşlarının fiziki olarak bir arada bulunamadığı durumlarda uzaktan eğitimi gerçekleştirmek ve dijital içeriklere kolaylıkla ulaşabilmek, uzaktan eğitimin olumlu tarafı olarak belirtilmiştir.

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INTRODUCTION

The use of digital content in learning-teaching processes is inevitable with the change in technology. As technology and the digital world have changed rapidly in recent years, the structure of in-class and out-of-class practices, teachers and students have had to change. Educational stakeholders (student-teacher), who only exist together in the classroom or school environment, have turned into an interactive system that can come together in different environments or times with the development of technology. With this change, distance learning environments, one of the rapidly developing digital learning technologies in recent years, have begun to be used by many people and have begun to replace face-to-face education environments (Gençer, 2015). Blended learning is also mentioned at the point where face-to-face education environments replaced by digital learning technologies meet with non-formal learning styles (Graham, 2013). However, most of the research on online teaching has focused on studies that combine online and face-to-face environments, rather than blended learning environments that make face-to-face education possible (Usta and Mahiroğlu, 2008).

The pandemic period seen all over the world as of 2020 accelerated this and subsequently made it a popular concept. Distance learning, which has many different types, appears as blended learning, which has an important place in academic research. Blended learning is learning practices in which face-to-face teaching environment is combined with internet and computer-based digital tools. Blended learning is defined as a distance education method used by combining technology with known face-to-face education and training (Allan, 2007; Bonk and Graham, 2013). Electronic materials as well as non-electronic materials can be used in distance education. Therefore, it is a more comprehensive term than e-learning (Altunsoy and Karademir, 2022). According to Matthews (1999), although distance education first emerged to meet the needs of individuals who cannot attend face-to-face or continuous education, it has been preferred over other education methods because it meets different content needs. While distance education provides a flexible learning environment for students, it also provides positive benefits to parents, society and all users (Harasim, 1996; Kuboni, 2013). Simultaneous or split-time tools offered by distance education have features that will increase interaction by eliminating people's time and space limitations (Sun et al., 2008). These opportunities offered by distance education offer more intensive, flexible and accessible programs to students without the need for educational institutions to physically build new places (Dixon, 1996). In this context, it makes it easier for teachers to give instant feedback to students, reach a wide and diverse audience, provide sustainable content, and enable different research (Deal, 2002; Revere and Kowach, 2011; Ruiz, Mintzer and Leipzig, 2006; Özcan, 2019). .

It is of great importance to focus on the experiences of teachers, one of the most important practitioners of distance education practices, in this process. Nowadays, when distance education has taken a different and effective path, it is a matter of curiosity how the understanding of distance education in science teaching will be adopted, teachers' willingness to this education, their acceptance of the change in their duties and roles, their adaptation to developing conditions, and their views on new technologies and distance education. Because the nature of the Science course includes practical experiments as well as theoretical knowledge. For this reason, the opinions of science teachers who conduct theoretical and applied courses regarding distance education are important. The purpose of this research is to reveal the problems experienced in the process based on the opinions of science teachers who teach online in distance education applications in terms of the learning-teaching process, content, technology usage status, measurement and evaluation dimensions. In accordance with this purpose; It is aimed that the positive and negative opinions of science teachers on this subject will give ideas to those who direct science education and teaching activities.

Within the framework of this problem, answers to the following research questions will be sought:

1. What are the teachers' opinions on distance education?

2. What are the practices of teachers regarding the learning-teaching process in distance education?

3. What are the conveniences and difficulties experienced in the distance education process for teachers?

4. What are their opinions on improving distance education practices for teachers?

METHOD

Research Model

This study was conducted with a case study model based on a qualitative approach. The important features of qualitative research are that qualitative research techniques are carried out sensitively to the natural environment, the researcher assumes the role of participant, has a holistic approach, ensures that participant perceptions are revealed, has flexibility in the research method and allows for an inductive analysis (Yıldırım & Şimşek, 2008). Case study is defined as a method in which one or more events, environments, programs, social groups or other interconnected systems are investigated in depth (McMillan, 2000, p. 10). What distinguishes case study from other types of research is that it is based on "How" and "Why" questions and allows for in-depth investigation of phenomena that the researcher cannot control (Çepni, 2010). In this study, it was conducted with this method, since it was aimed to examine in detail the opinions of science teachers who teach online on the use of distance education applications.

Study Group

Case studies examine an existing situation, event or process in depth with a limited number of samples. According to Patton (2014), purposeful sampling allows the situations/events to be examined in depth in order to provide rich data. For this reason, since in-depth analysis was aimed when selecting the study group, maximum diversity sampling, one of the purposeful sampling methods, was preferred. The main purpose of this sample selection is not to make generalizations, but rather to identify commonalities between various situations and to reveal differences within the scope of this diversity (Yıldırım and Simsek, 2013). Within the scope of this sampling method the study group of the research consists of 19 science teachers working in schools in different regions and socio-economic levels of Türkiye. 15 of the participants were female and four were male; 14 of them teach at public secondary schools, four of them at private secondary schools, and one of them teaches at the Science and Art Center. It is seen that the teachers participating in the research have different years of professional experience. However, it is seen that the majority of the teachers participating in the research have 6-10 years of experience. The codes of the participants participating in the research and their demographic characteristics such as gender and years of professional experience are given in Table 1.

Table 1. Demographic characteristics of the study group

Code of Teacher	Gender	Seniority year	Type of School	Weekly Lesson Hours Conducted by Distance Education
T1	Female	6-10	Public School	18
T2	Male	11-15	Public School	20
T3	Female	6-10	Private School	28
T4	Female	11-15	Public School	20
T5	Female	6-10	Public School	24
T6	Female	16-20	Public School	28
T7	Female	26-30	Public School	20
T8	Male	6-10	Public School	24
T9	Female	1-5	Private School	16
T10	Female	26-30	Public School	16
T11	Female	6-10	Private School	20
T12	Female	15-20	Public School	12
T13	Male	11-15	Public School (SAC*)	30
T14	Female	6-10	Private School	32
T15	Female	6-10	Public School	24
T16	Female	6-10	Public School	26
T17	Male	21-25	Public School	16
T18	Female	6-10	Public School	20
T19	Female	6-10	Public School	28

*Science and Art Center

Data Collection Tool

In this study, it was aimed to reveal the opinions of the science teachers who teach with online methods on distance education based on their own experiences and a structured interview form was used. The draft form on "Science Teachers' Opinions on Distance Education Practices" was created by taking the literature review and expert opinions (2 faculty members working in the field of science education, 1 measurement and evaluation expert, 2 science teachers, 1 language expert). Necessary arrangements were made in line with the evaluation and suggestions of the experts. After obtaining permission from the relevant authorities, the scale prepared for the research was pre-applied to three randomly selected science teachers. and they were asked to make an assessment of the scale. In this way, the validity of the interview form was tested. As a result of the participant evaluations, a consensus was reached, necessary corrections and additions were made in some items, and the form was finalized. The final version of the form was applied to the participants on a voluntary basis.

Data Analysis

The data obtained from the research were analyzed according to the content analysis technique, which is an analysis technique used in qualitative research methods. Content analysis technique is expressed as a systematic, innovative analysis technique in which some words are described with small content categories by using coding based on certain rules of the texts obtained from the participants (Büyüköztürk et al., 2008).

• While organizing the data, notes were kept primarily.

• It is aimed to reach the details by reading several times.

• In the readings, attention was paid to repetition and associations.

• It was tried to reach codes from the importance levels of the same and different opinions and temporary themes reflecting teachers' opinions. This tentative table of themes has been created.

• The tentative themes table was transformed into final themes through various readings, and the determined themes were combined to create categories.

• Categories are supported with examples.

FINDINGS

The themes obtained as a result of the content analysis carried out in this section and the sub-themes formed in line with these themes are given in Table 2. The findings are stated accordingly. Since some of the answers given by the participants during the analysis process are related to more than one category, the frequency numbers in the tables given in the findings section and the number of participants may vary. In addition, one-to-one quotations from teachers are included in this section..

Table 2. General themes of the research

Number of Theme	Theme	Sub-theme
Theme-1	Opinions on General Characteristics of Distance Education	-
Theme-2	The Conveniences Provided by the Distance Education Process	-
Theme-3	Difficulties Experienced in the Distance Education Process	-
Theme-4	Opinions on the Distance Learning-Teaching Process	Lesson Preparation Method Online Education Platform Educational Applications Measurement and Evaluation Tool
Theme- 5	Opinions on Improving the Distance Education Process	-

Findings of Theme-1: Opinions on General Characteristics of Distance Education

Science teachers were asked about their knowledge of distance education and what kind of education model distance education is. In the light of the answers received from the teachers who participated in the research, the theme of "Opinions on the general characteristics of distance education" was formed. The created theme is divided into four different categories. The categories and frequencies related to the theme of "opinions on the general characteristics of distance education" are given in Table 3.

Table 3. Categories and frequencies of Opinions on General Characteristics of Distance Education's

Number of Category	Categories	f
1	Ability to Use Various Communication Tools	15
2	Teaching Anywhere (Independent of Space)	10
3	Being Independent of Time	3
4	A System with Low Interaction	3

According to Table 3, the majority of science teachers (15) answered the question of their knowledge about distance education and what kind of an education model distance education is. About distance education; teachers (10) frequently expressed the answer of being able to teach anywhere (being independent of the space). Apart from these, the statements of being independent of time (3) and a system with low interaction (3) are other opinions expressed by the teachers.

Some of the prominent answers under this theme are directly quoted:

As T1 stated; "Teacher-student relationship in computer and internet environment." (Category-1)

As T2 stated; "It is the educational activities that teachers and learners do without the limitation of time and place." (Category-3)

T2 emphasizes that the distance education process is independent of both space and time(Category-2/3).

As T6 stated; "Distance education is the continuation or completion of the trainings that cannot be done in the same place for any reason, by bringing together teachers and students in online environments." (Category-2)

As T13 stated; "Educational activities are carried out in online environments. It should not be taken to mean that the same face-to-face education in schools is conducted in online environments. There is no contact, no emotional attachment in online environments. This results in low engagement." (Category-4)

T13 stated that there is no contact between the teacher and the student in distance education, so there is no emotional bond between them. This situation reveals that the distance education process is a system with low interaction.

As T16 stated; "Training conducted through various channels without the need for all participants to be in the same venue. While this training sometimes takes place simultaneously, sometimes it is not needed." (Category-2)

As T18 stated; "It is a form of education made by using various communication tools without the student and teacher face to face."

, T18 expresses distance education as an education system using various communication tools. (Category-1)

Findings of Theme-2: The Conveniences Provided by the Distance Education Process

Science teachers were asked about the ease of use of distance education applications. According to the answers given by the participants, the theme of "The Conveniences Provided by the Distance Education Process" was divided into eight different categories. The categories and frequencies formed in this direction are given in Table 4.

Table 4. Categories and frequencies of The Conveniences Provided by the Distance Education Process

Number of Category	Categories	f
1	Being independent of location	13
2	Flexibility in Time	10
3	Easy Access to Technologically Equipped Virtual Environments	7
4	Economy	6
5	Effective Use of Educational Technologies	6
6	More Problem Solving Opportunities	3
7	Practicality	2
8	Individual Working Opportunity	2

According to Table 4, most of the science teachers stated that it is independent of space (13) and provides flexibility in terms of time (10). In the answers given by the teachers, easy access to virtual environments equipped with technological opportunities (7), affordability (6), effective use of educational technologies (6), more problem solving opportunities (3) are stated as the conveniences provided by distance education. In addition, practicality (2) and the opportunity to work individually (2) are among the conveniences stated by the teachers.

Some of the prominent answers under this theme are directly quoted:

As T1 stated the following about this issue:; "Flexibility in terms of time is one of the greatest conveniences provided by distance education… Moreover, time spent on the way to school is saved. Smart board, internet etc. Lessons can be taught in a virtual environment where technological opportunities are more than in a classroom environment that does not exist." (Category-2)

With these statements, T1 stated that the convenience provided by the distance education process is about time, access to virtual environments equipped with technological opportunities and practicality.

As T2 stated the following about this issue:; "The convenience of distance education applications is that we benefit more from technological resources and enable us to develop technology skills for the future." (Category-5)

As T3 stated the following about this issue:; "Conveniences, time and place independence, using many technological tools and materials and providing the opportunity to work individually." (Category-8)

With this statement, T3 stated that the distance education process provides individuals with the opportunity to work individually, as well as the convenience of teaching anywhere and providing flexibility in time. This shows that individuality is at the forefront rather than group work in distance education.

As T9 stated the following about this issue:; "It is one of the conveniences of distance education that teachers can use the time efficiently in any place with internet access." (Category-2)

As T10 stated the following about this issue:; "It is independent of time and space. It provides equal opportunity in education. It reduces the cost of education." (Category-4)

With these statements, T10 stated the following about this issue; they experienced in time and space, and stated that the cost of education decreased. Although the establishment of the infrastructure required for distance education is very costly, it is a very suitable education model compared to other education systems. In this direction, T10 emphasized that one of the conveniences provided by the distance education process is economy.

As T11 stated; "One of the greatest conveniences is that I can solve questions in a shorter time..." (Category-2)

With this statement, T11 stated that he solved more questions in a shorter time during the distance education process. This is a situation that is beneficial in reinforcing the gain.

As T13 stated; "The convenience that distance education provides for me is that I can carry out my activities in a more planned manner. My pre-class preparations are of higher quality than face-to-face education. When I am unprepared in face-to-

face education, while I am conducting improvisation activities; My distance education activities are progressing more regularly and in a planned manner. Designing new activities for distance education is what motivates me in terms of my personal and professional development… I feel more researching and more creative. I can use educational technologies more. Because I give them much easier access." (Category-2/4/5/7)

With these expressions, T13 especially in distance education where the use of communication technologies is inevitable; He stated that he used educational technologies a lot. Therefore, it is an advantage of the distance education process that teachers use educational technologies effectively and provide easier access to them.

As T15 stated; "Teaching lessons in the comfort of home has been very good in terms of protection from disease during the epidemic process. Apart from that, I think that distance education is more economical (no transportation, food, etc. expenses for going to school) and practical." (Category-2/6)

As T17 stated; "The easy aspect is the opportunity to reach the source you want without wasting time and conduct the lesson through different question sources and different visuals..." (Category-3/4)

With these expressions, T15 and T17 stated that distance education is more efficient in terms of time and resource usage.

Findings of Theme-3: Difficulties Experienced in the Distance Education Process

Science teachers were asked about the difficulties they experienced in distance education applications. According to the answers given by the participants, the theme of "Challenges Experienced in the Distance Education Process" was divided into nine different categories. The categories and frequencies formed in this direction are given in Table 5.

Table 5. Categories and frequencies of Challenges Experienced in the Distance Education Process

Number of Category	Categories	f
1	Technical Problems (Infrastructure, Hardware and Software Problems)	15
2	Failure to Detect Learning Deficiencies	10
3	Weakening of the Teacher-Student Bond	9
4	Students' Interest in Extracurricular Elements During Class	8
5	Student Absenteeism	8
6	Staying Passive on Screen	7
7	Unavailability of the Laboratory	6
8	Collaboration Between Teachers	5
9	Lack of Certain Working Hours	3

According to Table 5, the majority of science teachers expressed the technical problems arising from infrastructure, hardware, software and the like (15) in the question of what are the difficulties experienced in the distance education process for teachers. Teachers stated that they could not detect the learning deficiencies of students in the distance education process (10) and that the teacher-student bond weakened (9). In the answers given by the teachers, they frequently stated that they could not control the students' involvement in extracurricular elements (8) and student absenteeism (8) during the lesson. The difficulties experienced in the distance education process were stated as the teachers being inactive for hours on the screen (7), the inability to use the laboratory (6), the change in the way the lesson was taught, and the decrease in the cooperation between the teachers (5). In addition, the absence of a certain working time during the day (3) is one of the difficulties experienced by the teachers.

Some of the prominent answers under this theme are directly quoted:

As T3 stated; "Technical problems, internet shortage, weakening of student-teacher bonds… In addition, not being able to learn by doing and living in a laboratory environment, only supporting it with videos, visuals and simulations is one of the difficulties I have experienced in the distance education process. (Category-1)

With these statements, T3 mentioned the technical problems, the weakening of the teacher-student bond and the inability to use the laboratory as the difficulties he experienced in the process.

As T6 stated; "I can say this because of its difficulty: It is very difficult to understand whether the student is really interested in the lesson in front of the screen… Apart from that, technical infrastructure problems, course absences cannot be followed effectively as in face-to-face education…"(Category-2)

With this statement, T6 emphasized that together with technical problems and student absenteeism, students are interested in extracurricular elements during the lesson. In the distance education process, students' camera and microphone, etc. It is possible to say that the distance education process is an environment open to extracurricular elements since it is not compulsory to use it.

As T9 stated; "It is very difficult to understand and eliminate the learning deficiencies of students. Moreover, since science course is a course for applying scientific process skills such as observing, measuring, classifying, changing and controlling variables, not being able to use them in online courses reduces the efficiency of the course." (Category-2/3)

With this statement, T9 stated the following about this issue that is against the nature of science. It was stated that there was no use of laboratories in distance education, with the statements that steps could not be taken to apply scientific process skills such as observation, measurement, classification, changing and controlling variables in lessons. Therefore, this situation prevents the course from being taught in a qualified way.

As T10 stated; "The absence of visual and audio participation during the lesson can make communication inadequate. During the live lesson, technical problems (internet interruption, hardware or software problems, not using an updated browser, etc.) may occur. In addition, the reliability of the exams made in distance education applications is also discussed." (Category-1/6)

As T13 stated; "I have difficulties with internet connection problem, lack of technological tools, body language, eye contact and emotional communication." (Category-1/9)

As T14 stated; "As a negative point, the lesson hours of the teachers spread throughout the day in this process, and students, parents and administrators were able to reach us at every hour. Apart from working hours, we have no time of our own and no such thing as private life. In addition, being inactive in front of the screen for a long time brought sedentary lifestyle problems…" (Category-6/8)

As T15 stated; "Distance education does not make it possible to learn by doing for the science course. Some methods that should be applied especially in our branch, such as experimentation, etc. Distance education is very difficult. Students get the impression that they are watching a video as a demonstration experiment, not by doing it themselves. This reduces the efficiency of the lesson." (Category-2/3)

As T16 stated; "Failure to follow up on absenteeism, lack of communication between teachers, not being able to measure and evaluate, not being able to understand whether the student has learned the subject or not…" (Category-3/4/5/6)

T16 especially stated that they could not identify the learning deficiencies of the students.

As T17 stated; "Distance education challenges for me; Our eyes are negatively affected by standing in front of the screen, we cannot make eye contact with the students, so the teacher-student relationship weakens and the technical infrastructure problems we experience from time to time." (Category-3/4/5/6)

As T19 stated; "The most important challenge of distance education is not being able to communicate with the student and enabling the students to focus on the lesson. Even if the cameras are on, we cannot prevent the child from doing other things on the computer. I have already understood how inefficient online lessons are in the face-to-face trainings that are made from time to time. I have to retell some subjects because the children are surprised as if they are hearing about it for the first time." (Category-3/4/5/6)

Findings of Theme-4: Teacher practices in the Distance Education-Teaching Process

Science teachers were asked in detail what they did during the online learning-teaching process (before the lesson, during the lesson and after the lesson). In line with the answers given by the teachers, the theme of "Opinions on the online learning-teaching process" was formed. The theme of " Teacher practices in the Distance Education-Teaching Process " was analyzed under five sub-themes. These are listed under the following headings:

- Lesson Preparation,
- Method,
- Online Education Platform,
- Educational Applications
- Measurement and Evaluation Tools.

The categories and frequencies formed in line with these sub-themes are given in Table 5.

Table 6. Categories and frequencies of Teacher practices in the Distance Education-Teaching Process

Sub-themes	Categories	f
Lesson Preparation	Video	15
	Enriched Book	10
	Web 2 Tools	19
	Slide (.ppt)	7
	Contents with pdf extension	3
	Working Sheet	3
Method	Expression	12
	Q&A	12
	Problem solving	6

Sub-themes	Categories	f
	Discussion	4
Online Education Platform	Education and information network*	15
	Zoom	7
	Meet	1
	Teams	1
Education Applicants	Education softwares	9
	Youtube	8
	Padlet	4
	Wordwll	4
	Kahoot	3
	Canva	2
	Khan Academy	1
	Phet	1
Measurement and Evaluation Tools	Whatsapp	11
	e-mail	7
	Online exam	5
	Gogole forms	3

*

According to Table 6, Online Learning-Teaching Process was examined under five sub-themes. In the sub-theme of Preparation for Lessons, it was seen that science teachers benefited from many different sources according to their learning outcomes. When the sources used by the teachers in the preparation process for the lesson are examined, the frequency of uttering is much to the lesser than the frequency of being said, in a total of six categories: video (15), Z-book (10), web 2.0 tools (10), slide (7), pdf (3) and worksheet (3). has occurred.

Some of the prominent answers in this sub-theme are directly quoted:

As T1 stated; "Finding videos suitable for the learning outcomes of the lesson before the lesson."

As T3 stated; "Points, videos, images, etc. related to the subject. material preparation."

As T6 stated; "Z-books, videos, worksheets, etc. required for the course. I have it ready."

As T8 stated; "Arranging pdf, worksheet and Z-books about achievements according to the course of the lesson and preparing related questions."

As T9 stated; "Finding visual documents, PowerPoint and documentaries according to the content of the subject to be covered."

As T10 stated; "The materials that will be needed (web2 tools, etc.) are determined and prepared according to the aims and objectives of the course."

With these statements, the teachers stated that they mostly benefited from the videos in the preparation stage for the lesson. E-book and Web 2.0 tools were used after the videos, which offer a very rich content visually. Apart from these, the teachers stated that they benefited from slides, pdfs and worksheets in the course preparation process.

In the method sub-theme, it was seen that science teachers benefited from the limited method according to the nature of the subject, the number of students and the possibilities. When the methods used by the teachers were examined, four categories were formed, namely lectures (12), question-answer (12), problem solving (6) and discussion (4).

Method sub-theme

Some of the prominent answers in this sub-theme are directly quoted:

As T2 stated; "I mostly use the lecture method in the lesson, but I also use the brainstorming technique."

As T7 stated: "I often use the problem solving method in my lessons. At times, I also prefer the discussion method where I am more in the role of guide and observer. I use this method mostly in situations where I do not have time concerns, the number of students is low, and the course outcome is appropriate."

As T11 stated; "I tried to carry out the course process in the form of questions and answers. During the question-solving hours, I gave each student an equal opportunity to speak and enabled them to analyze."

As T12 stated; "I make a short repetition of the previous lesson and move on to the new topic. First, I explain, I make short notes on the places that I consider important, and I watch short videos to reinforce the subject. Finally, I do exercises and finish the lesson by giving homework."

As T13 stated; "I try to have a one-on-one conversation with each of my students at the beginning of the lesson. Since I make my lesson activity-based, I make a brief introduction about the activity. Question and answer, like brainstorming. I share the

instructions about the activity both verbally and visually. During the activity, I give feedback by following my students. I promise different people to ensure that everyone speaks and actively participates."

As T14 stated; "I make programs and preliminary assessments that support the visual aspects of students in the online process. However, in my lectures, I mostly explain through presentation."

As T15 stated; "I watch videos during the lesson. I teach my lessons through the presentation that allows me to convey what I will tell to the student as soon as possible. I try to activate the students in the lesson as much as possible with question solutions."

As T18 stated; "I usually use the question-answer method after giving the topic during the lesson. However, in distance education, students are more reluctant to answer in crowded classrooms. Since the time in distance education is more limited than in formal education, I especially use the presentation method in 8th grades."

With these expressions, the teachers stated that they often preferred the straight lecture method in the teaching of the lesson. Teachers used the straight lecture method, which is one of the oldest methods, because they transferred many subjects to large groups in a short time. The question and answer method in which the student is active, as well as the lecture method, which is traditional in the distance education process and in which the student is inactive, has taken its place in the lessons. Question and answer method; It motivates the student, makes him think, gives him the opportunity to comment, and at the same time socializes him. In this direction, the question and answer method has been a method frequently used in distance education. The problem solving technique, which is a method in which students are very active and develops their independent thinking skills, is another method used in the lessons. In addition, the teachers stated that they benefited from the discussion method in the teaching of the lesson. Since the discussion method is more suitable for face-to-face education in terms of application, it is more preferred in cases where the number of students is low.

In the Online Education Platform sub-theme, it was observed that science teachers generally benefit from free education platforms in line with the institution they work for and their own means. When the online education platforms used by the teachers were examined, four categories were formed: EBA (Education Information Network) (15), Zoom (7), Meet (1) and Microsoft Teams (1).

Some of the prominent answers in this sub-theme are directly quoted:

As T3 stated; "I do my lessons through EBA and Zoom."

As T4 stated; "I use the Zoom platform in distance education applications."

As T6 stated; "Because it is free, I provided training by connecting via Zoom."

As T11 stated; "I use the EBA platform in my online courses."

As T13 stated; "I primarily use Zoom and Teams applications as online education platforms."

As T16 stated; "I use the EBA platform in distance education."

In these statements, the system they preferred most was EBA, Turkey's first and only information network. It has become the most widely used online education platform in our country, as it is a free platform and as a result of the information provided by the Ministry of National Education to conduct the trainings through EBA. It was stated that the Zoom platform, which can be used free of charge for a certain period of time after EBA and provides a lot of practicality, is used. Apart from these, Meet and Teams platforms were used, albeit a little.

In the Education Applications sub-theme, it has been seen that science teachers benefit from many different applications in distance education applications, since it is quite easy to access virtual environments equipped with technological opportunities. When the educational applications used by the teachers are examined, it is seen that the frequency of being told is less than Morpa Kampüs (9), Youtube (8), Padlet (4), Wordwall (4), Kahoot (3), Derslig (3), Classroom (2), Canva (2), There were 15 categories: Digital Study (1), Leaningaps.org (1), Khan Academy (1), Phet (1), Bookwidgets (1), Miro (1), Quizizz (1).

Some of the prominent answers in this sub-theme are directly quoted:

As T2 stated; "I benefit from applications such as morpakampüs, digital etudes, padlet, Word Wall, as I can make students more active in the course with interactive activities and lecture animations in distance education applications."

As T3 stated; "I use web 2 tools (kahoot, learningapps.org, canva, padlet…) a lot in distance education applications."

As T4 stated; "I use Word Wall, khan Academy and classroom apps in my classes. I rarely use the youtube app."

As T6 stated; "I use digital etudes, youtube and morpa campus applications in my online courses."

As T8 stated; "I use the Phet app and the Derslig app."

As T10 stated; "I use morpa campus, bookwidgets applications in distance education."

As T13 stated; "To make online lessons interesting and interesting, applications such as Word Wall, bookwidgets, kahoot and games etc. I design content. I also prefer applications such as padlet for exchanging ideas with my student group and miro for concept maps. In this way, even though we cannot meet face to face with my students, we work together. Finally, at the stage of measuring the lesson, I create exams with various question types with the quizizz application."

Teachers stated that they frequently use Morpa Campus and Youtube as educational applications. It is known that they are familiar with these practices from the face-to-face training process. Our teachers, who want to color the lessons in the distance education process to make them more attention and interesting, have increased the scale of the education applications they use.

In this direction, educational applications such as Padlet, Wordwall, Kahoot, Derslig, Classroom, Canva, and Digital Etude have taken their place in distance education courses, where many digital applications can be easily used.

In the Assessment and Evaluation Tool sub-theme, it was observed that science teachers used several sources to evaluate students in terms of their learning status after the lesson. When the tools used by the teachers during the assessment and evaluation phase were examined, four categories were formed: WhatApp (11), mail (e-mail) (7), online trial (5) and Google survey (3).

Some of the prominent answers in this sub-theme are directly quoted:

As T2 stated; "After the lesson, I want the students to answer the questions in the MEB science book. According to the feedback they give, I evaluate whether the achievements are obtained or not with the WhatsApp application."

As T3 stated; "With the subject screening tests, I identify the learning deficiencies of the students and help them to overcome these deficiencies. I provide tests related to the subject with applications where I can prepare online question content."

As T8 stated; "I will send tests and exercises on WhatsApp after class."

As T9 stated; "After the lesson, I do the things I deem necessary as homework on WhatsApp, where our class group is. I also use the Google survey application to get feedback about the achievements once in 3 weeks."

As T10 stated; "Actually, the opportunities that online courses provide us are not at a level that can be underestimated. By conducting online trials, we have provided the opportunity to evaluate the level of education given. Of course, besides these, it is necessary to think about the validity and reliability of online exams…"

As T12 stated; "During the assessment and evaluation phase, I send resources such as activities, tests and mock exams to the class group via WhatsApp. Students send their feedback about these individually via e-mail."

As T13 stated; "At the end of the lesson, I evaluate the results of the activity together with the students. I evaluate with various web 2.0 tools and share the results with my students. If a product comes out as a result of the activity, I request its photo or video from the students and give feedback on missing or incorrect places."

As T19 stated; "I want them to prepare short summaries about the subject and write them in the notebook, and I want them to send me the photos of the notebook via e-mail. When the subject is over, my students send a test and tell me how many correct and how many mistakes they have. Afterwards, I answer questions they do not understand over WhatsApp."

In these statements, the teachers stated that they frequently use the WhatsApp application as a measurement and evaluation tool. WhatsApp application, which we use quite widely in our daily life, has been a practical way for teachers in this process. Apart from this, e-mail, online trial and Google survey are used as measurement and evaluation tools.

Findings of Theme-5: Opinions on Improving the Distance Education Process

Science teachers were asked what their suggestions were for the improvement of distance education practices. According to the answers given by the teachers, the theme of "opinions on the improvement of the distance education process" was divided into eight different categories. The categories and frequencies formed in this direction are given in Table 7.

Table 7. Categories and frequencies of Opinions on Improving the Distance Education Process

Categories	f
Each Student Has Their Own Computer and Internet Access	9
Strengthening the Technical Infrastructure	7
Taking Effective Measures for Class Participation	7
Teaching Teachers About Online Learning Processes	6
Configuring the Assessment and Evaluation Process for Distance Education	5
Diversification of Digital Content	4
Making Textbooks Suitable for Distance Education	3
Making the Curriculum Suitable for Distance Education	3

According to Table 7, the question of what are the suggestions for the improvement of distance education applications, nine of the science teachers said that each student should have their own computer and internet access, seven of them said that the technical infrastructure should be strengthened and effective measures should be taken for participation in the lesson, and six of them said that teachers should be trained about online learning processes. stated. In addition, five of the teachers stated that the measurement-evaluation process should be structured in accordance with distance education. In addition to these,

diversification of digital content (4), making textbooks suitable for distance education (3), making the curriculum suitable for distance education (3) are among the answers given.

Some of the prominent answers under this theme are directly quoted:

As T1 stated; "Strengthening Internet and EBA infrastructure."

As T2 stated; "More effective measures should be taken for students to participate in the lesson. Digital content should be diversified and content should be prepared in which students will be more active."

As T4 stated; "The technical infrastructure (internet access and hardware) should be fixed."

T4 stated that the technical infrastructure should be strengthened in order for the distance education process to be more effective. This situation reveals the necessity of improving technological infrastructure conditions such as online course presentation tools, visual and video pool, online library service, student information systems, portal pages, database etc.

As T7 stated; "In addition to digital content, textbooks should be made suitable for distance education and printed resources should be increased."

T7 stated that textbooks should be made suitable for distance education. This situation reveals that the textbooks provided to the students free of charge by the Ministry of National Education should have the form of e book.

As T10 stated; "More video and game content needed."

T10 emphasized video and game contents and stated that digital contents should be diversified.

As T12 stated; "I advocate that distance education should be able to enter every house, that the inadequacy of infrastructure should be eliminated, and that technological tools should be equal in every house."

As T15 stated; "Introducing attendance requirement in online courses."

 T15 expresses the obligation to take attendance and states that more effective measures should be taken for students' participation in the lesson.

As T17 stated; "Digital programs and documents that can be used in distance education have many features. But we know and practice very little of them. Teachers can be trained on these."

With these statements, T17 stated that teachers should be given training on online learning processes.

As T19 stated; "Every student should have access to the internet, especially in districts and villages, this situation is dire."

With this statement, T19 stated that every student should have computer and internet access based on the problems experienced by students living in districts and villages in this process.

DISCUSSION

In this research, most of the teachers generally have a positive perspective on distance education because it eliminates the boundaries of time and space. According to Altıparmak et al. (2011), distance education is considered a positive process that benefits more from students whose financial situation does not allow it and therefore cannot study. In addition, Bozkurt (2020) emphasized that technologies should be used extensively in distance education during the epidemic and that digital skills should be developed in this way. In the study conducted by Kaya (2002), the advantage of distance education is; It was stated that it reduces education costs and is an independent learning system. According to Parsa-Yekta (2004), individuals have the opportunity to continue their education in any environment through distance education. These can also be considered as positive reflections of technology on education. In this context, the views of most of the teachers participating in the research overlap with the literature.

In this study, teachers emphasized that the distance education process is significantly related to the ability to use digital materials. They reported that not all teachers working in Ireland have skills for distance education and that they experience various problems with hardware, software and technological skills (Burke and Dempsey, 2020). In this research, it was seen that the majority of teachers directly used EBA as an online education platform. Fidan, Sariaslan and Yılmaz (2022) found that Turkish teachers mostly use Turkish textbooks, EBA platforms and auxiliary resources in the distance education process; Research results

are consistent with this. Şengül (2021) states that the use of technological materials in ISE distance education processes has increased and that these materials are an important content transfer tool. According to Chao, Saj and Tessier (2006), the quality and richness of learning-teaching resources and materials affect the quality of online education; Many teachers have the opportunity to access materials during distance education processes.

In this research, teachers stated that, as a negative aspect especially in distance education, they could not detect students' learning deficiencies. They stated that during the distance learning process, students were exposed to external influences during the course, they could not control student absences, therefore their participation in online courses was low and students' motivation was low. According to Yıldırım (2022); A general problem that teachers encounter during the distance education process is student apathy and low participation in classes. In the study of Sari and Nayır (2020), they emphasize that the participants' problems such as not being able to communicate with the student in distance education and not being able to follow the student remotely make classroom management difficult in distance education. In the study of Şener, Ertem and Meç (2020), classroom management was considered as a problem in distance education, and reasons such as children not wanting to turn on their cameras and reluctance towards the lesson were considered as difficulties in classroom management. According to Akgül and Oran (2020), the majority of teachers stated that students' motivation for the distance education course was low. Baran and Sadık (2021) and Fidan (2020) stated in their studies that teachers' classroom management is difficult in distance education, and while it is difficult to teach the rules to students even in face-to-face classes, this is much more difficult in virtual classes. Similarly, Sintema (2020); reported that students' communication skills with teachers were weak, and there was a decrease in performance due to the lack of e-learning opportunities during the COVID-19 pandemic.

CONCLUSION AND RECOMMENDATIONS

For teachers' distance education; teaching lessons using various communication technologies and emphasizing the expressions of being able to teach anywhere showed that they were satisfied with the process. In this context, it can be said that most of the teachers have positive opinions on distance education. The fact that some of the teachers included statements about a system with low interaction about distance education shows that they do not have positive opinions about distance education. The convenience that teachers experienced in the distance education process, most of the teachers answered that they are independent of the place and flexibility in time. One of the conveniences experienced by teachers in the distance education process has been easy access to virtual environments equipped with technological opportunities. It has been seen that the other conveniences provided by the distance education process in the eyes of the teachers are the economy and the opportunity to work individually. Considering the opinions of the teachers, it is one of the conveniences brought by this process that teachers use educational technologies more effectively. The fact that teachers use educational technologies more actively in online trainings and design new activities and content affects teachers positively in terms of their personal and professional development. The difficulties that teachers experienced in the distance education process, the majority of the teachers expressed technical problems arising from internet connection, hardware, software and the like. It is thought that factors such as the lack of direct feedback from teachers to students in online learning environments, the inability to make eye contact with the student, the student not using the camera and microphone for various reasons affect the motivation of the teachers negatively.

Most of the teachers participating in the research think that they cannot complete their laboratory or workshop studies with distance education. It was seen that teachers who stated that they could do practical work such as laboratory and workshop studies generally wanted students to do the practice at home by sending sample videos. It has been seen that the materials used by the teachers during the preparation for the online lesson are much more diverse and equipped with technological opportunities compared to face-to-face education. It has been observed that most teachers use videos that combine education and interactive learning in preparation for the lesson. Again, it was seen that the majority of them benefited from e-books and web 2.0 tools during the course preparation phase. Another part of the teachers benefited from slides, pdfs and worksheets that are frequently used in face-to-face education. Considering the sub-theme of educational applications used in the course, when considering the classroom environments where there is no smart board in face-to-face education, there is smart board but no internet; In the online education process carried out in virtual environments equipped with technological and digital opportunities, teachers' access to these has led to a wealth of materials. Some of the teachers benefited from educational videos on Morpa Campus, Youtube, and some of them benefited from web 2.0 tools such as Padlet, Kahoot, Wordwall, and Phet. When the issue of improving distance education practices was examined, most of the teachers stated that each student should have their own computer and internet access. Apart from this, it is among the opinions of most teachers that the technical infrastructure should be strengthened and effective measures should be taken for students' participation in the lesson. It is the opinion of many teachers that the distance education process will become more qualified by structuring the curriculum, textbooks and assessment and evaluation process in accordance with distance education.

Considering the results of this research, the following suggestions can be made within the scope of this study;

- This study was conducted with the opinions of science teachers. It is recommended to study with teachers working in different branches.

- This study was conducted with teachers who experienced the distance education process during the pandemic. It is recommended to conduct different studies with teachers who have received training on distance education processes.

Declaration of Conflicting Interests

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Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

It has been approved with the decision of Eskişehir Osmangazi University Social and Human Sciences Scientific Research and Publication Ethics Committee, numbered 2021-01 and dated 07.01.2021. "Ethics Committee Approval Document" is attached.

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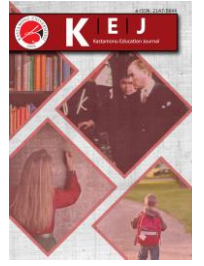
A Cross-cultural Validation of Multidimensional Digital Stress Scale in Türkiye

Çok Boyutlu Dijital Stres Ölçeğinin Türkiye'de Kültürlerarası Geçerliği

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Abstract

Purpose: The Multidimensional Digital Stress Scale, originally developed in English by Hall, Steele, Christofferson, and Mihailova (2021), was aimed to be adapted to Turkish culture in this study. To achieve this goal, the suitability of the Turkish translation, Turkish grammar control, and translation from Turkish to English back were examined by an expert whose mother tongue is English and who is proficient in Turkish.

Design/Methodology/Approach: The study was conducted with a participant group of 409 young individuals enrolled in the Gazi Faculty of Education during the 2021-2022 Spring Semester, ranging in age from 18 to 30. Within the scope of the adaptation study, exploratory factor analysis (EFA) was first performed to provide evidence for validity. Then, the obtained structure was tested with confirmatory factor analysis (CFA).

Findings: The scale, adapted based on the findings from EFA and CFA, consisted of 5 dimensions and 24 items, consistent with the original scale. Cronbach's alpha, stratified alpha, and McDonald's ω coefficient were sequentially computed to assess the reliability of both the sub-dimensions and the entire scale. The stratified alpha coefficient calculated for the complete scale was .95. Additionally, measurements for each dimension yielded reliable results.

Highlights: According to all findings, the scale maintained the same structure in Turkish culture.

Öz

Çalışmanın amacı: Çalışmanın amacı Hall, Steele, Christofferson ve Mihailova (2021) tarafından İngilizce olarak geliştirilen Çok Boyutlu Dijital Stres Ölçeğini Türk kültürüne uyarlamaktır. Bu amaç doğrultusunda, Türkçe çevirinin uygunluğu, Türkçe dilbilgisi kontrolü ve ana dili İngilizce olan ve Türkçe bilen bir uzman tarafından Türkçe'den İngilizce'ye geri çeviri incelenmiştir.

Materyal ve Yöntem: Çalışma grubu, Gazi Eğitim Fakültesi'nde öğrenim gören ve yaşları 18 ile 30 arasında değişen 409 öğrenciden oluşmaktadır. Uyarlama çalışması kapsamında geçerliğe kanıt sağlamak amacıyla ilk olarak açımlayıcı faktör analizi yapılmıştır. Sonrasında elde edilen yapı doğrulayıcı faktör analizi ile test edilmiştir.

Bulgular: Çalışmada AFA ve DFA bulgularına göre uyarlanan ölçek, orijinal ölçek formunda olduğu gibi 5 boyut ve 24 maddeden oluşmuştur. Çalışmada ölçeğin alt boyutlarının ve ölçeğin tamamının güvenirliği için sırasıyla Cronbach-alfa, tabakalı-alfa ve McDonald's ω katsayısı hesaplanmıştır. Ölçeğin tamamı için hesaplanan tabakalı alfa katsayısı 0,95'tir. Ayrıca, her bir boyut için yapılan ölçümler güvenilir sonuçlar vermiştir.

Önemli Vurgular: Tüm bulgulara göre ölçek Türk kültüründe aynı yapıyı ölçmektedir.

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INTRODUCTION

Approximately 68% of the world's population has internet access (Internet world stats, 2022). In Türkiye, the proportion of households with internet access is 92% and the proportion of individuals using the internet is 85% (TÜİK, 2022). Compared to the world average, it can be stated that a much higher proportion of individuals in Türkiye use the internet. This percentage signifies the extent of digitalization's prevalence and offers insights into the nature of interpersonal communication (Nesi & Prinstein, 2015) because digital communication applications serve as platforms for social interaction and maintaining friendships (Anderson & Jiang, 2018). The availability of applications like Facebook and Instagram on smartphones, enabling messaging, has redefined the concept of staying connected (Hall, Steele, Christoferson & Mihailova, 2021). Especially during the Covid-19 pandemic, people who had to stay at home instead of being involved in social environments were able to stay connected with the resources provided by technology (Brown & Greenfield, 2021).

It has been confirmed through research that both adolescents and adults in developed countries spend a significant amount of time on social media (Nesi & Prinstein, 2015; Reinecke, 2017). Particularly, the Covid-19 pandemic has resulted in increased internet and social media usage (Çelik, Karadağ & Bayazıt, 2022; King et al., 2020). An international study reported that 45% of individuals spent more time messaging and 44% on social media during the Covid-19 pandemic (Gökler & Turan, 2020). There is a differentiation between the studies on the psychological effects of this increase. For example, Feng and Tong (2022) examined whether there is a relationship between online-chatting and psychological well-being and found that there is a positive relationship between online-chatting and happiness and self-esteem. They also found that there is a negative relationship with loneliness. In addition, Orben, Tomova, and Blakemore (2020) stated that digital connection tools can be useful for people who have difficulty or do not have the opportunity to communicate face-to-face with their peers. On the other hand, there are some findings opposite to these studies. A study of young adults aged 19-32 found that high social media users were much more likely to feel socially isolated than their counterparts who do not use social media as often (Primack vd., 2017). Also, some clinical studies have revealed that this excessive information exposure can lead to digital stress in individuals, resulting in consequences such as anxiety, major disorders, and burnout (Fischer, Reuter & Riedl, 2021; Smith, Fowler, Graham, Jaworski, Firebaugh, et al., 2021). To better evaluate these contradictory results, it is thought that it is important to clearly reveal the effect of technology use on psychology with data to be obtained from different groups. At this point, it can be stated that the use of valid and reliable measurement tools is also very important for an appropriate evaluation. In this study, a valid and reliable measurement tool for determining the level of stress caused by using technology on individuals was adapted to Turkish.

Digital stress is experienced due to the complexity arising from continuous information and communication technology use and the challenges in using, managing, and deriving outcomes from it (Wrede, Anjos, Kettschau & Claaben, 2021; Steele, Hall & Christoferson, 2020). Digital tools offer flexibility in terms of time and space in daily life and work, and technological advancements have accelerated the pace of daily life. This current situation leads to increased online engagement, forming the foundation of digital stress (Özyılmaz, 2021). Studies have been conducted on the effects of digital stress on human psychology. One of these was carried out by Nick et al. (2022) with 680 students. The study revealed that many participants, regardless of gender and ethnicity, felt distress and pressure while using social media. In addition, it was determined that people with high digital stress have more mental and psychosocial difficulties.

Steele, Hall, and Christofferson (2020) pointed out the absence of a framework for structures related to digital stress and its complications in the literature. They introduced a multidimensional conceptual model that included four dimensions: accessibility stress, approval anxiety, fear of missing out (FoMO), and excessive connection. Accessibility stress represents the anxiety an individual feels when others expect them to respond or be accessible via digital tools. Approval anxiety entails uncertainty or concern about others' responses or reactions to their online presence. Fear of missing out (FoMO) reflects the distress arising from the inability to partake in appealing social experiences involving others. Another dimension, excessive connection, describes the distress induced by excessive digital notifications. Hall, Steele, Christoferson, and Mihailova (2021) conducted a scale development study on digital stress, originally conceived as four-dimensional. The factor analysis revealed that the structure was not four-dimensional but five-dimensional. In the process of scale development, four items from the FoMO subscale formed a distinct factor, termed "unanticipated," which was referred to as online vigilance. The online vigilance factor includes compelling items related to compulsively checking social media accounts and accessing one's phone.

Because scale development studies are demanding, expensive, and time-consuming, they can be employed in scale adaptation studies by researchers. In scale adaptation studies, it is demonstrated that it is suitable to adapt a scale originally designed for another language and culture to a new cultural and linguistic context. In these adaptation studies, which facilitate the bypassing of extended phases such as the creation of an item pool and the solicitation of expert opinions, there is substantiating evidence that the scale yields valid and reliable results within the language and culture aimed for adaptation. Although it represents a pioneering effort for the "Multidimensional Digital Stress" scale, which encompasses 24 items and five dimensions, this is a scale that has been meticulously examined during its developmental phase, rendering it capable of producing valid and reliable

measurements. Given today's lifestyle and the amount of time individuals devote to the internet, adapting this scale to Turkish culture will make a substantial contribution to researchers and our body of literature.

METHOD/MATERIALS

In this section, firstly, the research design is introduced. Then, descriptive statistics are presented over the study group in which the data were collected. Subsequently, brief information about the Digital Stress Scale as a data collection tool and detailed information about the scale adaptation process are presented.

Study Design

Psychometric properties of a measurement tool developed for a specific culture are examined through scale adaptation studies, wherein adaptation to other cultures is carried out (Deniz, 2007).

Study Group

The research's study group comprised 409 undergraduate students enrolled at Gazi University, Gazi Faculty of Education, in Ankara during the 2021-2022 academic year. The scale was administered to volunteer participants online via "Google Docs." Ethical approval necessary for the study was granted by the Gazi University ethics committee (Date and reference number: 19.04.2022/E-344780).

When selecting the study group, the criteria outlined in the original form of the scale were taken into account. These criteria included: (i) participants being 30 years of age or younger, and (ii) possessing active social media accounts. Descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics for the study group

Variable		N	%
Gender	Female	320	78.2
	Male	87	21.3
	Other	2	0.5
Grade	1st Grade	172	42.1
	2nd Grade	168	41.1
	3rd Grade	52	12.7
	4th Grade	17	4.2
Time allocated to digital technology applications	Less than 1 hour	23	5.6
	1 to 3 hours	116	28.4
	3 to 5 hours	157	38.4
	More than 5 hours	113	27.6

Examinations of the study group in terms of gender revealed that 78.2% of the group were women (n=320), 21.3% (n=87) were men, and 0.5% (n=2) belonged to the other group. In terms of grade level, 42.1% (n=172) of the group were in the 1st grade, 41.1% (n=168) were in the 2nd grade, 12.7% (n=52) were in the 3rd grade, and 4.2% (n=17) were in the 4th grade. Lastly, regarding the time spent on digital technology, it was reported by the participants that 5.6% (n=23) spent less than one hour, 28.4% (n=116) spent 1 to 3 hours, 38.4% (n=157) spent 3 to 5 hours, and 27.6% (n=113) spent more than five hours on digital technology.

Data Collection Tool

The Multidimensional Digital Stress Scale, developed by Hall, Steele, Christofferson, and Mihailova (2021), comprises 24 items that measure 5 sub-dimensions. Additionally, scale items are in a 5-point Likert type, with answers ranging from "never" to "always". In the stage of determining the scale's factor structure, firstly, parallel analysis was conducted, and the analysis findings supported the 4-factor structure theoretically proposed by Steele et al. (2020). However, EFA (exploratory factor analysis) revealed that the dimension of fear of missing out was not uniformly distributed and was divided into two factors. The items related to online vigilance constituted a new factor, resulting in the scale becoming five-dimensional. In addition to EFA, CFA was carried out to verify the structure of the scale. As a result, it was determined by CFA that the five-dimensional structure was perfectly compatible with the data (RMSEA = .044 (90% CI of .039-.048), CFI = .973, TLI = .969, SRMR = .040, $\chi2/df$ = 2.41). The approval anxiety and excessive connection dimensions of the scale consist of 6 items, while the accessibility stress, fear of missing out, and online vigilance dimensions contain 4 items each. The internal consistency coefficients of reliability, calculated using Cronbach's alpha based on dimension, varied between 0.86-0.93; however, it was 0.85 for the whole scale.

Adaptation Procedures

Translation Phase

In the adaptation procedure, permission was initially obtained from the researchers who owned the original English form of the scale to adapt it to Turkish. Subsequently, a series of studies were conducted to demonstrate the cross-cultural equivalence of the original form of the scale and the translation form. First, the scale items were translated into Turkish by the researchers, and Turkish grammar experts examined the translated items. Then, Turkish translations were presented to English experts, and their opinions on suitability were sought. The Turkish translations were translated back into English by the researchers. Opinions about the suitability of the items translated into English and the original items of the scale were also obtained from foreign language experts whose mother tongue was Turkish. In the last stage, the final Turkish form of the scale was created and an expert, who is a native speaker of English and has a good command of Turkish, gave an opinion on the suitability of the final version of the scale items for translation.

Application Phase

In the application phase, the necessary permissions were obtained from the Gazi University Ethics Committee. Subsequently, data were collected through Google Documents from volunteer participants studying at Gazi University in the spring semester of the 2021-2022 Academic Year. The scale application took approximately 15 to 20 minutes.

Phase for Validity-Reliability Analysis

In the data analysis phase, the data set was randomly divided into two parts and exploratory factor analysis and confirmatory factor analysis were applied respectively to obtain evidence of the construct validity of the scale. The number of factors was determined through EFA, and the factor structure established through CFA was confirmed. Additionally, the fit indices obtained according to the created model were reported and interpreted based on predetermined criteria. Item discrimination coefficients were also calculated within the scope of item analyses to provide evidence of validity. Each item in the scale needed to have a significant relationship with the total score, which was examined by calculating the correlation between the item score and the total score for each item (DeVellis, 2003, p.93). As the scale was multidimensional, Cronbach's alpha and Mc Donald's ω coefficients were calculated for each dimension for internal consistency. For the entire scale, the stratified alpha coefficient was also calculated.

Data Analysis

Within the data analysis, Mahalonobis values were first examined to determine whether the data met the assumption of multivariate normality. Consequently, the data of 20 individuals identified as extreme values were excluded from the analysis. After the extreme values were removed from the data, the data were randomly divided into approximately 50% and EFA was performed on 214 data and CFA was performed on 195 data.

The SPSS 25.0 package program was utilized for EFA to establish evidence of the scale's construct validity. Subsequently, Kaiser-Meyer-Olkin (KMO) and Barlett Test values were examined to assess the sample's suitability for factor analysis for EFA. For factorization of the dataset, the recommended KMO value should be at least 0.50. The significance of the Barlett statistic indicates a sufficient relationship between the variables (Field, 2013, p.659).

EFA also assessed the degree of dimensionality in responses to items. Various methods were employed to evaluate the number of significant factors underlying participants' responses to latent variables. When determining the number of factors, this study considered the explained variance ratio and eigenvalues greater than 1 (Kaiser, 1960). Additionally, the "principal axis analysis" method was used as the factor extraction method, and the "promax" method was employed as the rotation method in the original scale.

In the CFA analysis, Mplus 8.3 package program was utilized for analysis and model fit indices and factor loadings were examined to assess the data's conformity with the structure. In model parameter estimation, Maximum Likelihood (ML) estimation was used. Model fit indices, including χ^2/sd, RMSEA, CFI, TLI, and SRMR values, were sequentially analyzed.

FINDINGS

Exploratory Factor Analysis

KMO and Barlett test results were examined before conducting EFA. The analysis revealed that the KMO value was 0.892, and the Barlett test yielded statistically significant results (χ^2= 3419.997; p<0.05). Based on these statistics, it was concluded that factor analysis was appropriate for the data obtained from the scale.

In Table 2, eigenvalues, explained variance ratios, and cumulative explained variance ratios obtained from the EFA conducted with the dataset from the entire study group are presented.

Table 2. Eigenvalues & explained variance ratios

Item	Eigenvalue	Explained Variance Ratio	Cumulative Explained Variance Ratio
1	9.021	37.586	36.101
2	2.330	9.710	44.520
3	2.246	9.360	52.560
4	1.629	6.787	58.055
5	1.387	5.781	62.206
6	.870	3.625	
7	.847	3.531	
8	.666	2.774	
9	.584	2.432	
10	.526	2.192	
11	.447	1.862	
12	.428	1.784	
13	.401	1.672	
14	.376	1.568	
15	.362	1.508	
16	.322	1.344	
17	.286	1.193	
18	.279	1.162	
19	.251	1.046	
20	.235	.977	
21	.168	.701	
22	.146	.607	
23	.122	.509	
24	.070	.290	

According to the analysis findings, the variance ratio explained by the first factor was 37.59%, the variance ratio explained by the second factor was 9.71%, and by the third factor, it was 9.36%. The variance ratios explained for the fourth and fifth factors were 6.79% and 5.78%, respectively. Additionally, the variance explained by the five factors amounted to 62.21% in total. Furthermore, the number of factors with eigenvalues above 1 was determined to be five.

Secondly, the scree plot graph was examined to determine the number of dimensions. According to the graph shown in Figure 1, a flattening was observed after the fifth dimension. Therefore, it was concluded that the number of dimensions of the scale should be 5, consistent with its original form.
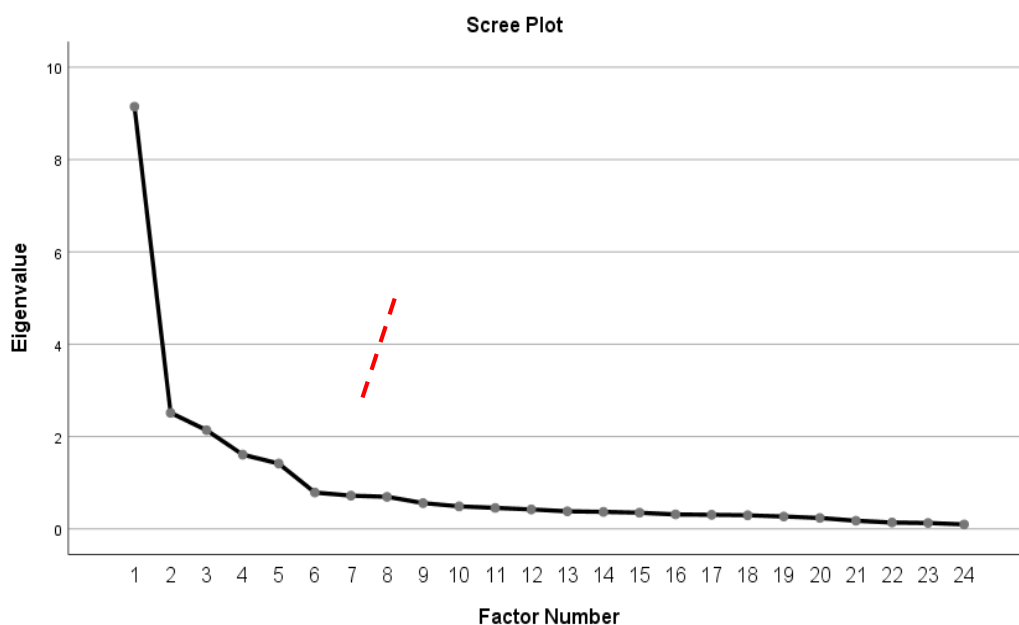
Figure 1. Multidimensional Stress Scale Scree-plot

The factor loadings obtained through EFA for the scale items are presented in Table 3.

Table 3. Distribution of factor loadings

Item	Factor1	Factor2	Factor3	Factor4	Factor5
7	.964				
6	.962				
8	.918				
5	.868				
10	.523				
9	.476				
18		.809			
19		.722			
17		.682			
16		.675			
20		.649			
15		.621			
22			.875		
24			.839		
23			.817		
21			.768		
2				.923	
1				.868	
3				.787	
4				.480	
11					.952
12					.923
13					.376
14					.332

In the first dimension, the factor loadings for the items, as displayed in Table 3, ranged from .476 to .964. Similarly, loadings for the items of the second dimension ranged from .621 to .809. Subsequently, loadings for the items of the third dimension ranged from .768 to .875. Additionally, loadings of the items of the fourth dimension ranged from .480 to .923. The loadings for the items of the fifth dimension ranged from .332 to .952. Consequently, all factor loadings exceeded .32.

The correlation coefficients between the scores obtained from the sub-dimensions of the scale and the scores obtained from all of them are presented in Table 4.

Table 4. Correlation between sub-dimensions and total score

Dimensions	1	2	3	4	5
1. Accessibility Stress	1				
2. Approval Anxiety	.507**	1			
3. Fear of Missing Out	.477**	.574**	1		
4. Excessive Connection	.393**	.541**	.318**	1	
5. Online Vigilance	.516**	.479**	.333**	.359**	1

**<.01

Confirmatory Factor Analysis

To validate the factor structure established by EFA, one and two-level CFAs were conducted in the study. Below, the findings from both analyses are presented.

One Level CFA

The fit indices obtained from the one-level CFA results, performed to assess the support for the five-dimensional structure, are presented in Table 5.

Table 5. Fit indices obtained as a result of the study

	χ^2/sd	RMSEA	SRMR	CFI	TLI
Perfect fit	$0 \leq X^2/sd \leq 2$	$0 \leq RMSEA \leq .05$	$0 \leq SRMR \leq .05$	$.95 \leq CFI \leq 1.00$	$.95 \leq TLI(NNFI) \leq 1.00$
Acceptable Fit	$2 \leq X2/sd \leq 5$	$.05 \leq RMSEA \leq .10$	$.05 \leq SRMR \leq .10$	$.90 \leq CFI \leq .95$	$.90 \leq TLI(NNFI) \leq .95$

Results	2.17	0.078	0.09	0.91	0.90
Comment	Acceptable Fit	Acceptable Fit	Acceptable Fit	Acceptable Fit	Acceptable Fit

The fit indices obtained as a result of CFA were interpreted according to the criteria determined by Schermelleh, Engel, and Moosbrugger (2003). An acceptable fit between the data and the model was observed based on RMSEA, SRMR CFI and TLI values. Additionally, the χ2/sd value was found to be lower than the specified range. While there is no conclusive acceptable criterion for its relative χ2 statistic in the literature, it is generally deemed acceptable up to 5.0 (Wheaton, Muthen, Alwin, & Summers, 1977). Taking into account all the fit indices obtained, it was concluded that the data demonstrated a good fit to the structure (χ2/sd = 2.17; RMSEA = 0.078; SRMR = 0.088; CFI = 0.91; TLI = 0.90). The structural model obtained as a result of CFA is presented in Figure 2.
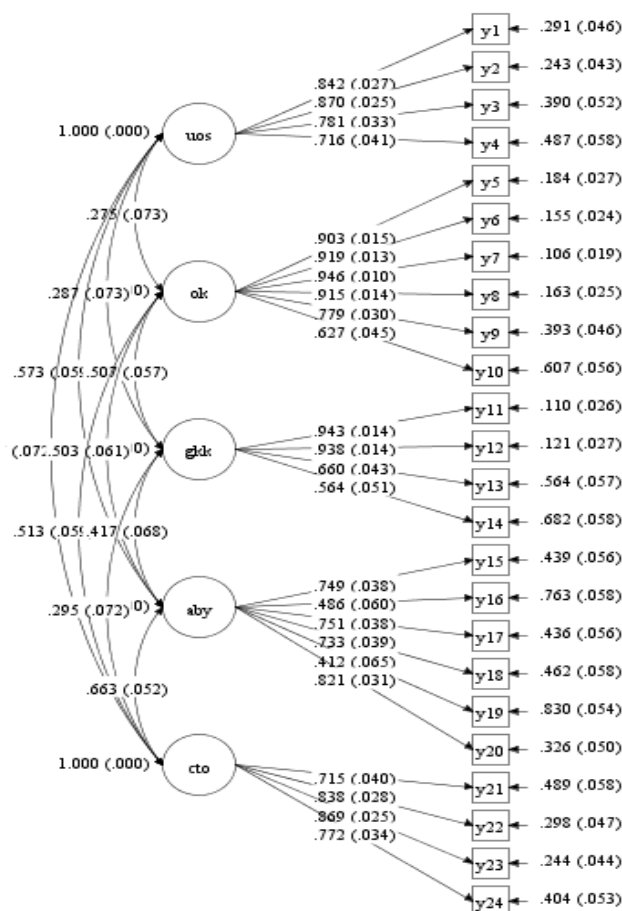
Figure 2. 5-Factor CFA Model

According to the factor loadings for the standardized prediction in the structural model as visualized in Figure 2, the loadings for the Accessibility Stress sub-dimension ranged from 0.66 to 0.82. Similarly, the loadings for the Approval Anxiety sub-dimension ranged from 0.61 to 0.95. Additionally, the loadings for the Fear of Missing Out sub-dimension varied between 0.53 and 0.93, while the loadings for the Excessive Connection sub-dimension ranged from 0.49 to 0.81. Lastly, the loading values for the Online Vigilance sub-dimension were found to vary between 0.74 and 0.84.

Two-level CFA

Following the single-level CFA stage, a two-level CFA was conducted using the data obtained from the study group. The fit indices obtained based on the results of the two-level CFA are displayed in Table 6.

Table 6. Fit indices obtained as a result of the study

	χ^2/sd	RMSEA	SRMR	CFI	TLI
Perfect fit	0 ≤ X²/sd ≤ 2	0 ≤ RMSEA ≤ .05	0 ≤ SRMR ≤ .05	.95 ≤ CFI ≤ 1.00	.95 ≤ TLI(NNFI) ≤ 1.00
Acceptable Fit	2 ≤ X2/sd ≤ 5	.05 ≤ RMSEA ≤ .10	05 ≤ SRMR ≤ .10	.90 ≤ CFI ≤ .95	.90 ≤ TLI(NNFI) ≤ .95

Results	2.25	0.080	0.098	0.91	0.90
Comment	Acceptable Fit	Acceptable Fit	Acceptable Fit	Acceptable Fit	Acceptable Fit

After analyzing the table values, it was evident that a strong compatibility with the structure was exhibited by the data, as indicated by all fit indices ($\chi2/sd$ = 2.25; RMSEA = 0.080; SRMR = 0.098; CFI = 0.91; TLI = 0.90). Figure 3 illustrates the structural model that was obtained through the two-level CFA.
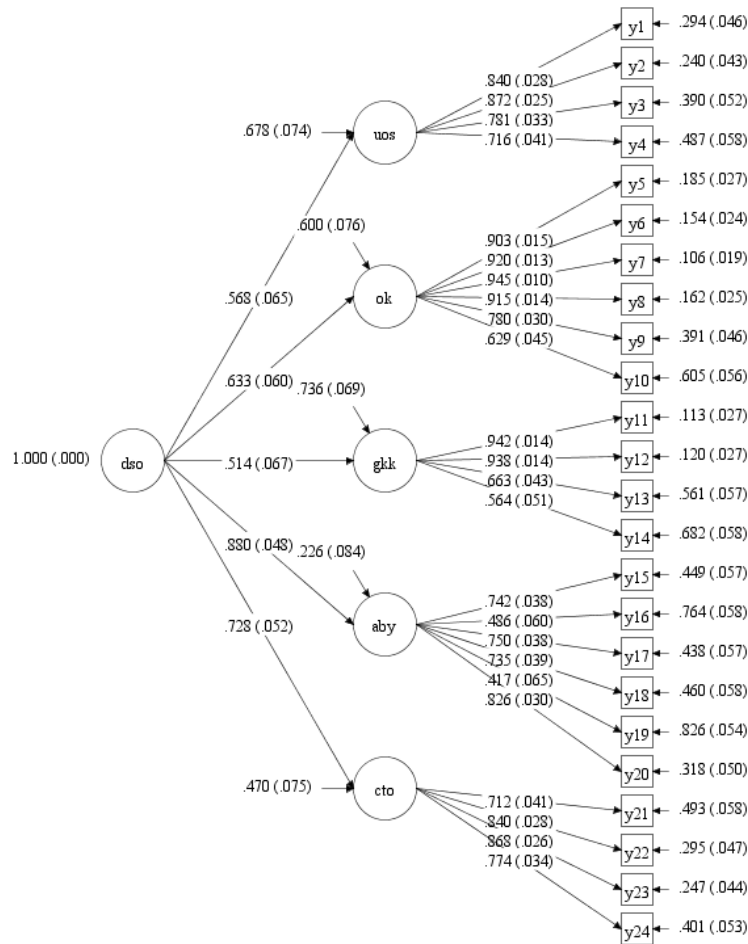
Figure 3. 5-Factor Two-Level Structural Model

In addition to providing evidence of the study's validity, corrected item-total correlations and alpha values based on each dimension were calculated for the scale items. Field (2013) emphasized that the corrected item-total correlation should exceed 0.3 (p. 713). Table 7 display the corrected item-total correlations and corrected Cronbach alpha coefficients for the items in each sub-dimension.

Table 7. Corrected item-total correlation for the items in the scale (for each dimension)

Dimension	Item	Corrected Item-Total Correlation	Cronbach's Alpha If Item Deleted
Accessibility Stress	1	.75	.80
	2	.78	.79
	3	.71	.82
	4	.60	.87
Approval Anxiety	5	.85	.91
	6	.88	.91
	7	.88	.91
	8	.85	.91
	9	.70	.93
	10	.63	.94
Fear of Missing Out	11	.74	.77

	12	.72	.78
	13	.66	.81
	14	.59	.83
Excessive Connection	15	.64	.80
	16	.54	.82
	17	.62	.81
	18	.70	.79
	19	.48	.84
	20	.70	.80
Online Vigilance	21	.68	.85
	22	.76	.83
	23	.75	.83
	24	.73	.84

The corrected item-total correlations for the items in the accessibility stress dimension were found to range from .60 to .75; for the items in the approval anxiety dimension were found to range from .63 to .85; for the items in the fear of missing out dimension were found to be ranged from .59 to .74; for the items in the excessive connection dimension were found to range from .48 to .70. Lastly, the corrected item-total correlations for the items in the online vigilance dimension were found to range from .68 to .76. These high correlations indicate strong item discrimination.

Finally, Table 8 provides the values obtained in the original development study of the scale, along with the factor loadings and R^2 values obtained in the adaptation study.

Table 8. Factor analysis results obtained in the original form and adaptation study

	Values Obtained in the Original Form of the Scale		Values Obtained as a Result of Adaptation		
	Factor Loading (EFA Result)	R2 value	Factor Loading (EFA Result)	Factor Loading (CFA Result-one level)	R2 value
Item 1	0.92	0.76	0.87	0.84	0.71
Item 2	0.88	0.71	0.92	0.87	0.76
Item 3	0.70	0.48	0.79	0.78	0.61
Item 4	0.62	0.68	0.48	0.72	0.51
Item 5	0.94	0.83	0.87	0.90	0.82
Item 6	0.90	0.82	0.96	0.92	0.85
Item 7	0.86	0.83	0.96	0.95	0.89
Item 8	0.85	0.78	0.92	0.92	0.84
Item 9	0.75	0.49	0.48	0.78	0.61
Item 10	0.71	0.38	0.52	0.63	0.40
Item 11	0.96	0.55	0.95	0.94	0.89
Item 12	0.87	0.52	0.92	0.94	0.88
Item 13	0.58	0.67	0.38	0.66	0.44
Item 14	0.47	0.40	0.33	0.56	0.32
Item 15	0.86	0.72	0.62	0.75	0.55
Item 16	0.86	0.54	0.68	0.49	0.24
Item 17	0.78	0.64	0.68	0.75	0.56
Item 18	0.76	0.54	0.81	0.73	0.54
Item 19	0.76	0.64	0.72	0.41	0.17
Item 20	0.71	0.53	0.65	0.82	0.68
Item 21	0.86	0.55	0.77	0.72	0.51
Item 22	0.82	0.67	0.88	0.84	0.71
Item 23	0.65	0.57	0.82	0.87	0.75
Item 24	0.65	0.52	0.84	0.77	0.60

As shown in Table 12, the lowest factor loading was observed in Item 14 (0.47), and the highest factor loading was found in Item 11 (0.96) based on the EFA conducted with data obtained from the original version of the scale. Likewise, in the EFA conducted with data collected for the adaptation study, the lowest factor loading was found in Item 14 (0.33), while one of the highest factor loadings was observed in Item 11 (0.95).

Evidence of reliability

Cronbach's Alpha (α) and McDonald's Omega (ω) coefficients were computed for each dimension, and the stratified-alpha (α) reliability coefficient (Cronbach, Schönemann & McKie, 1965) was determined for the entire scale to establish the reliability of the scales obtained from the instrument. Table 9 displays the resulting statistics.

Table 9. Cronbach alpha, mc donald's omega, and stratified alpha reliability coefficients

Dimension	Cronbach's α	Stratified-α	Omega
Accessibility Stress	.861		.863
Approval Anxiety	.931		.932
Fear of Missing Out	.839	.95	.823
Excessive Connection	.837		.839
Online Vigilance	.872		.875

Based on the analysis of the computed reliability coefficients, it was found that the Cronbach Alpha values for each dimension were above 0.83, and the Omega coefficients exceeded 0.82. The reliability coefficient for the entire scale was determined to be 0.95. Hence, the calculations for both the five dimensions and the entire scale were considered reliable.

Table 10 presents a summary of the reliability coefficients obtained from the original form of the scale and those obtained in the adaptation study, along with the factor loadings.

Table 10. Reliability coefficients obtained in the original form and adaptation study

	Values Obtained in the Original Form of the Scale	Values Obtained as a Result of Adaptation
1. Accessibility Stress	.93	.86
2. Approval Anxiety	.88	.93
3. Fear of Missing Out	.91	.84
4. Excessive Connection	.87	.84
5. Online Vigilance	.86	.87
Total digital stress	.85	.95

Based on the examination of the coefficients presented in the table, it is evident that the reliability values obtained from both the original scale and the adaptation study were high.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This study aimed to establish evidence of validity and reliability by adapting the Digital Stress Scale to Turkish culture. Initially, the study conducted an Exploratory Factor Analysis (EFA) using data from the study group. The findings from the EFA, including the examination of eigenvalues and scree plots, indicated the presence of 5 dimensions in the latent structure, mirroring the original scale. These 5 dimensions accounted for approximately 70% of the total variance. Furthermore, the factor loadings ranged from 0.41 to 0.98. The results show that the scale structure is applicable to Turkish culture.

Additionally, Confirmatory Factor Analysis (CFA) was performed to verify the established model. The CFA results demonstrated a good fit between the data and the model for both the one-level and two-level structures. Upon examining the factor loadings, it was evident that the items exhibited appropriate factor loadings across all sub-dimensions. This reaffirmed the presence of the five-dimensional structure.

Regarding reliability, Cronbach's Alpha and McDonald's Omega (ω) reliability coefficients were calculated for each subscale, all of which exceeded 0.82. Moreover, the stratified reliability coefficient for the entire scale was high at 0.95. Consequently, the calculations in this regard were considered reliable.

When the scales developed and adapted in Türkiye are examined, it is seen that there is no measurement tool to measure technological stress. When the latent constructs close to digital stress were examined, it was determined that the "Digital Burnout Scale" developed by Erten and Özdemir (2020) and the "Techno-Stress Scale at Workplace" adapted by Türen, Erdem and Kalkın (2015) were used in the Turkish literature. However, the latent construct addressed in the first of these scales, the "Digital Burnout Scale", is burnout. There are three dimensions in this measurement tool and these dimensions are named as "digital attrition", "digital deprivation" and "emotional exhaustion". When the dimensions are considered, it is seen that it has different sub-dimensions with the existing measurement tool. The other measurement tool has the sub-dimensions of "technological workload overload", "technological complexity" and "technological uncertainty" and measures different latent characteristics with the current measurement tool.

In addition, there are some measurement tools in the Turkish literature for the "Fear of Missing Out", which is one of the dimensions in the current measurement tool. Çelik and Özkara (2020) adapted the "Fear of Missing Out (FoMO) Scale" into Turkish and obtained a valid and reliable measurement tool to measure individuals' sense of FoMO. This measurement tool has two

dimensions and is named as "personal FoMO" and "social FoMO". However, in the current measurement tool, FoMO is evaluated as a single sub-dimension and its relationship with other sub-dimensions in the scale can be revealed by using this measurement tool.

As a result, the examination of the validity and reliability results, in general, determined that all the items in the original form of the scale were also found to be suitable for Turkish culture, and the measurement model presented in the original form was found to be similar to Turkish culture. In this regard, the Digital Stress Scale can be employed within Turkish culture for individuals aged 18 to 30, enabling the determination of the stress level induced by digital technology in adults. In addition, cross-cultural measurement invariance studies can be conducted by applying the scale in the culture in which it was developed and in Turkish culture.

Declaration of Conflicting Interests

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Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

"Multidimensional Adaptation of Digital Stress Scale into Turkish: Reliability and Validity Analysis" Gazi University Ethics Commission, at its meeting dated 19.04.2022 and numbered 08 unanimously approved.

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APPENDIX

DİJİTAL STRES ÖLÇEĞİ Değerli Katılımcı, bu ölçme aracı ile bireylerde Dijital Stres Düzeylerinin belirlenmesi amaçlanmaktadır. Ölçme aracında toplamda 24 madde olup, 1=hiçbir zaman; 2= nadiren; 3= bazen; 4= sık sık ve 5=her zaman olacak şekilde maddelere katılım düzeylerinizi belirtmeniz istenmektedir. Katılımınız için şimdiden çok teşekkür ederiz.	1 (Hiçbir zaman)	2 (Nadiren)	3 (Bazen)	4 (Sık sık)	5 (Her zaman)
1) Arkadaşlarım benden sürekli çevrimiçi olmamı bekliyor.					
2) Arkadaşlarım için sürekli çevrimiçi olmam önemlidir.					
3) Arkadaşlarımın çoğu, sürekli çevrim içi olmamı onaylar.					
4) Sürekli çevrim içi olma yönünde sosyal bir zorunluluk hissediyorum.					

5)	İnsanların gönderilerime ve fotoğraflarıma nasıl tepki vereceği konusunda gergin hissediyorum.				
6)	Sosyal medyada yeni bir fotoğraf paylaştığımda başkalarının nasıl tepki vereceği ile ilgili kaygı duyuyorum.				
7)	Bir gönderi veya fotoğraf paylaştıktan sonra başkalarının nasıl karşılayacağı beni geriyor.				
8)	Sosyal medyada hayatımla ilgili değişiklikleri paylaştığımda başkalarının nasıl karşılayacağı beni geriyor.				
9)	Çevrim içi ortamda diğer insanların onay vereceği bir fotoğraf bulmak veya oluşturmak için çok çaba sarf ederim.				
10)	Paylaştığım gönderileri ve mesajları oluştururken çok çaba sarf ederim.				
11)	Arkadaşlarımın benim yaşadığımdan daha cazip deneyimler yaşamasından korkuyorum.				
12)	Diğer insanların benim yaşadığımdan daha cazip deneyimler yaşamasından korkuyorum.				
13)	Arkadaşlarımın bensiz eğlendiğini öğrendiğimde endişeleniyorum.				
14)	Arkadaşlarımın ne yaptıklarını bilmediğim zaman kaygılanıyorum.				
15)	Çok fazla bildirimi kontrol etmek zorunda kalıyorum.				
16)	Telefonumdaki mesajların/bildirimlerin akışı beni bunaltıyor.				
17)	-Yanıp sönen bir ışık veya vızıltı gibi- ilgilenmem gereken başka bir mesaj olduğunu her zaman hatırlatan bir şey varmış gibi geliyor.				
18)	Önemli olanlara ulaşmak için birçok önemsiz bildirimi gözden geçirmem gerektiği için stresli hissediyorum.				
19)	Yapmam gereken diğer şeylerin yanı sıra, bildirimleri takip etmek bir angaryadır.				
20)	Bildirimlere/mesajlara yanıt vermek için çok fazla zaman harcıyorum.				
21)	Neler olduğunu takip edebilmem için telefonum yanımda olmalı.				
22)	Telefonum olmadan kaybolmuş veya "çıplak" hissediyorum.				
23)	Mesajlar/bildirimler için telefonumu sürekli kontrol ediyorum.				
24)	Telefonum yanımda olmadığında sosyal olarak ulaşılabilir olmadığımı hissediyorum.				

Boyutlar

Ulaşılabilir Olma Stresi: 1., 2., 3. ve 4. maddeler

Onaylanma Kaygısı: 5., 6., 7., 8., 9. ve 10. maddeler
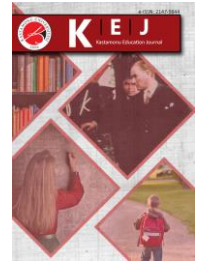
Gelişmeleri kaçırma korkusu: 11., 12., 13. ve 14. maddeler

Aşırı Bağlantı Yükü: 15., 16., 17., 18., 19. ve 20. maddeler

Çevrimiçi Tetikte Olma: 21., 22., 23. ve 24. maddeler

There are no reverse items in the scale. A high score from the scale indicates a high level of digital stress.

Note: You can use the scale in your study by citing it. Also, no permission is required.

Investigation of Digital Competence Levels of Online Learners

Çevrimiçi Öğrenenlerin Dijital Yeterlik Düzeylerinin İncelenmesi

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Abstract

Purpose: This study aims to analyze the digital competence levels of online learners in terms of different variables.

Design/Methodology/Approach: A total of 303 students participated in the study conducted with the cross-sectional screening model of the quantitative research method. The data were collected online via the "University Students Digital Competencies Scale".

Findings: Students' digital competence levels show a significant difference according to the variables of gender, age, technology usage competence and duration of using technological devices. It was concluded that students with high technology use competence also have high problem-solving ability in virtual environments. It was determined that as the duration of students' use of technological devices increased, their level of content development in digital environments also increased.

Highlights: Considering the finding that as the average daily usage time of students' technological devices increases, students' digital competence levels also increase, it is recommended to prepare more activities to increase the average daily usage time of students' technological devices in distance education environments, to organize synchronous meetings and asynchronous forum activities, and to develop educational policies to take into account the time students spend in the distance education environment and their completion rates in measurement and evaluation processes.

Öz

Çalışmanın amacı: Bu çalışma, çevrimiçi öğrenenlerin dijital yeterlik düzeylerini farklı değişkenler açısından analiz etmeyi amaçlamaktadır.

Materyal ve Yöntem: Nicel araştırma yönteminin kesitsel tarama modeli ile yürütülen çalışmaya toplam 303 öğrenci katılmıştır. Çalışmanın verileri "Üniversite Öğrencileri Dijital Yeterlikler Ölçeği" aracılığıyla çevrimiçi olarak toplanmıştır.

Bulgular: Öğrencilerin dijital yeterlik düzeyleri cinsiyet, yaş, teknoloji kullanım yeterliği ve teknolojik cihazları kullanma süresi değişkenlerine göre anlamlı bir farklılık göstermektedir. Teknoloji kullanım yeterliği yüksek olan öğrencilerin sanal ortamlarda problem çözme becerilerinin de yüksek olduğu sonucuna ulaşılmıştır. Öğrencilerin teknolojik cihazları kullanma süreleri arttıkça dijital ortamlarda içerik geliştirme düzeylerinin de arttığı belirlenmiştir.

Önemli Vurgular: Öğrencilerin günlük ortalama teknolojik cihaz kullanımı süreleri arttıkça dijital yeterlik düzeylerinin de arttığı bulgusu dikkate alındığında, uzaktan eğitim ortamlarında öğrencilerin günlük ortalama teknolojik cihaz kullanımı sürelerini artırmaya yönelik daha fazla etkinlik hazırlanması, senkron toplantılar ve asenkron forum etkinlikleri düzenlenmesi, ölçme ve değerlendirme süreçlerinde öğrencilerin uzaktan eğitim ortamında geçirdikleri süreyi ve tamamlama oranlarını dikkate alacak eğitim politikaları geliştirilmesi önerilmektedir.

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INTRODUCTION

Constant developments in information and communication technologies have enabled the realization of learning activities that require distance-learning students to have higher-level skills and competencies through the effective and efficient use of current technologies in learning management systems. The usage of advanced information and communication technologies which will ensure that students perform learning activities demanding higher level skills and competencies in distance learning environments requires students who need to use these technologies productively and actively to acquire digital competencies (Afacan-Adanır & Gülbahar-Güven, 2022).

Examining the definitions made within the scope of digital competencies in the literature, it is observed that digital competency, which is closely related to 21st-century skills and is a core competency in the acquisition of 21st-century skills (Ferrari, 2012; Juhász et al., 2022), is defined as the competencies necessary for students to use information and communication technologies effectively and efficiently (Kuzminska et al., 2019). In another study, digital competencies were considered as the skills needed to use information and communication technologies effectively and efficiently to achieve lifelong learning, entertainment, and socialization in education and working life by employing the skills of problem-solving, communication, collaboration, content creation, and sharing, which are among the 21st-century skills (Ferrari, 2012). In a further study, digital competencies (European Commission, 2018), which are determined by the European Commission as one of the competencies required for lifelong learning, are identified as competencies determined in five dimensions which are information and data literacy, communication, and collaboration, digital content development, security, problem-solving within the framework of Digital Competences 2.1 for individuals to use information and communication technologies consciously, safely, responsibly and to show commitment to digital technologies for their participation in learning, professional and social life (Carretero et al., 2017).

Digital competencies, which have an important role in shaping the economic and social levels of individuals (Gümüş, 2021), also play an important role in establishing interactions between students and instructors in distance learning environments in the field of education and enabling students to conduct technology-enriched collaborative activities with instructors and other students (Korucu, 2020). Since it is crucial for university students to have digital competencies addressed in the dimensions determined in the Digital Competencies 2.1 Framework to achieve success and satisfaction in their educational and professional lives (Kuzminska et al., 2018), higher education institutions need to provide digital competencies for all university students in a practice-oriented manner (Afacan-Adanır & Gülbahar-Güven, 2022). It is critical for higher education institutions, especially in crisis processes such as earthquakes and epidemics, to have digital competencies, for students who are studying in distance education institutions and postgraduate education in distance non-thesis programs should use information and communication technologies effectively and efficiently in distance learning environments.

RELATED RESEARCH

There are many studies in the literature on examining the digital competence levels of learners. For example, in a study conducted with university students in Chile, the digital competence levels of undergraduate students were examined and it was found that students had medium level digital competence (Silva-Quiroz & Morales-Morgado, 2022). In another study, the digital competence levels of pre-service teachers studying at universities in Spain were analysed. As a result of the study, it was found that pre-service teachers had moderate digital competence and some difficulties in creating content (Galindo-Domínguez & Bezanilla, 2021). In another study by Nyikes (2018), the digital competence levels of university students in Hungary were examined. As a result, it was determined that the digital competence levels of university students in Hungary were not at the expected level. In another study examining the digital competence levels of teachers and students in Ukraine, it was concluded that the digital competence levels of university students in Ukraine were at a high level (Kuzminska et al., 2018). Vodă et al. (2022) examined the digital competence levels of students studying at three large universities in Belgium and Romania in line with seven basic skill components. As a result of the analysis, it was revealed that students in Belgium had higher digital skills such as communication and cooperation, knowledge and problem solving compared to other skills, while students in Romania had higher creativity and technological skills compared to other digital skills.

When the studies conducted with graduate students in higher education institutions are examined in the literature, two main studies emerge. In the first of these studies, Prabhu et al. (2022) investigated whether the digital competence levels of 315 undergraduate and 44 graduate students at a private university in India differed according to gender. As a result of the research, gender differences were found in problem solving competence parameters, which include the ability to solve technical problems, use technology creatively, and identify needs and technological responses. Another study conducted by Kassymova et al. (2023) analyzed the perceptions of digital competence in online learning and teaching of 49 graduate students who attended distance evening courses at a private university in Kazakhstan and worked as English teachers in various educational institutions during the working hours. As a result of the study, it was found that Kazakhstani postgraduate students were well-equipped for online and distance learning and teaching, they received a good ICT education for online teaching at the university through the use of different digital tools in their learning processes, their digital competence levels for online learning were higher than their digital competence levels for online teaching, and they needed special training in using ICT for pedagogical purposes.

When the studies on digital competence in Turkey are examined, it is seen that there are activity studies aimed at improving the digital competence of pre-service teachers (Çebi & Reisoğlu, 2020). In the study conducted by Kaya (2020), the relationship

between the self-efficacy perceptions of education faculty students towards technology integration and their digital competence levels was investigated. As a result of the research, it was determined that there was a relationship between self-efficacy perception towards technology integration and digital competence levels and that digital competence levels differed significantly according to gender, age and department of study. In another study on digital competence, it was found that pre-service teachers had high levels of digital awareness, digital competence and digital fluency (Karakuş, 2022). As a result of the literature review, it has been seen that there are limited number of studies examining the digital competence levels of graduate students and that new scientific research is needed. In this context, it is considered that it is important to investigate the digital competence levels of graduate students studying through distance education. For this reason, it is thought that this study, which addresses the digital competence levels of graduate students studying through distance education from different perspectives, is thought to be important and contribute to the related literature. In this study, it was aimed to examine the digital competence levels of non-thesis master's degree students studying through distance education in terms of different variables. In the framework of this main purpose, answers to the following research questions were sought:

1. Do the digital competence levels of students studying in Distance Education Non-Thesis Master's programs differ according to the gender?
2. Do the digital competence levels of students studying in Distance Education Non-Thesis Master's programs vary according to the age?
3. Do the digital competence levels of students studying in Distance Education Non-Thesis Master's programmes differ according to technology usage competence?
4. Do the digital competence levels of students studying in Distance Education Non-Thesis Master's programs differ according to the average daily time spent using technological devices?

As a result of the research, pioneering findings were provided to the literature with the results obtained by evaluating the digital competence levels of graduate students in distance education environments in terms of different variables.

METHOD

In this study, the descriptive research method, which is one of the quantitative research methods, was used. Descriptive research is a type of research that aims to directly investigate an ongoing situation and detect the current situation (Karakaya, 2014). In the descriptive research method, it is fundamental to clarify a situation and to make various evaluations to establish the relationship between events (Büyüköztürk et al., 2014). This method tries to define the individuals, events, or objects that are the subject of research as they are by assessing them within the conditions they are in (Karasar, 2012).

Research Model

This study was conducted to investigate the digital competence levels of students studying in Anadolu University Institute of Social Sciences Distance Education Non-Thesis Master's Degree programs in terms of various variables. The cross-sectional screening model, one of the general survey models, was used in the study. Survey models within the descriptive research method are the arrangements made on the whole population or a sample to be taken from the population to have a general opinion about it in a population with a high number of elements (Karasar, 2012). Cross-sectional screening models are research models that include communities of individuals with different qualities from one another and generally have a large sample size. The variables to be depicted in this survey model are measured at one time (Büyüköztürk et al., 2014; Fraenkel et al.,2012). In this study, the cross-sectional screening model was used since it was intended to determine the digital competence levels of non-thesis master's degree students studying through distance education by measuring them at one time according to different variables.

Population and Sample

The population of the study consists of students enrolled in Anadolu University Institute of Social Sciences Distance Education Non-Thesis Master's Degree programs in the spring semester of the 2022-2023 academic year. The sample of the study consists of a total of 303 students enrolled in distance education non-thesis master's programs and responding to the data collection tools presented to them. While forming the sample group of the study, the convenience sampling method, which is one of the non-random sampling methods, was used. This sampling method, which is based on the principles of being both accessible and convenient, is a method that enables researchers to collect the most accurate information quickly (Büyüköztürk et al., 2014). Researchers using this sampling method mostly work with individuals who are easy to access and volunteer to participate (Erkuş, 2005).

Information on the demographic characteristics of the students constituting the sample of the study was collected via a personal information form. Information on the demographic characteristics of the students is given in Table 1.

Table 1. Demographic information of the students

Attribute	Variable	Frequency (N)	Percentage Value (%)
Gender	Female	141	46.5
	Male	162	53.5

Attribute	Variable	Frequency (N)	Percentage Value (%)
	18-25 years	56	18.5
	26-33 years	101	33.3
Age	34-41 years	86	28.4
	42-49 years	48	15.8
	50 years and over	12	4.0
	Basic Level	46	15.2
Technology Use Competency	Intermediate Level	155	51.2
	Advanced Level	102	33.7
	Between 0-3 hours	26	8.6
Average Daily Usage Time of Technological Devices*	Between 3-5 hours	69	22.8
	Between 5-7 hours	93	30.7
	7 and more hours	115	38.0

*Participants with an average daily technological device use of 3 hours were included in the 3–5 hour group, and those with 5 hours were included in the 5-7 hour group. Analyses were carried out accordingly.

Data Collection Tools

In the study, a personal information form and the "University Students Digital Competencies Scale" adapted into Turkish by Afacan-Adanır and Gülbahar-Güven (2022) were adopted to collect data. The data of the study were collected online through Google Forms. The electronic questionnaire form created in the online environment was applied to students studying in Anadolu University Institute of Social Sciences Distance Education Non-Thesis Master's Degree programs between December 15, 2022 and March 26, 2023. The data collection process with the help of Google Forms was conducted based on the principle of volunteerism. Only the data of the participants who declared that they participated voluntarily were used in the study. In the online questionnaire form, participants were given a single answer and care was taken not to create a biased sample group. The students who constituted the sample of the study were given the necessary information to answer the questions in the questionnaire form in a credible way and were given the right to examine the collected data if desired.

Personal Information Form

The personal information form is a form prepared to determine the demographic characteristics of the participants such as gender, age, technology usage competence and average daily usage time of technological devices.

University Students Digital Competencies Scale

The scale used in the study was adapted into Turkish by Afacan-Adanır and Gülbahar-Güven (2022). This scale, which consists of 29 items and 5 sub-dimensions in total, is a 4-point Likert scale. Items 1, 2, 3, 4, 5, 6, 7, 8, 9 of the scale measure students' digital content development levels; items 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 measure students' information and data literacy levels; items 20, 21, 22 measure students' contact skills; items 23, 24, 25, 26 measure students' skills in the use of virtual tools and social communication levels; and items 27, 28, 29 measure students' problem-solving skills in virtual environment. On the other hand, Cronbach's Alpha internal reliability value was also examined to test the reliability of the scale and it was found that this value was α= 0.907. The reliability coefficients of the sub-dimensions of the scale were calculated as α>0.70 (Afacan-Adanır & Gülbahar-Güven, 2022).

Confirmatory Factor Analysis (CFA) was applied to ascertain the validity and reliability of the scale used in the study. As a result of CFA using IBM AMOS 21.0 (Analyses of Moment Structures) program, the adjusted chi-square value is χ^2/sd= 1.831, which is one of the values indicating compliance. According to Kline (2011), this value is in the range of $0 \leq \chi^2/sd \leq 2$ means that there is an impeccable fit. Therefore, it was found that this value obtained as a result of CFA had an excellent fit. In the study, another fit value, the Root Mean Square Error of Approximation (RMSEA) value was investigated, and it was found that this value was RMSEA=0.052. In the literature, this value is in the range of $.05 \leq RMSEA \leq .08$ indicating that there is acceptable compliance. In this regard, the obtained value was found to have an acceptable match (Browne & Cudeck, 1993). When the CFI value, which is another fit index, was examined, it was seen that this value was CFI= 0.95. According to Kline (2011), a value greater than 0.95 indicates a good fit. TLI value, which is another goodness of fit, was calculated as 0.95. Hu and Bentler (1999) considered this value to be in the range of $0.95 \leq TLI \leq 1.00$ as a good fit criterion. In this context, it was determined that the calculated TLI value had a good fit. Another goodness of fit index examined as a result of CFA is the IFI value. In this study, IFI=0.96 was calculated. The fact that this value is in the range of $0.90 \leq IFI \leq 1.00$ is an indication of having a good fit index (Bollen, 1989). SRMR value, another goodness of fit value, was calculated and it was found that this value was 0.48. SRMR value less than 0.80 indicates a good fit according to Hu and Bentler (1999). In this respect, it was determined that the SRMR value obtained has a good fit value. The Adjusted Goodness of Fit Value (AGFI) was calculated as AGFI= 0.92. According to Schermelleh-Engel and Moosbrugger (2003), this value being in the range of $0.90 \leq AGFI \leq 1.00$ is considered as a good fit criterion. Therefore, it can be said that this result obtained is a good fit criterion. To assess the reliability of the scale, Cronbach's

Alpha (α) value was calculated. As a result of the calculation, it was found that Cronbach's Alpha value for the whole scale was α= 0.93. The Cronbach's Alpha values of the sub-dimensions of the scale were found to be higher than α= 0.70.

Data Analysis

Before starting the analysis process, it was checked whether there was any incorrect data entry and a normality test was performed to determine the analyses to be used in the resolution of the data. To determine whether the research data displayed a normal distribution, kurtosis and skewness values and histogram graphs were examined respectively. According to the results of the normality analysis, it was found that the kurtosis and skewness values of the data set were in the range of -1/+1 and the histogram graphs showed a normal distribution (Huck, 2012). As a result of the normal distribution of the data set, it was decided to use measurement techniques such as frequency analysis, independent samples t-test, and one-way analysis of variance (One-Way ANOVA) respectively. While the calculation of kurtosis and skewness values, frequency analysis showing percentage value distributions, independent samples t-test, One-Way ANOVA, and other parametric test techniques were carried out in the IBM SPSS 26.0 package program, the CFA, which was conducted due to the study on a different research population, was prepared in the AMOS 21.0 package program. Cohen's d values and eta squared (η^2) values were computed to determine the effect sizes of significant differences (Cohen, 1988a; Cohen, 1988b).

FINDINGS

In this section of the study, statistical analyses were carried out to investigate the significance of students' digital competence levels in terms of different variables. Following the analyses, the findings were presented and interpreted in tables.

Independent samples t-test was used to determine whether the students' digital competence levels varied considerably based on the gender variable. The results of the analysis demonstrating the level of correlation between the variables are given in Table 2.

Table 2. Differentiation of students' digital competence levels according to gender variable

Subscale/ Scale	Gender	N	X̄	S	t	df	p
Digital Content Development	Female	141	2.156	.5963	-3.202	301	.002*
	Male	162	2.380	.6128			
Information and Data Literacy	Female	141	2.888	.6442	-2.776	301	.006
	Male	162	3.089	.6138			
Contact	Female	141	3.141	.7062	-.081	301	.935
	Male	162	3.148	.6413			
Using Virtual Tools and Social Communication	Female	141	2.586	.6331	1.471	301	.142
	Male	162	2.479	.6298			
Problem Solving in a Virtual Environment	Female	141	2.983	.7739	-1.334	301	.183
	Male	162	3.096	.7036			
Total	Female	141	2.655	.5280	-2.335	301	.020*
	Male	162	2.792	.4862			

In Table 2, whether the digital competence levels of the students differed significantly according to the gender variable was examined. According to Table 2, it was found that students' digital competence levels (t(301)= -2.335, p<0.05) differ considerably according to gender variable. In this regard, the digital competence levels of male students were seen to be at a higher level than female students. This indicates that the gender variable is an influential variable on students' digital competence levels. To determine the degree of this significant difference, Cohen's d value was examined and it was seen that this value was 0.026. With this value, we can see that the significant difference has a small effect magnitude. When the sub-dimensions were analyzed, students' digital content development levels (t(301)= -3.202, p<0.05) also showed a significant difference based on the gender variable. Thus, the level of digital content development of male students was observed to be at a relatively higher level than that of female students. This significant difference was detected to have a small effect (d= 0.036). On the other hand, students' levels of information and data literacy (t(301)= -2.776, p>0.05), communication (t(301)= -.081, p>0.05), using virtual tools and social communication (t(301)= 1.471, p>0.05) and problem-solving in a virtual environment (t(301)= -1.334, p>0.05) did not show a significant difference in terms of gender variable.

A One-Way ANOVA test was applied to find out whether the digital competence levels of the students differed depending on the age variable. Information about the test results is given in Table 3.

Table 3. Differentiation of students' digital competence levels according to age variable

Subscale/ Scale	Variables	N	X̄	sd	df	F	p	Difference
Digital Content Development	18-25 years	56	2.434	.5028	302	3.140	.015*	18-25 years> 42-49 years
	26-33 years	101	2.292	.6725				
	34-41 years	86	2.311	.6189				
	42-49 years	48	2.046	.5481				
	50 years and over	12	2.064	.5694				

		N			df	F	p	Difference
Information and Data Literacy	18-25 years	56	3.160	.6271	302	2.015	.092	-
	26-33 years	101	3.034	.6844				
	34-41 years	86	2.945	.5620				
	42-49 years	48	2.862	.6363				
	50 years and over	12	2.800	.6208				
Contact	18-25 years	56	3.178	.7546	302	0.333	.856	-
	26-33 years	101	3.168	.7065				
	34-41 years	86	3.155	.6107				
	42-49 years	48	3.076	.6422				
	50 years and over	12	3.000	.5318				
Using Virtual Tools and Social Communication	18-25 years	56	2.687	.5625	302	3.390	.010*	18-25 years> 42-49 years
	26-33 years	101	2.549	.6736				
	34-41 years	86	2.558	.6285				
	42-49 years	48	2.250	.5880				
	50 years and over	12	2.541	.5204				
Problem Solving in a Virtual Environment	18-25 years	56	3.166	.7275	302	0.839	.501	-
	26-33 years	101	3.056	.7558				
	34-41 years	86	3.038	.7166				
	42-49 years	48	2.916	.7421				
	50 years and over	12	2.916	.7929				
Total	18-25 years	56	2.872	.4625	302	2.979	.020*	18-25 years> 42-49 years
	26-33 years	101	2.753	.5578				
	34-41 years	86	2.726	.4684				
	42-49 years	48	2.552	.4948				
	50 years and over	12	2.569	.4708				

When the test results presented in Table 3 are reviewed, it is seen that students' digital competence levels showed a significant difference (F(2,302)= [2.979], p<0.05) concerning the age variable. Similarly, this significant difference was observed in the sub-dimensions of developing digital content, using virtual tools and social communication. To determine the source of these significant differences in the total and sub-dimensions of the digital competencies scale, the Bonferroni test, which is used when the variances are equal, was used (Field, 2005). As a result of the test, students between the ages of 18-25 ($\bar{X}$=2.872, sd=.4625) had a higher level of digital competence than students between the ages of 42-49 ($\bar{X}$=2.552, sd=.4708). It was observed that this statistically meaningful difference had a small effect magnitude (η2=0.038). Furthermore, students between the ages of 18-25 ($\bar{X}$=2.434, sd=.5028) showed higher levels of digital content development than students between the ages of 42-49 ($\bar{X}$=2.046, sd=.5481). However, this significant differentiation (η2=0.040) has a small effect magnitude. Another significant variation was found in the sub-dimension of using virtual tools and social communication. Therefore, it was determined that the level of using virtual tools and social communication of the students between the ages of 18-25 ($\bar{X}$=2.687, sd=.5625) was higher than that of the students between the ages of 42-49 ($\bar{X}$=2.250, sd=.5880). When the effect size of this difference was evaluated, a small effect size (η2=0.043) was observed.

A one-way ANOVA test was carried out to see whether the digital competence levels of the students varied considerably regarding the technology usage competence variable. The results of the one-way ANOVA test are shown in Table 4.

Table 4. Differentiation of students' digital competence levels according to technology use competence variable

Subscale/ Scale	Variables	N	$\bar{X}$	sd	df	F	p	Difference
Digital Content Development	Basic Level	46	2.009	.4474	302	33.505	.000*	Advanced Level > Intermediate Level, Advanced Level > Basic Level
	Intermediate Level	155	2.115	.5357				
	Advanced Level	102	2.640	.6291				
Information and Data Literacy	Basic Level	46	2.650	.5608	302	38.618	.000*	Advanced Level > Intermediate Level, Advanced Level > Basic Level
	Intermediate Level	155	2.840	.5738				
	Advanced Level	102	3.388	.5629				
Contact	Basic Level	46	2.891	.6168	302	8.257	.000*	Advanced Level > Intermediate Level, Advanced Level > Basic Level
	Intermediate Level	155	3.094	.6598				
	Advanced Level	102	3.336	.6658				
Using Virtual Tools and Social	Basic Level	46	2.331	.5987	302	4.254	.015*	Advanced Level > Intermediate Level, Advanced Level > Basic Level
	Intermediate Level	155	2.509	.5837				

Communication	Advanced Level	102	2.649	.6958				
Problem Solving in a Virtual Environment	Basic Level	46	2.637	.7091				Advanced Level > Intermediate Level, Advanced Level > Basic Level
	Intermediate Level	155	2.907	.6769	302	28.214	.000*	
	Advanced Level	102	3.434	.6696				
Total	Basic Level	46	2.431	.4504				Advanced Level > Intermediate Level, Advanced Level > Basic Level,
	Intermediate Level	155	2.603	.4315	302	42.394	.000*	
	Advanced Level	102	3.053	.4813				Intermediate Level > Basic Level

The results of the analysis given in Table 4 demonstrate that there is a significant difference ($F_{(2,302)}$= [42.394], $p<0.05$) between the digital competence levels of the students and the technology usage competence variable. The findings indicate that the digital competence levels of students with advanced level of technology use competence (X̄=3.053, sd=.4813) are higher than the other students. It has been observed that this significant difference has a large effect ($\eta2=0.220$). In this context, as students' technology use competence increases, their digital competence levels also rise. Likewise, significant differences were also reported in other sub-dimensions of the scale. Bonferroni test was run to analyze these differences. Based on the results of the test, advanced (X̄=2.640, sd=.6291) students with advanced technology use competence had higher levels of digital content development than intermediate (X̄=2.115, sd=.5357) and basic (X̄=2.009, sd=.4474) students. This significant difference was characterized by a strong effect size ($\eta2=0.182$). Furthermore, it was concluded that students who could use technology at advanced level (X̄=3.388, sd=.5629) had higher levels of information and data literacy than students who used technology at intermediate level (X̄=2.840, sd=.5738) and basic level (X̄=2.650, sd=.5608), which indicates a significant effect magnitude of $\eta2=0.182$. Another important difference was found in the communication sub-dimension. In this respect, it was found that students with advanced technology use competence (X̄=3.336, sd=.6658) had higher communication levels than students who used technology at intermediate level (X̄=3.094, sd=.6598) and basic level (X̄=2.891, sd=.6168). This emerging difference was reported to have a small effect ($\eta2=0.052$). In this regard, it can be said that as technology use competence increases, the level of communication also increases. Another significant differentiation is observed in the sub-dimension of using virtual tools and social communication. Based on this, it was concluded that as the students' technology use competence increased, their ability to use virtual tools and social communication level also increased, which indicated a small effect ($\eta2=0.027$). One more significant difference obtained with the result of the test is in the sub-dimension of problem-solving in a virtual environment. Based on this, it was determined that students who could use technology at an advanced level (X̄=3.434, sd=.6696) had higher levels of problem-solving in a virtual environment compared to other students. From this point of view, it was observed that as the ability to use technology rose, the level of problem-solving in a virtual environment also rose. Considering the effect magnitude of this significant difference, it is seen that this value is $\eta2=0.158$ and therefore has a large influence.

It was desired to see whether there was a significant difference between the students' digital competence levels and the average daily usage time of technological devices, and a one-way ANOVA test was carried out in this sense. Information about the test results is provided in Table 5.

Table 5. Differentiation of students' digital competence levels according to the average daily duration of use of technological devices

Subscale/ Scale	Variables	N	X̄	sd	df	F	p	Difference
Digital Content Development	Between 0-3 hours	26	2.085	.6720				7 and more hours> Between 0-3 hours, 7 and more hours> Between 3-5 hours, 7 and more hours> Between 0-3 hours
	Between 3-5 hours	69	2.157	.6042				
	Between 5-7 hours	93	2.179	.5290	302	6.565	.000*	
	7 and more hours	115	2.468	.6288				
Information and Data Analysis	Between 0-3 hours	26	2.930	.5760				7 and more hours> Between 5-7 hours
	Between 3-5 hours	69	2.972	.6599				
	Between 5-7 hours	93	2.879	.6252	302	2.648	.049*	
	7 and more hours	115	3.119	.6267				
Contact	Between 0-3 hours	26	3.153	.6270				-
	Between 3-5 hours	69	3.202	.6082				
	Between 5-7 hours	93	3.003	.7605	302	2.091	.101	
	7 and more hours	115	3.223	.6286				
Using Virtual Tools and Social Communication	Between 0-3 hours	26	2.480	.6477				-
	Between 3-5 hours	69	2.539	.6042				
	Between 5-7 hours	93	2.502	.6680	302	.182	.909	
	7 and more hours	115	2.556	.6230				
Problem Solving in a	Between 0-3 hours	26	2.961	.6688	302	1.524	.208	-

Virtual Environment	Between 3-5 hours	69	3.009	.7604				
	Between 5-7 hours	93	2.953	.7495				
	7 and more hours	115	3.156	.7245				
	Between 0-3 hours	26	2:632	.4628				
Total	Between 3-5 hours	69	2.687	.5017	302	4.046	.008*	7 and more hours > Between 5-7 hours
	Between 5-7 hours	93	2.630	.4912				
	7 and more hours	115	2.854	.5194				

According to the results of the analysis presented in Table 5, there is a statistically significant differentiation ($F_{(2,302)}$= [4.046], $p<0.05$) between students' digital competence levels and the average daily usage time of technological devices. When the sub-dimensions of the scale were studied, it was noticed that there was a similar differentiation in the sub-dimensions of digital content development and information and data literacy. Bonferroni multiple comparison test was done to find out the source of the significant differences found in the total and sub-dimensions of the digital competence scale. The results of the test revealed that students who use technological devices for an average of 7 or more hours a day ($\bar{X}$=2.854, sd=.5194) had higher levels of digital competence than students who use them for 5-7 hours ($\bar{X}$=2.630, sd=.4912), which corresponds to a small effect magnitude ($\eta 2$=0.039) for this significant difference. Furthermore, these results show that there is no meaningful differentiation before the 5th hour. A further differentiation was noted in the sub-dimension of digital content development. Thus, as the average daily usage time of technological devices gradually increased, it was observed that students' digital content development levels also increased. However, the effect size of this significant difference was found to be moderate ($\eta 2$=0.061). Moreover, another significant difference was found in the information and data literacy sub-dimension. According to this, students who use technological devices more than 7 hours a day on average had higher levels of information and data literacy than students who use these devices between 5 and 7 hours a day, which indicates a small effect size ($\eta 2$=0.066). This finding shows that there is no significant difference in the information and data literacy levels of students who use technological devices less than 5 hours a day on average.

CONCLUSION AND DISCUSSION

Within the scope of this study, the digital competence levels of students studying in distance education non-thesis master's degree programs were investigated in terms of a range of variables. Numerous findings were identified with the research and these findings are reported below respectively.

As gender and age variables are the most frequently examined variables in studies conducted to measure digital competencies (Lucas et al., 2021), this study primarily examined whether students' digital competency levels differ according to gender and age variables. Examining the findings obtained for the gender variable, it has been concluded that the digital competence levels of the students differ substantially depending on the gender variable. Hence, the digital competence levels of male students were reported to be higher than those of female students. However, this significant difference was observed to possess a small effect magnitude. The finding that male students have higher proficiency levels than female students is similar to the findings of Prabhu et al. (2022), Çebi and Reisoğlu (2020), Kaya (2020), Cabezas-Gonzalez et al. (2017), Yazar and Keskin (2016), and Yaman et al. (2013). Prabhu et al. (2022) conducted a research to investigate whether the digital competency levels of 315 undergraduate and 44 graduate students studying at a private university in India differ by gender. According to the results of their research, it was concluded that there was no distinction between female and male students in terms of information literacy, communication, and content creation competency levels, and male students had higher levels of competencies than female students in terms of solving technical problems, determining needs and technological responses, and innovating by using technology creatively. Cabezas-Gonzalez et al. (2017) conducted a study to find out the digital competence levels of university students studying at the Faculty of Psychology and Educational Sciences of the University of Porto and concluded that male students had higher digital competence than female students. The findings that male students have higher proficiency levels than female students are in contrast with the findings of Karakuş (2022), Galindo-Domínguez and Bezanilla (2021), and Kuzminska et al. (2018). Galindo-Domínguez and Bezanilla (2021), as a result of their research conducted to determine the digital competencies of 79 pre-service teachers studying at the public university in the Basque Country of Spain and 121 pre-service teachers studying at the private Deusto University, showed that there was no statistically notable difference in the digital competencies of pre-service teachers concerning gender variable. Kuzminska et al. (2018), conducted a study to identify the level of digital competencies of 193 university students studying at the National University of Life and Environmental Sciences of Ukraine, National Aviation University of Ukraine, and Boris Grinchenko Kyiv University, and concluded that there was no meaningful disparity between the level of digital competencies of male and female students. Although the digital competence levels of male students are significantly higher than the digital competence levels of female students, the fact that this significant difference has a small effect size does not mean that male students use digital technologies more effectively than female students. Taking into consideration that the students participating in the study received their postgraduate education in distance education environments where digital technologies are used intensively, since all students are expected to have high levels of digital competence, it is necessary to develop educational policies to overcome gender inequality among students by increasing the awareness of female students towards the use of digital technologies and enhancing their digital competencies.

Looking at the findings obtained according to the age variable of the students, it has been concluded that the specified variable shows a meaningful change in the digital competence levels of the students participating in the study. Based on this, students between the ages of 18-25 had a higher level of digital competence than students between the ages of 42-49. It was determined that this noteworthy difference between the students had a low-level effect magnitude. Results of the study showed that students' digital competence levels increased with decrease in age, which contradicts the findings of Galindo-Domínguez and Bezanilla (2021), Guillén-Gámez et al. (2020), Kaya (2020), Kuzminska et al. (2018) and Cabezas-Gonzalez et al. (2017). Guillén-Gámez et al. (2020), as a result of their research conducted to determine the digital competencies of 108 pre-service teachers studying at the Pontifical University of Salamanca, stated that there was no statistically meaningful change in students' digital competencies based on the age variable. Galindo-Domínguez and Bezanilla (2021), Kuzminska et al. (2018), and Cabezas-Gonzalez et al. (2017) reported that there was no statistically considerable discrepancy between students' digital competence levels based on age. Despite having a small effect on the age levels of the students participating in the study, a considerable variance is a finding that needs to be taken into account. Given that in other studies conducted in the literature, while the age range among university students is close to each other in this study, the age difference of the students who received postgraduate education is higher, and as a result of the research, students in the higher age group have lower digital competencies. It is necessary to develop educational policies to eliminate the age inequality among students by increasing the awareness of students in the higher age group who have previously received their undergraduate education face-to-face for the use of digital technologies and improving their digital competencies.

It has been stated that there is a statistically meaningful differentiation between the digital competence levels of the students and the variable of technology usage competence. In this regard, it has been noted that as the students' competence in using technology rises, their level of digital competence also rises. To determine the effect degree of this significant difference, eta square ($\eta2$) values were calculated and it was determined that there was a large effect size ($\eta2=0.220$) between these two variables. These results also indicate that there is a positive correlation between the two variables. A similar differentiation was encountered in the sub-dimensions of the scale. To ascertain the source of this difference, a multiple comparison test was applied. Based on the results of the test, students who use technology at an advanced level produce more digital content than students who use technology at an intermediate and basic level, which refers to a significant difference with a high level of effect magnitude ($\eta2=0.182$). Furthermore, another significant difference was found in the information and data literacy sub-dimension. Hence, students who can use technological devices at an advanced level have higher levels of information and data literacy than students who can use technological devices at an intermediate or basic level. This significant difference was identified to have a significant effect ($\eta2=0.204$). Another significant difference was detected in the communication sub-dimension. Accordingly, students with high technology use competence were also characterized as having high levels of communication, which indicates a difference with a low-level effect ($\eta2=0.052$). A similar difference was observed in the sub-dimension of using virtual tools and social communication. This means that as proficiency in using technology improves, the students' ability to use virtual tools and social communication levels also increase. This meaningful variance was found to have a value of $\eta2=0.027$ and thus a small effect size. Moreover, another significant difference captured by the analysis was found in the sub-dimension of problem-solving in the virtual environment. This indicates that students with high technology use competence also have high problem-solving ability in virtual environments. This emerging difference was found to have a substantial effect ($\eta2=0.158$). Research findings that there is a notable positive correlation between students' digital competence levels and technology use competence levels are similar to the findings of Kaya (2020). Kaya (2020), as a result of his research, which aimed to investigate the association between technology integration self-efficacy perceptions and digital competence levels of 681 students studying at Balıkesir University, shared the results that there was a positive and significant relationship between students' technology integration self-efficacy perceptions and digital competence levels, there was a positive and significant relationship between students' self-efficacy levels in using computer technologies and digital competence levels, and students' self-efficacy perceptions towards technology integration significantly predict their digital competence levels.

Another question that the research seeks to answer is whether students' digital competence levels differ significantly in terms of the average daily usage time of technological devices. The results showed that students who used technological devices for 7 hours or more on average per day had higher levels of digital competence than students who used technological devices for 5-7 hours per day on average. According to these findings, there is no homogeneous differentiation before the 5th hour. This implies that there will not be any change in the digital competence levels of students who use technological devices less than 5 hours a day. This meaningful difference was observed to have a low effect size ($\eta2=0.039$). When the sub-dimensions are analyzed, it is seen that significant differences occur in digital content development and information and data literacy sub-dimensions. In this respect, as the average daily use of technological devices rises, students' level of content development in digital environments also increases. Calculating the effect size of this significant difference, it is seen that there is a moderate effect ($\eta2=0.061$). Another sub-dimension in which a significant difference was recorded was the information and data literacy sub-dimension. Thus, there was no homogeneous differentiation in the information and data literacy levels of students who use technological devices less than 5 hours a day. These results inform us that information and data literacy levels start to increase after the 5th hour. This is one of the results of the study that creates a difference, and this significant difference is considered to have a small effect ($\eta2=0.025$). According to the results of the study, the finding that students' digital competence levels increase as the average daily usage time of technological devices increases is consistent with the findings of Martinez-Lopez et

al. (2020), Hernández-Martín et al. (2021), and Korucu et al. (2016). Martinez-Lopez et al. (2020), as a result of their research with 205 students studying at various state universities in Russia, found that there was a strong positive correlation between students' internet usage time and their digital competence levels. Hernández-Martín et al. (2021) concluded that students who used social networks daily had better digital competence levels than those who used social networks only three or four times a week. Korucu et al. (2016) detected that as students' mobile device ownership and weekly internet usage time increased, their digital competence also increased. In distance education environments, it is essential to prepare more activities to increase the average daily usage time of students' technological devices, to organize synchronous meetings and asynchronous forum activities, and to develop educational policies to ensure that the time spent by students in the distance education environment and their completion rates are taken into account in measurement and evaluation processes.

LIMITATIONS AND RECOMMENDATIONS

This research has some limitations. This research, which was conducted to measure the digital competence levels of learners studying in distance education non-thesis master's programmes in terms of different variables, is limited to non-thesis master's students studying at Anadolu University Institute of Social Sciences and the scale used in the research.

As a result of this research conducted within the limitations mentioned above, some suggestions were made for future scientific research. These suggestions are as follows:

1. The fact that the digital competence levels of male students participating in the study are higher than female students is a finding that should be taken into consideration by policy makers. Therefore, it is recommended to develop new educational policies that will increase the digital competence levels of female students.

2. The significant difference between the age levels of the students participating in the study is a finding that should be taken into consideration. Therefore, it is suggested that various seminars should be organized to increase the awareness levels of students in the older age group regarding the use of digital technologies.

3. Considering the finding that there is a significant relationship between students' digital competency levels and technology usage competency levels, in order to increase students' technology usage competencies, they can be provided free access to some programs by collaborating with international organizations such as Apple, Cisco, Google, Microsoft.

Declaration of Conflicting Interests

On behalf of all authors, the corresponding author declares that there is no conflict of interest in this research.

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Statements of publication ethics

This research was conducted following the approval of the Scientific Research and Publication Ethics Board of Social Sciences and Humanities of T.R. Anadolu University dated 22.11.2022 and numbered 442539. The consent to use the scale, which was required for the start of the data collection process, was obtained from the relevant researchers via e-mail.

### Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

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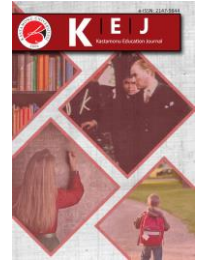
| Research Article / Araştırma Makalesi|

Investigating Syntactic and Morphological Differences in the Written Productions of Turkish Learners Based on the Learning Context

Türkçe Öğrenenlerin Yazılı Üretimlerindeki Sözdizimsel ve Morfolojik Farklılıkların

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Abstract

Purpose: The aim of this study is to investigate the potential impact of the learning context on learners' written production. Comparing the syntactic and morphological errors, the study tries to find out whether there are differences between written language productions of learners learning Turkish in Turkey and the ones outside the target community.

Design/Methodology/Approach: Following descriptive research method, the study adopted qualitative design through systematic content analysis to analyse the data gathered from 78 learners of Turkish at A2 proficiency level, in Turkey (N=42) and outside of Turkey (N=36). The statistical analyses were then carried out to identify the ratios and the categorical distributions of errors determined through error analysis.

Findings: The results reveal that learning a language in the target context impacts writing performances significantly at syntactic and morphological level. Based on the findings, instructional implications are provided to enhance effective language input.

Highlights: Writing, an important and functional skill in multiple domains, is one of the most challenging skills to master and requires receive sufficient and meaningful authentic language input. As Turkish possesses distinct characteristics compared to Germanic or Semitic Languages, learners of Turkish have additional challenges at language production level. Learners of Turkish display significant differences in the types of syntactic and morphological errors in their writing depending on their learning contexts. The learning context has impacts on the writing productions of learners. The results suggest that educators and program developers in the field of Turkish Language teaching need to consider the role of the context in learning a foreign language while incorporating the special linguistic characteristics of Turkish in designing their teaching programs, materials and lessons*.

Öz

Çalışmanın amacı: Bu çalışma, öğrenme ortamının öğrencilerin yazılı üretimi üzerindeki potansiyel etkisini araştırmayı amaçlamaktadır. Çalışma, sözdizimsel ve morfolojik hataları karşılaştırarak, Türkiye'de Türkçe öğrenenlerin yazılı dil üretimleri ile Türkiye dışındaki bir ülkede öğrenenler arasında farklılıklar olup olmadığını ortaya koymaya çalışmaktadır.

Materyal ve Yöntem: Araştırmada, betimsel araştırma yöntemi benimsenerek, Türkiye'de (N=42) ve Türkiye dışında (N=36) A2 yeterlik düzeyindeki 78 Türkçe öğrencisinden toplanan verilerin analizi için sistematik içerik analizi yoluyla nitel tasarım benimsenmiştir. Daha sonra hata analizi ile belirlenen hataların oranlarını ve kategorik dağılımlarını belirlemek için istatistiksel analizler yapılmıştır.

Bulgular: Sonuçlar, bir dili hedef bağlamda öğrenmenin sözdizimsel ve morfolojik düzeyde yazma performanslarını önemli ölçüde etkilediğini ortaya koymaktadır. Bulgulara dayanarak, etkili dil girdisini geliştirmek için öğretimsel sonuçlar sağlanmıştır.

Önemli Vurgular: Birçok alanda önemli ve işlevsel bir beceri olan yazma, ustalaşılması en zor becerilerden biridir ve yeterli ve anlamlı otantik dil girdisi almayı gerektirir. Türkçe, Germen veya Sami dillerine kıyasla farklı özelliklere sahip olduğundan, Türkçe öğrenenler dil üretimi düzeyinde ek zorluklarla karşılaşırlar. Türkçe öğrenenler, Türkçe'yi nerede öğrendiklerine bağlı olarak yazılarındaki sözdizimsel ve morfolojik hata türlerinde önemli farklılıklar gösterirler. Öğrenme ortamınınöğrencilerin yazma üretimleri üzerinde etkileri vardır. Sonuçlar, Türkçe öğretimi alanındaki eğitimcilerin ve program geliştiricilerin, öğretim programlarını, materyallerini ve derslerini tasarlarken Türkçenin özel dilbilimsel özelliklerini dahil ederken, yabancı bir dil öğrenmede ortamın rolünü göz önünde bulundurmaları gerektiğini göstermektedir.

INTRODUCTION

There has been an upward trend in teaching Turkish as a foreign language in recent years (Akcaoğlu, 2018; Arslanyılmaz, 2013; Atak & Çetin, 2016; Ekmekçi, 2016; Kara, 2010). As the seventh most frequently spoken language in the world, it has been reported that there is also a growing demand for non- Turkish citizens to learn Turkish (Balibey, 2010). Although Turkish is spoken mainly by the Turks in Europe, the fact that the Turkish channels are being watched in many countries in the world enables Turks to maintain their Turkish and is an important factor that also encourages non-Turkish citizens to learn Turkish. Today, Turkish is taught by various public and private institutions, Turcology Centers, and at Turkish Teaching Schools (TTS) at universities in Turkey. Among these institutions, Yunus Emre Institution has over 2,000 Turkish Cultural centers around the globe and is one of the leading institutions that provides pedagogical guidelines, teaching, and evaluation resources for teaching Turkish as a foreign language (Boylu, 2014).

However, research in the field has frequently reported the significant lack of teaching resources in general such as up-to-date and diversified teaching materials, pedagogical guidelines, online resources, or supporting resources for evaluation and assessment (Altınkamış & Ağırdağ, 2014; Cerci, Derman & Bardakçı, 2016; Göçer, Tabak & Coşkun, 2012; Kara, 2010) as well as the paucity of empirical research in this area that could provide pedagogical implications. In addition, considering that Turkish possesses distinct characteristics compared to Germanic or Semitic Languages, learners of Turkish have been reported to have different challenges at production level, particularly in their writing performances (Genç, 2017; Kara, 2010; Sonkaya, 2019). The present study, in this respect, aims to explore learners' errors in terms of syntax and morphology. In particular, it aims to investigate the potential impact of the learning context on the writing performances of the learners in Turkey (LITR) who could obtain authentic language input outside the educational contexts in their daily lives and in a non-Turkish context (LOOTR) who are to a large extent limited to the language input within the educational contexts. The specific research questions of the study are as follows:

1. What are the most common errors of learners of Turkish in their writing performances?

2. Do the common syntactic and morphological errors of learners differ depending on the context of learning, in Turkey and out of Turkey?

Main Features of Turkish Language

In terms of source, the main language families in the world are: a) Ural-Altaic Language Family (e.g., Hungarian, Finnish, Turkish, Japanese); b) Indo-European (Indo-Germanic) Language Family (e.g., Greek, Armenian, English, German, Russian, Bulgarian, French, Spanish, Persian, Hindi, Latvian); c) Sino-Tibetan Language Family (e.g., Chinese (Mandarin), Vietnamese, Cantonese, Tibetan, Burmese, Thai); d) Hami-Semitic Language Family (e.g., Arabic, Hebrew, Abyssinian, Syriac, Akkadian); and e) Bantu Language Family (e.g., African languages) (Ercilasun, 2013).

Typologically, on the other hand, world languages are divided into three: a) Monosyllabic (isolating / analytic) languages; b) Agglutinating languages; c) Inflectional / fusional languages (Ercilasun, 2013; Özkan & Musa, 2004). Monosyllabic languages do not have inflectional suffixes. Sentences are made up of single syllable words. The meaning is expressed according to the place of the words in the sentence or their relation to each other. The meaning at the articulation level is revealed by the intonation of words and their combination with each other. The most important representative of this group is Chinese. Tibetan, Burmese, Thai, Vietnamese, some African languages, and Basque in Europe are monosyllabic languages (Ercilasun, 2013). In inflected languages, the root of the word is changed with the reproach called ablaut (internal change), or inflection occurs with the vowel change. For example, sing-sang-sung verb conjugation in English or ketaba (wrote), kutibe (written), kitab (book) in Arabic, which can be regarded as the most typical example of inflected languages. Indo-European languages (English, German, French, Persian, Hindi) are also included in this group. As for agglutinative languages, the affixes that are added to the words determine the meaning. They can be added to the beginning (prefix), to the end (suffix), or to the middle (infix) of words. The best example for this group is Turkish along with some other Altaic languages (Mongolian, Manchu-Tungus, Japanese), Uralic languages (Finnish, Hungarian, Samoyed) and some African languages.

Turkish, which belongs to the Altay branch of the Ural-Altaic linguistic family, possesses different linguistic characteristics when compared to the languages spoken in Europe or Asia from other language families. (Barın, 2004; Ercilasun, 2013). Syntactically, among the six different sentence structures in the world languages (i.e., SVO, SOV, VSO, VOS, OVS, OSV), Turkish has the form of SOV, that is, subject-object-verb (Ercilasun 2013). Also, the order of clauses in complex sentences in Turkish is fixed, which is head-final (Özgen & Koşaner, 2020). That is, while the order of dependent and independent clauses may change in some languages, the dependent clause is always at the beginning and the main clause is placed at the end in Turkish (Karaağaç, 2009). Another distinctive feature of Turkish syntax is in the structure of the phrases. While the head of the phrase is at the beginning in Indo-European and Semitic languages (e.g., the man who opened the bottle), Turkish has head-final parameter (e.g., şişeyi açan adam [*opened the bottle who the man*]).

Morphologically, Turkish is an agglutinative language, which uses affixes to form morphological structures, specifically suffixes (post-positional). Thus, Turkish word forms have a mathematical structure. In this mathematical system, the root of the word remains constant in all cases, and the inflectional and/or derivational suffixes can be easily distinguished from the root

(Arslanoğlu, 2016). The affixes in Turkish may indicate either the grammatical function of the word or be used to create new words or both. Almost all the grammatical functions embedded in a word in relation to the sentence that it is used in are signalled by affixes: person, tense, case, interrogation, copula 'be', plurality, etc (Göksel & Kerslake, 2000; Yavuz, Balcı & Turan, 2000). The extensive use of affixes can easily yield to extremely long words, e.g., Bayramlaşamadıklarımız (Lewis,2001, p.287) [*Those with whom we could not exchange greetings for the bairam* (*religious fest*)].

Furthermore, some phonological characteristics of Turkish language are reflected in its morphological structure. Although Turkish is a phonetic language (i.e., each sound is represented with a single letter; and thus, they are written as they are read), it also has strict phonetic harmony rules. For example, the use of suffixes must follow vowel and consonant harmony rules in Turkish (For more detailed information, check https://www.tdk.gov.tr/icerik/yazim-kurallari/buyuk-unlu-uyumu/). These rules require specific changes in the letters of the suffixes or of the root (e.g., kitap-lar [book-s] but ev-ler [house-s]). There are also some special letters in the Turkish alphabet (ç,ş,ğ,ı,ö,ü) that are not found in other languages, which usually have very high frequencies in the spelling errors of learners of Turkish.

METHOD

The study adopted descriptive research method and followed qualitative design through systematic content analysis to analyse the data gathered from the participant learners of Turkish. As content analysis allows researchers to analyse the data qualitatively as well as to quantify the data (Sandelowski, 2010; Vaismoradi, Turunen, & Bondas, 2013), the statistical analyses were carried out to identify the ratios and the categorical distributions of errors determined through error analysis.

Participants

The data for the study was gathered from 78 learners of Turkish. Among these, 42 (% 53.8) of the learners were learning Turkish in four different cities in Turkey (namely, Amasya, Bilecik, and Balıkesir). While 27 (64.2 %) of the LITR group were comprised of female learners, 15 (35.7 %) of them were males. As for the learners who were learning Turkish out of Turkey, the number was 36 (46.1 %). Residing in four different countries (i.e., Belgium, England, France, and Germany), the LOOTR group of Turkish learners consisted of 27 (75 %) females and 9 (25 %) male learners. The age of the learners in both groups varied between 17 and 28. All learners were at A2 Turkish proficiency level at the time of the study.

DATA ANALYSIS AND FINDINGS

The data gathered for the study was descriptively analysed following systematic content analysis method, which is broadly defined as "a complied scientific method where written materials are analysed systematically, and then, grouped based on specific criteria in order to make information obtained available and finally, to provide a ground for future research" (Dinçer, 2018, p.177). Accordingly, the writing performances of the participant learners were first read by the two researchers for systematic coding. The analysis process followed these specific steps: First, all the paragraphs were read separately by the two researchers to identify a) the quantity of the total words used; b) the quantity of the errors made. Secondly, the paragraphs were analysed separately by the two researchers in order to determine error types and quantities. Third, the categories of error types found in the participant learners' performances were set by the two researchers. And finally, the emerging error categories and their frequencies were crosschecked. The results of the analyses by the two researchers were compared for consistency until consensus was reached.

Table 1. Overview of the Sentences Used in the Participant Learners' Writings*

	Sentences by LITR Group		Sentences by LOOTR Group		Total	
	F	%	F	%	F	%
Sentences without any errors	337	42.2	324	42.8	661	100
Sentences with errors**	461	57.7	432	57.1	893	100
Total	798	100	756	100	1554	100

*The number of the sentences were determined based on a) punctuation markers such as full stop, question mark, etc; b) capitalization used for the first letter of the first word. The phrases or word groups that did not have any clear indication were excluded from the sentence count.
**The sentences that had a minimum one error were counted in this group.

As Table 1 shows, the number of sentences used in the paragraphs of the learners in Turkey is higher than the number for the learners out of Turkey (M=798 and 756, respectively). Similarly, the number of the total word count for the learners in Turkey (M=4368 words) was also higher than the word count of the writings from out of Turkey (M= 4032). As for the rates for the total errors, it can be seen that both groups displayed almost the same percentages (57.7 % and 57.1 %, respectively). Table 2 displays the results for the main categories of the errors identified in both groups.

Table 2. The Results for the Main Categories of the Errors for Both Groups

	LITR Group		LOOTR Group		Total	
	F	%	F	%	F	%
Syntax Errors	58	12.5	71	16.4	129	14.4
Morphological Errors	150	32.5	227	52.5	377	42.2
Spelling Errors	253	54.8	134	31	387	43.3
Total	461	100	432	100	893	100

When the total numbers of errors based on the main categories are analysed, it is found that the highest frequency of errors for both groups belong to spelling (43.3 %), which is followed by morphological errors (42.2 %). Errors of syntax were found to have the lowest rates for both groups (12.5 % and 16.4 %, respectively). However, when each group is considered separately, the results indicate that the highest rate for learners in Turkey is spelling errors (54.8 %) whereas the learners out of Turkey has the highest rate for morphological errors (52.5 %). Table 3 presents more detailed information on the syntax errors by both groups.

Table 3. The Types of the Syntactic Errors by Learners

	LITR Group		LOOTR Group		Total	
	F	%	F	%	F	%
Sentence Word Order: Simple sentences	31	53.4	71	100	102	79
Sentence Word Order: Compound & Complex sentences	15	25.8	-	-	15	11.6
Noun & Adjective Compounds	12	20.6	-	-	12	9.3
Total	58	100	71	100	129	100

The results for syntactic errors indicate that the most frequent error type was related to the word order in simple sentences for both groups (79 %). However, it is interesting to find out that all the syntax errors made by the LOOTR group were word order errors in simple sentences while LITR group also had word order errors in their complex and compound sentences and in their noun or adjective compounds (25.8 % and 20.6 %, respectively), though less frequent. The reason for this finding is that there were much fewer compound and complex sentences in the writing performances of LOOTR group. They also used noun and adjective compounds much less frequently when compared to LITR group. The following excerpts exemplify erroneous word order use by both groups:

Table 4. Samples of erroneous use of word order in simple sentences

	LITR	LOOTR
Excerpts	Ben düşünüyorum Turk vatandaş olmak	Bazen basketbol oynuyorum arkadaşim ile.
Corrected Version	Ben Türk vatandaşı olmayı düşünüyorum. [*I am thinking of becoming Turkish citizen.]*	Bazen arkadaşım ile basketbol oynuyorum. [*I sometimes play basketball with my friend*.]
Excerpts	Hafta sonlari futbol ve basketbol arkadaşımla oynuyorum.	Koşuyorum parkta her sabah.
Corrected Version	Hafta sonları arkadaşımla futbol ve basketbol oynuyorum. [*I play football and basketball with my friends at the weekends*.]	(Ben) parkta her sabah koşuyorum. [*I run in the park every morning*.]
Excerpts	Ama ben çok özlüyorum senin yemekler.	Dinliyoruz Türk muzik her zaman.
Corrected Version	Ama ben yemeklerini çok özlüyorum. [*But I miss your food a lot.*]	(Biz) Her zaman Türk müziği.dinliyoruz. [*We always listen to Turkish music*.]

Table 5. Samples of erroneous use of word order in compound and complex sentences

	LITR
Excerpt	Sonra yatağa gidiyorum için sabah erken kalkacağım.
Corrected Version	Sonra sabah erken kalkacağım için yatağa gidiyorum. [*Then I go to bed as I am going to get up early.*]
Excerpt	Ne zaman mevzun olacağım düşünüyorum cünkü istiyorum işe başlamak hemen.
Corrected Version	Ne zaman mezun olacağım diye düşünüyorum çünkü hemen işe başlamak istiyorum. [*I think about when I will graduate because I want to start work as soon as possible.*]

LITR	
Excerpt	Haftasonu arkadaşlarımla muzeye giderim için iyi vakit geçirmek.
Corrected Version	Haftasonu iyi vakit geçirmek için arkadaşlarımla müzeye giderim. [*I go to the museum with my friends at the weekends to have nice time.*]

Table 6. Samples of erroneous use of word order in noun and adjective compounds

LITR	
Excerpt	Bu bir Türkiye'deki güzel yemekler.
Corrected Version	Bu, Türkiye'deki güzel yemeklerden biri. [*This is one of the delicious meals in Turkey.*]
Excerpt	Onlar farklı bir güzel insanlar.
Corrected Version	Onlar farklı güzel insanlar. [*They are different nice people.*]
Excerpt	Sınıfta öğrenciler ülken Africada.
Corrected Version	Sınıftaki öğrencilerin ülkesi Afrika. [*The country of the students in the classroom is Africa.*]

Table 7 presents more detailed information on the morphology errors by both groups.

Table 7. The types of the Morphological Errors by two groups of learners

	LITR Group		LOOTR Group		Total	
	F	%	F	%	F	%
Case Markers in Nouns	89	59.3	108	47.5	197	52.2
Subject-Verb Agreement (Person Marker)	22	14.6	53	23.3	75	19.8
Possessives	20	13.3	31	13.6	51	13.5
Plurality in Nouns	19	12.6	-	-	19	5
Interrogation	-	-	24	10.5	24	6.3
Negation	-	-	11	4.8	11	2.9
Total	150	100	227	100	377	100

Considering morphological errors, the results reveal that errors related to case markers had the highest frequencies for both groups (59.3 % for LITR and 47.5 % for LOOTR). For LITR group, the second highest rate belongs to errors in the use of person markers in predicates (14.6 %), which was followed by the errors in the use of possessives and plurality in nouns (13.3 % and 12.6 %, respectively). There were no errors in the use of suffixes for interrogation or negation for LITR group. As for LOOTR group, the second highest rate of errors were also found in the use of person markers in predicates (23.3 %), though slightly higher than that of LITR group's, and in the use of suffixes for possessives (13.6 %). Different from LITR group, LOOTR groups' writing texts displayed errors in the use of suffixes for interrogation and negation (10.5 % and 4.8 %, respectively). Yet, there were no errors found in the use of plurality markers for LOOTR group.

Table 8. Samples of erroneous use of case markers

	LITR	LOOTR
Excerpts	Neyi inanıyorsun?	Babam çok seviyorum.
Corrected Version	Neye inanıyorsun? [*What do you believe in?]*	Babamı çok seviyorum. [*I like my father very much*.]
Excerpts	Senin ellerinde öpüyorum.	Sınıf çiçek ve bitki yok.
Corrected Version	Senin ellerinden öpüyorum. [*I kiss your hands.]*	Sınıfta çiçek ve bitki yok. [*There are no flowers or plants in the classroom*.]
Excerpts	Ben Balıkesir'e çok seviyorum.	Okula kapalı Cumartesi.
Corrected Version	Ben Balıkesir'i çok seviyorum. [*I like Balıkesir very much*.]	Okul Cumartesi günü(günleri) kapalı. [*The school is closed on Saturday(s)*.]
Excerpts	Benim Samsun gideceğim.	Öğretmen konuşanları kızıyor.
Corrected Version	Ben Samsun'a gideceğim. [*I will go to Samsun*.]	Öğretmen konuşanlara kızıyor. [*The teacher gets angry with students who make noise in (disrupt) the lesson*.]

Table 9. Samples of erroneous use of person markers

	LITR	LOOTR
Excerpts	Ben biraz iyi.	Ben burada çok üzgün.
Corrected Version	Ben biraz (daha) iyiyim. [I am fine (better) here.]	Ben burada çok üzgünüm. [*I am very sad here.*]
Excerpts	Siz biraz kendini anlat.	Sen sınıfta mi?
Corrected Version	Sen biraz kendini anlat. [*Talk about yourself a little*.]	Sen sınıfta mısın? [*Are you in the class?*]
Excerpts	Ama biz mont aldınız.	Siz araba kullanıyor
Corrected Version	Ama biz mont aldık. [But we bought a coat.]	Siz araba kullanıyorsunuz. [*You are driving a car.*]
Excerpts	Kardeşlerimi çok çok özledim ve çok çok seviyorlar.	Yeni evimizin çok hoşuma gidiyoruz.
Corrected Version	Kardeşlerimi çok çok özledim ve onları çok çok seviyorum. [*I miss my siblings a lot and I love them very very much*.]	Yeni evimiz çok hoşuma gidiyor. [*I like our new apartment a lot.*]

Table 10. Samples of erroneous use of possessive, plurality, interrogation, and negation markers

	LITR	LOOTR
Excerpts for Possessive	Arkadaş isim Samha.	Ben iki çocuku var.
Corrected Version	Arkadaşımın ismi Samha. [*My friend's name is Samha*.]	Benim iki çocuğum var. [*I have two children*.]
Excerpts for Plurality	Dersimlerim biraz zor.	N/A
Corrected Version	Derslerim biraz zor. [*My lessons are a bit hard.*]	
Excerpts for Interrogation	N/A	Türk kahvesi seversin mi?
Corrected Version		Türk kahvesi sever misin? [*Do you like Turkish coffee?*]
Excerpts for Negation	N/A	Hiçbir zaman televizyon izliyorum.
Corrected Version		(Ben) Hiçbir zaman televizyon izlemiyorum. [*I never watch TV.*]

Although erroneous spelling is not within the scope of the present study, it should be briefly reminded that spelling errors constitute the highest rate of errors as well when the two groups are considered collectively (43.3 %). However, these rates comprise different sizes within each group (LITR=54.8 % and LOOTR=31 %). While spelling errors covered over half of the total errors for LITR group, only one-third of the errors were spelling related for LOOTR group. This implies that learners in LITR group made more spelling errors compared to the ones in LOOTR group. Table 11 displays some examples of the most frequent spelling errors made by both groups.

Table 11. Samples of erroneous use of spelling

Error Type	Errors by LITR Group	Errors by LOOTR Group
Excerpts for Vowels	Şihir	ayleme
Corrected Version	Şehir [*city*]	Aileme [*to my family*]
Excerpts for Vowel harmony	Turkiye'daki	… yapacak musun?
Corrected Version	Türkiye'deki [*the one in Turkey*]	… yapacak mısın? [*Will you do/make?*]
Excerpts for Consonants	hakında	anlatım
Corrected Version	Hakkında [*about/ regarding*]	anlattım [*I explained/told*]
Excerpts for Consonant Harmony	Polisden	O …. etiyor.
Corrected Version	Polisten [*from the police*]	O …. ediyor. [… *is doing/making/having*]
Excerpts for Foreign-origin words	Fotbol	Basketboll
Corrected Version	Futbol [*football*]	Basketbol [*basketball*]
Excerpts for Special Letters (ç, ş, ğ, I, ü, ö)	Taşınacayiz	Açik
Corrected Version	Taşınacağız [*We are going to move.*]	Açık [*open*]

Overall, the results indicate that the two groups have similar frequencies for some type of errors while they differ significantly in other error types. Accordingly, the participant learners from both contexts have the highest frequencies in spelling errors. This rate was followed by errors at morphological level and at syntax level, respectively. Nevertheless, a closer analysis of the errors reveals that the groups differ in the frequency of erroneous use in the subcategories. For example, while both groups had similar erroneous use rates for syntax main category, LITR group seem to have more difficulty in terms of sentence structure compared to LOOTR group, who are found to be able to use compound/complex sentences only rarely. Similarly, LITR group performed better than LOOTR group with respect to interrogation and negation markers whereas they had more frequent errors for plurality markers.

CONCLUSION AND RECOMMENDATIONS

The present study has been conducted in order to explore the potential impact of the learning context on the writing productions of learners of Turkish in Turkey, who could obtain authentic language input outside the educational contexts in their daily lives, and on the learners' writing performances learning Turkish in a non-Turkish context, who are to a large extent limited to the language input within the educational contexts. For this purpose, the writing performances of Turkish learners in LITR and LOOTR groups at A2 level were systematically analysed and the data from these groups were compared in terms of erroneous use in terms of syntax and morphology.

Considering the first research question, the results revealed that the groups had similar frequencies in terms of the number of sentences with errors. For both groups, it has been found that spelling errors had the highest rates, though LITR group had higher frequency compared with LOOTR group. Spelling errors among the learners of Turkish has been often reported in previous studies (Büyükikiz & Hasırcı, 2013; Çetinkaya, 2015; Ersoy, 1997; İnan, 2014; Yılmaz, 2015). The groups also had significant error rates in the other main categories, namely syntax and morphology. This finding has also been reported by numerous studies (Bölükbaş, 2011; Boylu, 2014; Çetin, 2022; Çetinkaya, 2015; Sonkaya, 2019).

As for the second research question, the analyses revealed differences in the rate of the errors made by the groups. The writing performances of LITR group revealed relatively lower rates of errors in the use of morphological markers while LOOTR group had lower frequencies in spelling and syntax errors. Regarding the errors at morphological level, both LITR and LOOTR groups had highest rates for errors in the use of case, person, and possessive markers. Previous studies have also pointed out to the high rates of errors in the use of such morphological markers (Çangal & Başar, 2018; Demirci & Dinçaslan, 2016; Emiroğlu, 2014; Sarıca & Od, 2015; Tuncel, 2013; Yıldırım, 2011; Yılmaz & Temiz, 2015). Yet, the two groups had significant differences in the subcategories of the morphological markers. While the learners in Turkey did not have any errors in the use of suffixes for interrogation and for negation, the learners out of Turkey had errors in the use of these markers. On the other hand, regarding plurality use in nouns, LOOTR group, contrary to LITR group, had no errors.

When the errors made at syntax level are considered, the groups showed similar results in terms of word order errors in simple sentences, which was found to be the highest frequent error type for both groups. A similar result has been reported in previous research (Ak Başoğul & Can, 2014; Akçaoğlu, 2018). Based on the high rates of grammar errors among the participant learners, Cetin (2022) emphasizes the need for developing and implementing methods and materials in order to better engage learners in the acquisition of grammatical features of Turkish along with their functions. In the present study, on the other hand, the group LOOTR showed significantly higher percentage of syntax errors in simple sentence word order compared to the group LITR. Although LOOTR group had no errors of word order in compound and complex sentences and in the use of noun and adjective compounds, in contrast with LITR group, this is likely due to restraining from or not trying to use compound/complex sentences as there were only two compound sentences and four noun/adjective compounds used accurately in the writings from LOOTR group.

As an important and functional skill in multiple domains, writing is considered to be one of the most challenging skills for learners to master as they need to receive sufficient and meaningful authentic language input while trying to comply with multiple linguistic features of the target language (McCutchen & Stull, 2015). The results of the present study, in this respect, may provide some implications for assisting learners of Turkish to improve their writing performances. Firstly, although it is necessary to follow the developments and recent pedagogical implications in contemporary methods and approaches in teaching other languages, it is also crucial to tailor them according to the specific conditions of Turkish language classrooms. Educators and program developers in the field of Turkish Language teaching may need to consider special linguistic characteristics of Turkish in designing their teaching programs, materials, and lessons, particularly with respect to syntactic and morphological features of Turkish. The fact that explicit grammar teaching is a highly debated issue and that it is almost completely discredited in contemporary language teaching approaches does not necessarily mean to overlook the operativeness of grammar in language. Whether implicit or explicit instruction of grammar is preferred, learners, particularly adult learners, are capable of acquiring grammatical features and functions through repeated exposures to authentic language input (Krashen, 2008). As communication-based approaches to grammar instruction highlight, grammar could be presented implicitly embedded in learning tasks and activities without necessarily focusing on form isolatedly (Batstone & Ellis, 2009; Nassaji & Fotos, 2011) or creating metalinguistic awareness (Ellis, 2009; Schmidt, 2001). For Spada and Lightbrown (1999), on the other hand, advance learners may even benefit from metalinguistic explanations and awareness of the functions of the grammatical items through their learning process.

Another important implication of the findings of the study is the role of the context in learning a foreign language. The differences found in the common errors in the writing performances of the learners learning Turkish in and out of the target language's context point out to the differing needs of the learners. Learners who learn Turkish in Turkey have better writing performance levels in using compound and complex sentences, noun and adjective compounds as well as interrogation and negation morphological forms. However, they have relatively poorer performance in the use of plurality forms and spelling. As for the learners who learn Turkish in a foreign context, it has been observed that that they are better in using plurality forms and spelling. Nevertheless, they have slightly higher syntax errors and use much fewer compound/complex sentences and noun/adjective compounds in their sentences. They also have more frequent errors in the use of interrogation and negation markers. These findings may suggest that the context of learning (i.e., in or out of the target language's community) should be considered as an important variable when planning and designing language lessons based on learners' needs. As learners in the target community's context have plenty opportunities for daily language input outside of the formal learning environment, they may require more focus on accuracy in spelling, sentence structure and morphological structures. Learners outside the target community, however, may need more opportunities for authentic language input and practice. Research in the field of Turkish language teaching has also frequently reported the lack of integrating daily language use and the need for more opportunities for practice and for adopting communicative teaching methods and techniques (Çetin, 2022; Genç, 2017; Gürler, 2019). Finally, Turkish language, as any other language does, reflects a rich and comprehensive cultural presence within words, expressions, and other language items (Çetin, 2022; Genç, 2017; Uygur, 2005; Yiğit & Arslan, 2014), thus, Turkish cultural elements have to be incorporated to a great extent in the language teaching and learning programs, materials, instructions as well as tasks and activities.

Declaration of Conflicting Interests

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Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully. We also confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

An application was submitted to the Amasya University Social Sciences Ethics Committee regarding the current research, and confirmation received that it was deemed ethically appropriate (decision dated 16/12/2022 and numbered 108.01-107690).

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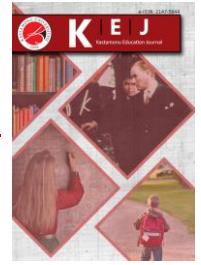
|Research Article/ AraştırmaMakalesi|

Lecturers' Perspectives on English Medium Instruction (EMI): Implications for Professional Development

Öğretim Elemanlarının İngiliz Dilinde Eğitime (İDE) İlişkin Bakış Açıları: Mesleki Gelişim İçin Çıkarımlar[1]

Mehmet BİRGÜN[2]

Abstract

Purpose: Turkish universities have increasingly embraced English Medium Instruction (EMI) as a teaching approach, which is a part of a global push to internationalize higher education. This present study examines the perspectives of 30 EMI lecturers working at universities in Turkey, emphasizing the role of EMI in the internationalization of higher education. The study aims to explore how these lecturers perceive EMI and how they engage with it, identifying both commonalities in their perspectives and the challenges they encounter.

Methodology: In this qualitative case study, purposive sampling was used to select the EMI lecturers from universities in Turkey. Data collection was conducted through semi-structured interviews, allowing for in-depth exploration of lecturers' perspectives and their insights. Content analysis, focusing on the complexities and nuances of EMI implementation, was used to systematically examine and interpret the themes emerging from the interviews.

Findings: The study identifies the key benefits of EMI as the increasing access to scientific knowledge, improved career prospects, and enhanced English proficiency. However, EMI also brings significant challenges, such as the difficulty of instruction in a foreign language, additional time requirements compared to Turkish Medium instruction (TMI), and issues related to terminology and cultural integration. These challenges underscore the need for targeted professional development to fully incorporate EMI's potential in improving higher education.

Highlights: EMI increases access to global scholarly resources and encourages the development of English proficiency in accordance with international academic standards. It promotes global competitiveness among graduates, providing significant career and academic opportunities. Challenges include linguistic barriers in teaching and learning and intensive preparation time. The study advocates for specific professional development programs to effectively address the pedagogical and linguistic challenges of EMI. Future implications are discussed, and suggestions are offered to help with implementation.

Öz

Amaç: Türk üniversiteleri, yükseköğretimi uluslararasılaştırma çabasının bir parçası olarak İngiliz Dilinde Eğitim (İDE) yaklaşımını giderek benimsemektedir. Bu çalışma, Türkiye'deki üniversitelerde görev yapan 30 İDE öğretim görevlisinin bakış açılarını incelemekte ve yükseköğretimin uluslararasılaşmasında EMI'nin rolünü vurgulamaktadır. Çalışma, bu öğretim görevlilerinin EMI'yi nasıl algıladıklarını ve nasıl uyguladıklarını, görüşlerindeki ortak noktaları ve karşılaştıkları zorlukları belirlemeyi amaçlamaktadır.

Yöntem: Bu nitel vaka çalışmasında, Türkiye'deki üniversitelerden İDE öğretim görevlilerini seçmek için amaçlı örnekleme kullanılmıştır. Veri toplama, yarı yapılandırılmış görüşmeler yoluyla gerçekleştirilmiş, öğretim görevlilerinin bakış açılarının derinlemesine araştırılmasına ve içgörülerine olanak sağlamıştır. Görüşmelerden ortaya çıkan temaları sistematik olarak incelemek ve yorumlamak için EMI uygulamasının karmaşıklıklarına ve nüanslarına odaklanan içerik analizi kullanılmıştır.

Bulgular: Çalışma, İDE'nin bilimsel bilgiye erişimi artırma, kariyer fırsatlarını iyileştirme ve İngilizce yeterliliğini geliştirme gibi temel faydalarını tanımlamaktadır. Ancak İDE, yabancı dilde eğitim ve öğretimin zorluğu, Türkçe eğitime kıyasla ek zaman gereksinimi ve terminoloji ile kültürel entegrasyon sorunları gibi önemli zorlukları da beraberinde getirmektedir. Bu zorluklar, İDE'nin yükseköğretimi geliştirme potansiyelini tam olarak hayata geçirmek için hedefe yönelik mesleki gelişim ihtiyacının altını çizmektedir.

Önemli Vurgular: İDE, küresel akademik kaynaklara erişimi artırır ve uluslararası akademik standartlara uygun olarak İngilizce yeterliliğinin gelişimini teşvik eder. Mezunlar arasında rekabeti teşvik ederek önemli kariyer ve akademik fırsatlar sunar. Karşılaşılan zorluklar arasında öğretme ve öğrenmede dilsel engeller ve yoğun hazırlık süresi bulunmaktadır. Çalışma, İDE'nin pedagojik ve dilsel zorluklarını etkili bir şekilde ele almak için özel mesleki gelişim programlarını savunmaktadır. Gelecekteki etkiler tartışılmış ve uygulamaya yardımcı olmak için öneriler sunulmuştur.

INTRODUCTION

English Medium Instruction (EMI) has gained popularity in higher education institutions worldwide, especially as it has the potential to increase social mobility and job opportunities at institutional and national levels (Macaro et al., 2017). Although EMI is seen as a very important tool in the internationalization strategies of higher education institutions, it is seen to pose significant challenges, especially in the professional development of lecturers. Research indicates that effective support in content delivery not only bolsters students' comprehension and language skills but also aligns with the broader goals of internationalization (Muttaqin, 2022). Although lecturers are experts in any subject, they seem to face difficulties in meeting the pedagogical requirements of content delivery in English because English is a second language for most of them. These problems, together with possible deficiencies in lecturers' English skills, can make it difficult to implement EMI effectively and negatively affect students' learning experiences (Hoan et al., 2023). These dimensions of EMI therefore highlight the need for specific professional development programs that address discipline specific points and language skills (Alhassan, 2021).

It can be argued that successful integration of EMI in higher education requires an approach that takes into account the diverse needs of both lecturers and students. This may include targeted support, personalized professional development and a comprehensive understanding of the challenges that EMI presents in different academic contexts.

LITERATURE REVIEW

EMI refers to the use of the English language to teach academic subjects to students in countries where English is not their first language. EMI has become a point of focus for many institutions seeking to increase their internationalization efforts and aim to improve students' English proficiency (Macaro et al., 2017). The widespread use of EMI in higher education builds on previous educational approaches. Content-Based Instruction (CBI) and Language and Content Integrated Learning (CLIL) approaches precede EMI and do not require the use of English. CBI is also used primarily in primary and secondary schools, where subject content is taught in a second language and combines language learning with content instruction (Wolff, 2007). EMI differs from the other approaches by focusing only on English.

The globalization of higher education and the rapid spread of EMI appears to be causing concern among students, teachers, educators and policy makers (Coyle et al., 2010; Kirkpatrick, 2014). This shift towards internationalization requires lecturers and students to have new skills to meet the changing educational needs of EMI (Van der Wert, 2012). Among them, the ability to engage in detailed discussions, the ability to grasp the scope of the content in English, and the ability to sustain the learning process in an engaging and motivated way are crucial. These issues are compounded by concerns about EMI teaching materials and assessment techniques (Tsou & Kao, 2017). These multifaceted demands can hinder the effective performance of EMI lecturers and students and require a range of outstanding skills (Helm & Guarda, 2015). Thus, the language skills of students and lecturers in EMI are crucial for sustaining high quality teaching and the successful implementation of EMI. However, the use of unfamiliar terms and complex sentence structures in EMI lessons can significantly complicate learning. Therefore, the importance of lecturers' language skills in EMI emerges (Evans & Green, 2007; Hellekjaer, 2010). This suggests that how lecturers modify their language use during lessons needs to be further explored. This area is currently underresearched (Dearden & Akıncıoğlu, 2016). Ball and Lindsay (2013) emphasize the importance of focusing on a range of effective practices and teaching techniques, especially when explaining complex concepts in a second language. In the EMI literature, classroom environment, professional standards and teaching strategies have been taken into account, but these factors have only been partially examined (Gökmenoğlu & Gelmez, 2013). For EMI lecturers, it is seen as crucial to understand that they may need additional support and guidance for teaching in another language.

Studies in the literature have examined lecturers' attitudes towards EMI, revealing different perspectives from various countries (Dearden & Macaro, 2016). Researchers have also examined various aspects of EMI, students' and teachers' perceptions, the advantages and disadvantages of EMI, and how it affects academic performance when courses are taught in English. It is noteworthy that although students acknowledge that English proficiency is beneficial for academic and practical reasons, they often find it difficult to understand English course content. Limited vocabulary and general English deficiency increase the degree of this difficulty (Borg, 2016; Cho, 2012). It can be argued that EMI requires a significant use of instructional strategies beyond simply reciting and translating content. According to O'Dowd (2018), educators without teaching strategies and a pedagogical foundation can be disadvantaged in English medium environments. The complexity of EMI does not only involve the simple transfer of content (Helm & Guarda, 2015; Werther et al., 2014).

Consequently, the literature on EMI emphasizes the multifaceted nature of this teaching approach. The purpose of this study is to explore the perspectives of lecturers involved in EMI programs and to predict their professional development needs based on these perspectives.

METHOD

This article is underpinned by a qualitative case study approach that forms part of a wider doctoral dissertation investigating EMI lecturers' views on EMI for professional development. Case study research was chosen for its ability to provide detailed insights into real-world examples that allow researchers to understand complex issues in their natural settings (Baxter & Jack, 2008). It involves taking an in-depth look at a specific, current phenomenon over time through the collection of comprehensive data (Creswell, 2009).

Study Group

The focus of this case study is on how EMI is implemented from the perspective of lecturers in Turkish universities offering EMI programs. "Purposive sampling" (Patton, 2002) was used to select participants for the study, thus obtaining a wide range of insights. Semi-structured interviews were conducted with 30 voluntary EMI lecturers from private and public universities after being selected through criterion sampling and maximum variation sampling. The criteria were that the lecturers were working in English-medium private and public universities, in different departments such as hard sciences and social sciences, and had maximum diversity of experience and titles. These participants included eight professors, five associate professors, fifteen assistant professors and two lecturers with experience ranging from one to fifteen years in various departments such as engineering, arts and sciences, economics, administrative sciences, medical sciences and health vacational schools.

Data Collection

The interviews were semi-structured, combining open-ended questions that aimed to gather lecturers' perspectives on EMI courses and classroom practices, as well as demographic information. This approach was designed to capture the nuances of the lecturers' experiences and insights into the implementation of EMI. Some of the questions were: "What are your thoughts on teaching in English? "Based on your experience, how would you describe the process of teaching English?"; "What do you think are your strengths in teaching English?"; "Do you have any difficulties or weaknesses in teaching English?"; "What challenges do you face in teaching English?" Ethics committee approval was obtained prior to the implementation.

Data Analysis

The approach to analyze the data is qualitative content analysis. This method involves a detailed examination of written, oral or visual data and the use of systematic steps to review and validate the information collected (Cohen et al., 2007). In practice, content analysis means organizing and categorizing data, making comparisons, and then drawing theoretical conclusions based on the content (Cohen et al., 2007). Bengtsson (2016) underlines an important decision in this process: to choose between analyzing the surface content of the data (manifest analysis) or delving deeper into the underlying meanings (latent analysis). For the study, latent analysis was conducted, as this deeper and more interpretive approach allowed to uncover and explore hidden meanings in the data. Then findings were presented in a table with direct quotes from the data to support the analysis.

Ethics

Before each interview, participants were assured that the purpose of the study was explained and it was emphasized that their participation was completely voluntary. Interviews were conducted online, scheduled at times that were most convenient for the participants. This approach was chosen to provide a comfortable and safe environment for the interviews. When participants preferred, face-to-face interviews were arranged according to their availability. Serious steps were also taken to protect the privacy of the participants and the confidentiality of the interviews. This included obtaining their consent to record interviews conducted online. They were assured that no audio or video recordings would be shared with anyone other than the researchers and that their names would remain anonymous.

FINDINGS

The research question sought to understand how EMI lecturers employed by EMI institutions felt about EMI. Two primary categories for the lecturers' viewpoints on EMI became clear after it was determined how the participants view EMI, how they explain its reflections, which elements they briefly highlight, and how they make sense of EMI in general. These are the "EMI Challenges" and the "EMI Benefits." Table 1 presents the views of EMI lecturers on EMI in terms of two categories and fourteen subcategories.

Table 1.

EMI Lecturers Perspective on EMI

Categories	Sub-categories	f-file	f-reference
EMI Benefits	A gate to scientific knowledge	10	12
	A way of internationalization	9	9
	Employment opportunities for graduates	8	12
	A way of learning English language	8	8
	A way of keeping up to date	7	11
	Academic career opportunities for graduates	4	4
	Advantageous over Turkish Medium Instruction	1	1
EMI Challenges	Challenging to teach in a foreign language	7	10
	Challenging to learn in a foreign language	7	7
	More time consuming than TMI	5	7
	Lacking of terminology in Turkish	4	7
	National exams in Turkish	2	2
	Causing cultural erosion	1	2
	Not satisfactory at undergraduate level	1	1

According to Table 1, EMI lecturers believe that EMI has a variety of "Benefits" and "Challenges." EMI lecturers list the following benefits under the category of benefits: "A gate to scientific knowledge," "a way of internationalization," "employment opportunities for graduates," "a way of learning English language," "a way of keeping up with the times," and "advantageous over Turkish medium instruction." Contrarily, EMI lecturers list the following under the category of challenges: "challenging to teach in a foreign language," "challenging to learn in a foreign language," "more time consuming than TMI," "lacking in terminology in Turkish," "national exams in Turkish," "causing cultural erosion," and "not satisfactory at undergraduate level."

One of the key factors affecting lecturers' opinions on EMI is the language they choose to describe it. The participants' responses throughout the interview demonstrated how they saw EMI as a method in terms of both its advantages and disadvantages.

Many lecturers (n = 10) believe that EMI serves as a bridge to scientific understanding. The following excerpts represent the perspectives of a few of these participants:

… I realized once again, that is actually the most important aspect, the strongest aspect of teaching in English medium… You have a very wide resource in front of you in terms of accessing information. Yes, because, as you know, in addition to the fact that countries such as America and England use English, various instructions are also in English in many countries. Today, when we sit down and research a subject on the internet, for example, when you look at YouTube videos, Indian people, German people explain things in English. Someone in another country also explains it in English. So English… a world language. For this, the biggest advantage of education in English medium is that you have access to a wide range of resources. (**Bulgan**- Engineering Faculty).

Now, from the student's point of view, for once, the horizons expand incredibly in English medium. It's something I've actually observed personally. Today, that is, universal knowledge is definitely written in English. This is not just in terms of the knowledge produced by the west, but also the knowledge the lands we live in: the information in the east, the information that the eastern culture presented to us in the history of humanity, from Ibn-i Sina to Ibn-i Gifar, the information produced in Spain, in Baghdad, these are available in English… I am not only talking about technological knowledge or today's knowledge; it is necessary to know English in order to reach even at this ancient

knowledge… So let me put it this way… I learn about Mevlana from the books written in English. When I look at Turkish sources… the resources that I can reach as a citizen are very limited. Therefore, if we say knowledge, we have to learn English very, very well. (**Zerrin** - Faculty of Arts and Sciences)

These show how EMI connects students to a wide range of concepts and cross-cultural historical understandings by acting as a portal to a huge array of global information. The common experiences underscore EMI's ability to extend educational horizons, the function of English as a universal language, and the importance of English competence for a thorough comprehension of both contemporary and historical knowledge. This demonstrates how EMI, which provides access to the vast amount of knowledge and viewpoints available throughout the world, may alter education.

The majority of participants stressed that having a wide variety of resources and sharing them in English is the largest benefit of schooling in the English language. The passages below highlight what some participants (n: 9) said about how English language instruction helps with internationalization:

Our students went to graduate school abroad, entered universities very easily, and they said: The curriculum abroad was like the curriculum we saw at school in Turkey, they said when they went there, they didn't feel as a foreigner at all. In other words, they said that they were more internationalized through EMI and they said they did not feel out of it in terms of education and teaching techniques. (**Ünal**- Economics and Administrative Sciences).

When we work together with students in the future, they should not have a problem with people abroad. Therefore, I think it is very necessary for the department courses to be in English medium, as it will benefit international cooperation and internationalization. (**Selim** - Faculty of Arts and Sciences).

These excerpts support the finding that "EMI is a way of internationalization," illustrating how EMI equips students with a global educational perspective. Students enrolled in EMI programs in Turkey felt connected to their foreign peers, smoothly transitioning to graduate programs abroad without feeling like outsiders. This suggests that EMI not only introduces students to worldwide curriculum standards, but also incorporates international teaching practices, generating a sense of belonging in a global academic community. Furthermore, the emphasis on English in department courses is underlined as critical for future international partnerships, emphasizing the notion that EMI prepares students for a world without boundaries, hence improving international cooperation and understanding.

Some participants (n: 8) stress that EMI offers employment chances for graduates in addition to opening doors to scientific information and exchange and serving as a means of internationalization:

Since students are really high in terms of entry rankings, their comprehension skills are much higher, and they find a job very easily… through English. In these last three or four years, it seems that there are hardly any English graduates among our graduates who cannot find a job in such a tough market… (**Ünal**- Economics and Administrative Sciences)

This excerpt underlines the finding that "Employment opportunities for graduates," showcasing how EMI significantly enhances job prospects. The speaker highlights EMI students' high admission rankings and comprehension skills, which directly translate into increased employability, particularly in competitive employment markets. The fact that practically all English graduates find work within a few years underscores the tangible benefit of EMI education in job placement, showing English proficiency as a valuable asset in the worldwide employment market.

Additionally, the following excerpt from one of the participants suggests that EMI is a method of learning English:

I think that having a university education in English provides me with an advantage, rather than learning it later. The English lessons you take in different professional subjects during four years at school help you to know English better. (**Cem**- Economics and Administrative Sciences).

It implies that obtaining English through university education, particularly across diverse professional disciplines across four years, results in a deeper grasp of the language than learning it outside of the academic context. This method improves English competence by ongoing, practical application, emphasizing EMI's importance not only in academic and professional success, but also as an effective language acquisition strategy.

Additionally, EMI aids in improved reading and understanding of English-language sources, therefore several lecturers (n: 7) note in the sample below that they stay current:

My vocabulary and my knowledge of English in my field generally remains fresh… It's like I made a new room in my brain, this room stays fresh for me, it is very advantageous in that sense. (**Hale** - Faculty of Nursing).

I find it very useful for teaching in English medium. Because I am renewing myself, if there are things I will miss about that subject or sometimes… I go back and prepare my lecture notes again and again and direct myself to prefer different words. I am trying to improve the vocabulary and present more accurate information to the student, that is, it updates me. (**Seçil**- Medical Sciences).

These excerpts illustrate the finding that "EMI is a way of keeping up to date," revealing how teaching and learning in English medium not only enriches vocabulary but also keeps the knowledge in specific fields current and refreshed. The concept of creating a "new room" in the brain where knowledge remains fresh emphasizes the personal and professional development that EMI facilitates. Furthermore, examining and updating English lecture notes to select more precise terms or deliver more correct information indicates a constant process of self-improvement and updating. As a result, EMI serves as a catalyst for both lecturers and students to constantly renew their expertise and keep up with innovations in their professions.

Consequently, having a strong command of English increases one's chances of pursuing an academic career in universities (n: 4). And the following lecturers' extracts help to illustrate this situation:

If a student is going to do a master's or doctorate after graduation, if he has a plan to go abroad, if he will participate in Erasmus programs, if he will take part in different platforms, English will make a great contribution to his life (**Hale** - Faculty of Nursing).

If they are considering an academic career, it will help, maybe there are students who want to go abroad. Apart from that, if one is planning to become an academician, it is important to have English in terms of literature review, at this point EMI will help them. (**Meryem**- Helalth Care Vocational School).

These extracts emphasize the importance of English in furthering one's education and academic career, particularly on a global scale. The importance on English for participating in programs like Erasmus or doing literature reviews as an academician demonstrates EMI's important contribution to academic growth. It implies that EMI not only provides students with the essential language skills for global academic participation, but also provides access to many platforms and opportunities beyond their home nations, allowing for a more seamless transfer into international academic circles.

In addition, one of the lecturers claims that EMI is better than TMI since EMI graduates are exempt from having to demonstrate their command of English in the passage below:

Such a department gives you English transcripts all over Turkey. It's already done… While tens of thousands of students from tens of thousands of departments need to prove their English, these students do not need.... I've experienced it too. I took a lot of exams, no one asked me about my English. Now, they're getting ahead and knowing another language makes them fly like a rocket hooked up. (**Arif**- Economics and Administrative Sciences).

This excerpt underscores the finding that "EMI is advantageous over Turkish Medium Instruction" by highlighting the unique benefit of graduating from an EMI department: the inherent proof of English proficiency. Unlike students from other departments, who must confirm their English skills, EMI graduates skip this stage, giving them a significant edge in the job market and future educational options. The speaker's own experience supports this benefit, stating that skill in English can greatly accelerate a graduate's career trajectory, akin to "flying like a rocket." This implies that EMI not only delivers an intellectual advantage, but also educates students with a critical skill set that propels them forward in a competitive environment.

Conversely, lecturers' perspectives cover specific difficulties. In this context, Tuğçe and Mehmet assert that it is difficult to teach in EMI; Sinem and Selim assert that it is difficult to learn in EMI; Burak, Cemre, and Hale assert that EMI requires more time than TMI; Hale and Cemre assert that EMI graduates lack the Turkish terminology; and Cemre and Elif assert that it is difficult for EMI graduates to take national exams in Turkish. Finally, relatively few EMI lecturers claim that EMI contributes to cultural eroding.

The following excerpts from lecturers demonstrate that it can be difficult to teach in a foreign language (n: 7), which only results in surface level learning:

It's getting harder for us to understand each other… If the mother tongue of both parties is the same, there are disadvantages when we compare it with that. Even if I say I know English a lot, if we assume that I know 90%, let's say that the student knows well, that is 90%. When multiplied, it's 81%. Therefore, we always have a rough calculation that 20% of what I try to give is lost due to language. (**Tuğçe**- Faculty of Engineering).

The disadvantage is, as I said… we have difficulties. For example, if 80 percent is going to be good, it will be 70 or 60 percent. Or if the student knows it 70 percent or 80 percent, the student understands 60 percent, 70 percent, so of course there is such a decrease, but I think this decrease is not important because its advantage is very high. (**Mehmet** - Faculty of Engineering).

These examples demonstrate the inherent problems in guaranteeing full comprehension and communication between teachers and students when neither party is speaking in their native language. The examples offered quantify the perceived loss in effectiveness owing to language barriers, indicating that even with great proficiency, knowledge transmission is significantly reduced. However, one speaker points out that, despite the decline in comprehension, the overall benefits of EMI outweigh the obstacles. This shows that, while teaching and learning in a foreign language presents challenges, the benefits in broader educational and professional contexts are seen more worthwhile.

Additionally, some lecturers claim that students struggle with comprehension and learning in lectures and tests, which raises questions about material comprehension. As noted in the following paragraphs, some lecturers claim that learning through a foreign language is difficult:

…In the first place… it is not my mother tongue, nor is it the native language of the person in front of me. This is the biggest disadvantage… Students experience a lot of disconnections in English medium lessons at one point or another… students may miss words. (**Sinem** - Faculty of Engineering).

The student understands more slowly. This is the biggest disadvantage… The second biggest problem is not being able to ask questions, students are afraid to ask questions. Students feel obliged to ask in English. Even normally, our students cannot ask questions easily, because their self-confidence is a little low, we are not able to improve the student in that direction. One thing that makes it worse is that there is no dialogue in the classroom, so you are asking something, should the student think about how to answer your question correctly or how to translate it into English? I realized something, one day, while explaining the subjects, there are times that students don't understand at all, especially in the first grade. Then I see that because they do not know a single word, they did not understand a whole thing and did not ask. For example, the English word for "koful" organelle is "vacuole". I say vacuole, they did not understand anything. Then I realized that because they did not know that the Turkish word for "koful" is vacuole, they did not understand it, so these are the difficulties. (**Selim-** Faculty of Arts and Sciences).

These sections describe the discovery that learning a foreign language, such as English, poses major hurdles. The main difficulties raised are misunderstandings caused by language barriers, delayed comprehension, and a reluctance to ask questions owing to fear or lack of confidence. The lack of discourse and interaction in the classroom exacerbates these issues, as students may struggle to translate their views from their original language to English or may misunderstand terminology owing to new vocabulary. These findings show that, while EMI has many advantages, it also necessitates measures for overcoming the inherent problems of learning in a foreign language for both teachers and students, which affects communication ease and depth of knowledge.

Additionally, lecturers (n: 5) report that EMI takes more time than TMI since giving lectures in English requires higher cognitive load and planning. Some of the speakers share their thoughts in this regard as follows:

I have to say this: My tiredness when I leave a 3-hour Turkish lesson is not the same as when I leave a 3-hour English lesson, because the brain is more active in EMI. (**Burak**- Economics and Administrative Sciences).

My lessons are mostly social lessons. I mean, it's not lessons with mathematical formulation and I have to stick to a text. More precisely, I need to prepare a text beforehand and I need to summarize this text to the students a little. If I were to teach the same lesson in Turkish, I would not do any preparation. (**Cemre**- Economics and Administrative Sciences).

I do not get prepared (in Turkish lessons), but in English, it is not so, I have to study. I need to do a separate study about whether I say the words correctly, it is a process that requires much more preparation time and effort for me compared to the normal lessons in Turkish. (**Hale**- Faculty of Nursing).

These examples demonstrate that teaching English involves more mental work and preparation than teaching one's native language. Lecturers report that EMI sessions are more demanding, both because their brains are more engaged and because they must prepare extensively to ensure accuracy and clarity in English. This contrasts with their approach to Turkish lessons, which require little or no prior study. The extra time spent preparing and presenting EMI courses

emphasizes the complexity of functioning in a non-native language, stressing the increased effort required by lecturers.

Additionally, some lecturers claim that students struggle to understand terminology in their professions, which affects how well they do in their careers after graduation. The following passages serve as an example of Turkish learners' limited vocabulary (n: 4):

But when you look at it professionally, English speaking patients are not hospitalized in our hospitals, so it may not contribute much professionally. (**Hale**- Faculty of Nursing).

Most of our students will not be able to work in a place where they will use a foreign language when they graduate, due to both the university entrance score we have received and the fact that our university has just been established. They will go to work in an organized industrial zone, or in a small medium-sized enterprise elsewhere, if they can't work in public sector…. Huge companies already recruiting students from specific universities and they are already doing international business looking for such skills. Therefore, I think that our current students will graduate with a lack of technical knowledge in Turkish (**Cemre**- Economics and Administrative Sciences).

They highlight a practical concern: while students gain proficiency in English, they may not find its professional use as relevant in their future workplaces, especially if they are employed in settings where English is not commonly used. This situation potentially leads to a gap in technical knowledge in Turkish, as the educational focus on English might not translate to the local professional context. These insights underline a critical consideration for EMI programs: balancing English proficiency with ensuring students also possess a strong command of technical terminology in their native language to be fully prepared for the local job market.

Some EMI lecturers claim that students who study in the English medium are at a disadvantage compared to those who have completed their education in the Turkish medium because they are not required to take the KPSS (Public Personnel Selection Exam) in English after graduating. KPSS is a national exam used to choose candidates for state openings. It includes questions on Turkish language, math, general culture, and field-specific knowledge. The only language used for the exam in Turkey is Turkish (n: 2), as shown in the following excerpts:

A disadvantage is that most of our students will work in Turkey. Those who want to work in the public sector take the Turkish exam in Turkey and the science exam is held in Turkish. They do not understand anything from this science exam. And for this, they go to private tutoring schools again, to learn in Turkish what they learned in English at university. However, if one learns in Turkish, he will not make an extra effort for those exams – KPSS (Public Personnel Selection Exam) exams. (**Cemre**- Economics and Administrative Sciences).

An economics student graduating from the English department starts maybe pretty far behind, especially in KPSS. Because Pierson, Addison Wesley… and other publishers handle the issues in a very international, very global context. They don't even mention the problems in Turkey at all and, that is very superficial. Yes, their visuals (for books) are very beautiful… I cannot say anything about the quality of the book. At KPSS, a student who graduated from English economics or English international relations or English political science learns all Turkish terminology from the very beginning, like a fish out of water. For example, when I say… "gross national product" they do not know that it is actually "gayri safi milli hasıla". In other words, they graduate badly in terms of exam preparation because they do not know the Turkish equivalents of these terms. (**Elif** - Economics and Administrative Sciences).

Students who are educated in English experience difficulty when taking national exams in Turkish, notably in the public sector, due to a mismatch in language and context. The necessity to relearn technical vocabulary and concepts in Turkish for exams such as the KPSS demonstrates a disconnect between their English-medium education and the demands of the local labor market. This situation frequently forces students to seek additional tutoring in Turkish, implying that, while EMI provides global perspectives and English proficiency, it may unintentionally leave students unprepared for specific national tests and terminology, reducing their competitiveness in certain local employment sectors.

EMI provides numerous benefits, including extensive access to global knowledge, job prospects, academic career growth, and language acquisition. However, challenges include the difficulty of teaching and learning in a foreign language, the additional preparation time compared to TMI, the possibility of a shortage of terminology in Turkish, and the obstacles of national exams. Additional worries include the potential of cultural loss and the perceived lack of EMI at the undergraduate level. Together, these findings provide a balanced assessment of EMI's benefits and

problems, emphasizing its importance in global education while identifying areas that need to be addressed to optimize its success.

DISCUSSION and CONCLUSION

These perspectives can provide suggestions for lecturers' professional development needs. In other words, lecturers' interpretations of EMI are heavily influenced by their preconceptions. Through the meaning they attribute to EMI, they can elaborate their views and potential positions in the context of professional development. For example, for EMI lecturers, the idea that EMI requires more time than TMI may be perceived as seeking professional support, because through professional support, EMI may not be perceived as something that requires more time. Also, by making EMI lecturers realize its advantages, it might be possible to increase the motivation of those who only see its disadvantages. The perspectives of EMI lecturers focus primarily on the categories of benefits and challenges, although they cover many concepts. To better understand the needs of students and the education system, EMI program lecturers need to be familiar with the global and cultural history and ideology associated with EMI (Coleman et al., 2018). Taking a broad perspective of the lecturers' perspectives, it can be argued that they need professional development support considering the advantages and disadvantages of EMI.

Lecturers describe the transition to EMI in Turkish higher education as transformative, primarily because it opens wide doors to global scientific knowledge. This transition is supported by the predominance of English in academic publishing, as English is notable for its prevalence in academia and research, with the majority of scientific and social science articles being published in English (Corrales et al., 2016; Hamel, 2007). The predominance of English not only facilitates access to the most up-to-date scientific information, but also facilitates the global dissemination of research findings. Lecturers find that utilizing English in their classrooms allows them to easily integrate the wealth of relevant scientific literature and enriches the content and objectives of their courses. As a result, mastery of the English language emerges as an important strength in supporting the professional development of lecturers, while at the same time enhancing students' academic and scientific literacy in their field.

Among 21st century skills, the importance of abilities such as innovation and continuous learning is increasingly recognized (Gelen, 2017). Lecturers state that EMI not only puts them and their students at the forefront of developments in their field, but also significantly supports English proficiency, a critical asset for academic and professional communication (Floris, 2014). Developing language skills in this way is in line with the growing academic career prospects of EMI graduates, as it gives them access to a wider range of resources and literature in English, increases their expertise, and enhances their preparedness for global challenges (Sahan & Sahan, 2022). With these aspects in mind, lecturers generally have a positive attitude towards EMI and emphasize its contributions not only to the dissemination of scientific knowledge but also to a more internationalized academic society. This interest in EMI stems from a commitment to professional development and a desire to increase scientific mobility, which can be seen as a source of motivation for lecturers to tackle EMI-related challenges.

Although there is a generally positive consensus on EMI, it is likely to be implemented with language proficiency barriers faced by both lecturers and students (Helm & Guarda, 2015). These challenges, when not combined with the selection of appropriate teaching methodologies, pose significant barriers to the effective delivery of EMI courses (Coleman, 2006; Floris, 2014; Kırkgöz, 2009). Airey (2011) emphasizes the difficulty of providing detailed instruction and feedback in English and notes the critical need for professional development tailored to the demands of EMI. Moreover, learners face barriers in making sense of content delivered in a second language, which is further complicated by the wide differences in levels of language proficiency (Kırkgöz, 2014, 2018; Unterberger, 2014). While the Common European Framework of Reference for Languages (CEFR) provides a reference point for language proficiency, it falls short in addressing the instructional subtleties necessary for effective EMI, it can be argued that the current framework is lacking in terms of supporting both instructors and learners. Therefore, a framework that specifies the qualifications required when teaching EMI courses can help lecturers to implement EMI effectively. A challenge in EMI in Turkey is that the language proficiency of students lags behind that of lecturers. To reduce this disparity, it is recommended to introduce English for Specific Purposes (ESP) and English for Academic Purposes (EAP) courses designed to meet the specific language needs of different academic disciplines, especially in collaboration with the preparatory school (Schmidt-Unterberger, 2018). As mentioned, this could be done in cooperation with Schools of Foreign Languages and EMI departments. Addressing these challenges through targeted professional development programs can enable lecturers to navigate the complexities of EMI more effectively.

Furthermore, research shows that learning a second language activates and stimulates the language centers of the brain, resulting in increased cognitive effort (Perez et al., 2019). As a result, lecturers find that the delivery of content

in English requires more energy than in their native language and often describe this process as challenging and time-consuming (Helm & Guarda, 2015). Despite the EMI aiming to raise the global position of Turkish higher education (Macaro & Akıncoğlu, 2018), the fact that students graduate with a gap in terms of content in their mother tongue is a significant consequence. In addressing this issue, the integration of EAP or ESP courses with the EMI curriculum promises to increase students' understanding of course materials, while offering a more comprehensive educational experience (Sahan & Sahan, 2022). Awareness of these issues can be raised through professional support for EMI teaching staff.

A major obstacle for graduates of EMI programs hoping to enter the public sector is the need to pass national exams like the Turkish-language KPSS. This presents a barrier to the coherence of learning for students who have studied mainly in English and makes it difficult for them to understand Turkish content. Concerns over EMI's impact on cultural identification have also been voiced; certain lecturers think that giving English priority could unintentionally weaken linguistic legacy (Köksoy, 2000). On the other hand, proponents of EMI contend that its objective is to advance a multicultural learning environment in which the purpose is to enhance cultural variety rather than lessen it (Tsou & Kao, 2017). Furthermore, graduate students who are thought to possess a high degree of responsibility and linguistic competency might find EMI more appropriate. Despite these difficulties, lecturers are aware of the advantages of EMI, and it's feasible that specific professional development initiatives could lessen language proficiency-related obstacles.

All in all, this study contributes to the existing research on EMI by highlighting lecturers' critical perspectives on implementation, aligning with and adding to current research on EMI (Doiz et al., 2019; Simbolon, 2016; Tange, 2010; Werther et al., 2014; Yeh, 2012). The findings underscore an urgent need for enhanced professional support, particularly addressing the educational challenges faced by EMI lecturers. Addressing these issues is crucial for improving EMI practices and ensuring that lecturers are equipped to handle the complexities of EMI. Considering the benefits and challenges based on the perspectives of the lecturers related to EMI, for instance, language proficiency and the potential disconnect between EMI education and national exam requirements as well as other identified points, lecturers should be supported professionally for a better EMI implemantation. Therefore, future EMI programs must make significant investments in identifying areas for improvement and development, deeply evaluating course design and implementation. This focused approach will not only enhance the effectiveness of EMI but also elevate the overall quality of education delivered within EMI model.

Based on the findings of this study, further research is needed in some important areas to deepen the implications for EMI and professional development. Future studies could investigate the effectiveness of targeted professional development programs for EMI lecturers, particularly focusing on pedagogical strategies and language proficiency challenges. Furthermore, comparative research studies could be conducted on the professional development of EMI lecturers in different countries. In particular, the views of EMI students at postgraduate level based on the perspectives of EMI lecturers could be examined and a broader professional development framework could be proposed, given that EMI is not satisfactory at postgraduate level. Furthermore, a more comprehensive framework could be proposed to address the identified issues and improve the overall quality of EMI.

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I hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

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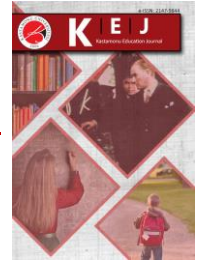
| Research Article / Araştırma Makalesi|

Adaptation of the Environmental Worry Index into Turkish: A Validity and Reliability Study on Teacher Candidates

Çevresel Kaygı İndeksi'nin Türkçeye Uyarlanması: Öğretmen Adayları üzerinde Geçerlik ve Güvenirlik Çalışması

Mustafa İlhan[1], **Melehat Gezer**[2], **Melek Gülşah Şahin**[3]

Abstract

Purpose: In the present research, it was aimed to adapt the Environmental Worry Index (EWI) developed by Oguntayo et al. (2023) into Turkish.

Methodology: The study was conducted with the participation of 508 teacher candidates. Exploratory graph analysis (EGA), exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed for the validity studies. The reliability of the measurements collected via the Turkish form of the scale was examined via the Cronbach's alpha internal consistency coefficient. Corrected item total correlations were calculated for item discrimination, and Ferguson Delta was computed to provide a discrimination index for the entire scale.

Findings: The EGA outputs and the results of parallel analysis run within the scope of EFA revealed a single-factor structure unlike the two-dimensional original form of the scale. In EFA, the variance explained for the single-factor solution was determined as 45.80% and the factor loadings ranged between .44 and .80. The CFA results showed that the fit indices for the unidimensional model were within the recommended limits and the factor loadings of the items varied between .41 and .71. Cronbach's alpha coefficient was estimated as .84 and corrected item total correlations ranged between .36 and .62. The Ferguson's delta statistic, on the other hand, was found to be .95.

Highlights: The results obtained provide evidence that the measurements collected through the Turkish form of the EWI have adequate psychometric properties.

Öz

Çalışmanın amacı: Bu araştırmada Oguntayo vd. (2023) tarafından geliştirilen Çevresel Kaygı İndeksi'nin (ÇKİ) Türkçeye uyarlanması amaçlanmıştır.

Yöntem: Çalışma 508 öğretmen adayının katılımıyla gerçekleştirilmiştir. Geçerlik çalışmaları kapsamında açımlayıcı grafik analizi (AGA), açımlayıcı faktör analizi (AFA) ve doğrulayıcı faktör analizi (DFA) yapılmıştır. Ölçeğin Türkçe formuyla elde edilen ölçümlerin güvenirliği Cronbach alfa iç tutarlık katsayısı ile incelenmiştir. Madde ayırt ediciliği için düzeltilmiş madde toplam korelasyonları hesaplanmış, ölçeğin geneline ilişkin bir ayırt edicilik indeksi sunmak amacıyla ise Ferguson delta katsayısından yararlanılmıştır.

Bulgular: AGA çıktıları ile AFA'ya ait paralel analiz sonuçları ölçeğin iki boyutlu orijinal formundan farklı olarak tek faktörlü bir yapı ortaya koymuştur. AFA'da tek faktörlü yapının açıkladığı varyans %45.80 olarak belirlenmiş ve faktör yüklerinin .44 ile .80 arasında değiştiği saptanmıştır. DFA sonuçları, tek boyutlu model için uyum indekslerinin önerilen sınırlar içerisinde kaldığını, maddelerin faktör yüklerinin .41 ile .71 arasında değiştiğini göstermiştir. Cronbach alfa katsayısı .84 olarak kestirilmiş ve düzeltilmiş madde toplam korelasyonlarının .36 ile .62 arasında değiştiği tespit edilmiştir. Ferguson delta istatistiği ise .95 olarak bulunmuştur.

Önemli Vurgular: Araştırmada ulaşılan sonuçlar ÇKİ'nin Türkçe formunun yeterli psikometrik özelliklere sahip ölçümler ürettiğine kanıt sunmaktadır.

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INTRODUCTION

Today, global environmental changes are increasing in frequency and severity. Increasing environmental pollution has many negative impacts on the economy, human health and wildlife. Scientists and various international organizations warn about these negative effects of environmental degradation. One of the most dangerous consequences of environmental degradation is global warming. The sustainable development report of the United Nations warns that the future negative impacts of global warming could greatly exceed the effects of the COVID-19 pandemic, which is still ongoing in various variants [United Nations, 2020]. Similarly, the World Bank (World Bank, 2016) and the Intergovernmental Panel on Climate Change (IPCC, 2018) point out that environmental problems will have increasing negative influences on both human health and economies in the near future.

One of the drivers of global environmental degradation is the deterioration of the aquatic ecosystem. These degradations are generally caused by factors of anthropogenic origin, such as the misuse of agricultural land, pollutants and heavy materials that enter water bodies (petrochemicals, pharmaceuticals and personal care products, pesticides and arsenic [As], mercury [Hg], lead [Pb], cadmium [Cd]) (Nguyen et al., 2022). For example, algae play a vital role in aquatic ecosystems, contributing to oxygen production and serving as a key component of the food chain. However, when algae are exposed to the above-mentioned pollutants, they show negative reactions and disrupt the balance of aquatic ecosystems (Le et al., 2023). As can be seen, human actions that negatively affect species and ecosystems accelerate global environmental degradation. The most striking of these environmental changes is climate change. In fact, the effects and consequences of climate change have enlarged that threaten the lives of billions of people and many species. It is anticipated that the environmental, social and economic consequences of climate change will be observed much more concretely in the upcoming years, and even directly affect the lives of future generations (IPCC, 2013). The consequences of climate change on a regional and global level are increasingly being reported in the media and the issue is becoming more frightening with its increasing visibility in the media.

Climate change refers to long-term changes in climate patterns, i.e. average seasonal temperature and precipitation regimes. The effects of climate variability have become much more visible, especially in the last few decades. The main problems caused by climate variability are followings: (a) changes and extinction of species, (b) food and water scarcity, (c) decreasing sea ice coverage, (d) sea level rise, (e) changing global and regional boundaries, (f) air, soil and water pollution, (g) increase in weather variability, unpredictable weather conditions and the number of uncontrollable forest fires, and (h) climate refugee crises. These problems are occurring rapidly and unpredictably, and they change the way and duration of people's lives. Due to climate change, many lives are lost worldwide and countries suffer significant economic losses.

In addition to climate change, biodiversity loss, plastic waste, ocean pollution and acidification, desertification, genetic pollution, carbon emissions, water stress, widespread air pollution, and traffic congestion are among today's global environmental problems (Oguntayo et al., 2023). Exposure to global environmental degradation/hazards can negatively affect individuals' mental health. Anxiety, fear, sadness, post-traumatic stress disorder, depression and even suicide are among the effects of environmental degradation on human psychology (IPCC, 2014; Stewart, 2021; World Health Organization, 2022). According to the World Health Organization (2007), today's children are growing up in a world burdened by environmental problems. Children may feel vulnerable to environmental degradation and have to cope with psychological problems such as anxiety (Sobel, 1996). Given the public attention to widespread environmental issues in the media (e.g. climate change, rainforest destruction, endangered species), some scholars argue that children are becoming increasingly eco-phobic. Sobel (1996) defines this as a generalized fear of environmental degradation. Indeed, research proves that children have negative emotions such as fear and pessimism about environmental problems (Hutchinson, 1997; Hicks & Holden, 2007). In her study, Barraza (1999) asked primary school children aged 7-9 in England and Mexico to draw the Earth as it will be in 50 years in order to examine their environmental perceptions, basic expectations and concerns about the future. As a result of the study, she determined that 37% of the children incorporated environmental problems such as pollution, global warming, loss of species, water scarcity and deforestation in their drawings and interpreted this finding as children having a deep sense of anxiety and pessimism about environmental problems. She was also reported that 54% of children think that the world will be in a worse situation in 50 years, meaning that they are pessimistic about the future. Such studies reveal that many children worldwide are deeply concerned about the state of the natural environment and that eco-phobia is on the rise (Sobel, 1996).

Böhm (2003) categorized the negative emotions that individuals may experience in relation to environmental risks and found that individuals experience feelings of regret, sadness or sympathy for environmental consequences that have occurred before them. On the other hand, she ascertained that they feel fear, anxiety or hopelessness for negative consequences that have not yet occurred and that are thought to occur in the future. Experiences of global environmental degradation play a decisive role in individuals' environmental concerns (Strife, 2008). For example, Chawla (1998) found that experiences of habitat degradation, destruction of a special natural area, pollution, radiation, and/or environmental disaster affected adults' environmental concerns. Stewart (2021) specified that exposure to bad weather can lead to anxiety and stress. Van der Linden (2017) mentioned that climate-related uncertainties can create feelings of anxiety and fear in people. Searle and Gow (2010) detected that women, individuals under the age of 35, environmentally oriented people and people with high levels of future anxiety were more likely to be concerned about climate change. Clayton et al. (2017) stated that individuals exposed to environmental degradation have a serious fear of death beyond the concern about climate change and environmental degradation; they also emphasized that even individuals who have not personally experienced any direct effects of climate change experience environmental anxiety.

Purpose and Originality of the Research

Environmental anxiety includes psychologically based reactions such as worry and fear related to many environmental disasters such as degradation of ecosystems, extinction of plant and animal species, air, water, soil and environmental pollution, deforestation, sea level rise and global warming. Today, the increase in the frequency and severity of natural disasters, forest fires and extreme weather events has paved the way for studies to determine the environmental anxiety levels of individuals/communities, and in parallel, various measurement tools have been developed for this purpose. When the measurement tools in the Turkish literature for measuring the anxiety caused by environmental degradation in people are reviewed, we come across the Climate Change Worry Scale (Gezer & İlhan, 2021), Climate Change Hope Scale (Gezer & İlhan, 2020), Climate Change Anxiety Scale (Cebeci et al., 2022), Ecological Identity Scale (Gezer & İlhan, 2018), and Eco-Anxiety Scale (Uzun et al., 2022; Türkarslan et al., 2023). These instruments generally focus only on the climate change component of environmental degradation. Nevertheless, environmental degradation has a multidimensional structure ranging from water, soil and air pollution to the depletion of ecological resources (Tabak & Özav, 2023). The eco-anxiety scale in the Turkish literature (Uzun et al., 2022; Türkarslan et al., 2023) was developed to measure individuals' psychological reactions to global warming, ecological destruction, resource depletion, species extinction, ozone depletion, ocean pollution, and deforestation. The Environmental Worry Index (EWI) recently developed by Oguntayo et al. (2023) in the international literature consists of items that aim to measure how much people worry about environmental risks/problems. This scale includes thoughts about the dangerous, immediate and long-term side effects of the degradation of our ecological system (Oguntayo et al., 2023). The EWI is intended to gauge personal concerns about both climate change and environmental degradation. The scale presents the different environmental problems to the participants in separate items and the respondents were asked to indicate how much the relevant environmental problem worried them. In this respect, the EWI differs from the existing instruments in the Turkish literature. Oguntayo et al. (2023) stated that the scale is a reliable and valid measurement tool for environmental concerns and suggested that the scale should be used on samples from different countries. Since the it addresses environmental worry in terms of diverse environmental elements and can do this in a very practical way with only 11 items, it is thought that the Turkish adaptation of the EWI will contribute to the literature and researchers who will study environmental anxiety. From this point of view, the current research aimed to adapt the EWI crated by Oguntayo et al. (2023) into Turkish.

METHOD

Participants

The original form of the EWI was developed on a sample aged between 18 and 65 from different educational levels. So, it was thought that it would be appropriate to conduct the adaptation study on a group of participants over the age of 18. The most accessible sample that meets this criterion for the researchers was teacher candidates. Therefore, the study data were collected from teacher candidates. More clearly, the study group was determined according to the convenience sampling technique in which the participants consist of people who can be accessed easily and quickly (Sim & Wright, 2000). Accordingly, the study was conducted on 508 teacher candidates, aged between 18 and 42 (Mean: 21.17, SD: 2.26), studying at Dicle University, Ziya Gokalp Faculty of Education. The distribution of the participants, 165 of whom were male and 343 of whom were female, according to their branches and grade levels were presented in Table 1.

Table 1. Distribution of participants according to their branches and grade levels

	Grade 1	Grade 2	Grade 3	Grade 4	Total
High school mathematics	21	14	1	0	36
Science	44	38	42	1	125
Middle school mathematics	50	35	42	44	171
Elementary school	0	32	35	2	69
Social studies	32	9	1	42	84
Geography	4	8	8	3	23
Total	151	136	129	92	508

Data Collection Tool

The study data were collected through the EWI developed by Oguntayo et al. (2023). During the development of the original form of the EWI, an item pool of 15 items was created and these items were administered to the participants using a 4-point Likert-type rating. They conducted an exploratory factor analysis (EFA) on the data obtained from 925 participants and acquired a two-factor structure explaining 50.059% of the total variance. In this structure, four of the items were excluded from the scale due to factor loadings below .50. Seven of the remaining 11 items were included in the first dimension named proximal with factor loadings ranging from .701 to .797, and the other four were included in the second dimension named personal worry experience with factor loadings ranging from .563 to .765. They found that the corrected item-total correlations of the scale items varied between .364 and .780, and reported Cronbach's alpha internal consistency coefficients as .894 for the proximal subscale, .671 for the personal worry experience, and .849 for the entire scale.

Translation Process of the EWI into Turkish

In order to adapt the scale into Turkish, permission was first obtained from the researchers who developed its original version. To this end, an e-mail was sent to Rotimi Oguntayo, the responsible author of the article in which the scale was developed, on 11.09.2023 and his approval was requested for the adaptation study. Subsequently, the forward translation procedure was operated. The scale was translated into Turkish by four experts, one expert each from English language education, social studies education, chemistry education, and measurement and evaluation. Three of these four experts, who have a good command of English, also have experience in scale adaptation.

In the next step, the translations made by the four experts independently of each other were brought together and the most appropriate Turkish statement for each item in the instrument was tried to be determined. In this process, three of the experts pointed out that the expression "*open defecation*" in item number three of the scale had no equivalent in Turkish culture. Therefore, the third item, which was originally written as "*I feel concerned about the littering of the environment and open defecation*", was translated into Turkish as "*I feel concerned about the littering of the environment*". Considering that scale adaptation is not a literal translation and that there may be differences from culture to culture in terms of the measured content (Behling & Law, 2000), it was thought that such a change would not pose a problem for adaptation. Accordingly, it was not required to obtain further approval from the authors who developed the scale's original form for this change.

After the Turkish form was crafted, opinions were taken from two experts, one from the field of geography education and the other from the field of English Language and Literature, about the equivalence of the Turkish form created with the English version. Both experts remarked that the modification made in the third item was appropriate and found the Turkish and the original form linguistically equivalent. In the Turkish version of the EWI, a 4-point rating was adopted, as in the original form of the scale. However, after consulting two measurement and evaluation experts, a different labeling was utilized for the categories than in the original one. While in the original form, the categories were labeled with time adverbs indicating frequency (*Not at all, a few of the days, more than half the days, almost every day*), in the Turkish form, labels indicating agreement were included as *Strongly Disagree* (1), *Disagree* (2), *Agree* (3) and *Strongly Agree* (4).

Obtaining Ethics Committee Approval and Data Collection

Prior to the data collection process, approval was obtained from Dicle University Social and Human Sciences Ethics Committee for the compliance of the study with current ethical standards (approval letter dated 11.10.2023 and numbered 580293). After the ethics committee permission was obtained, the data collection process was initiated and the data were collected in November and December in the Fall Semester of the 2023–2024 Academic Year. While the scale was administered to 290 teacher candidates in the sample in paper-pencil form in their classroom, 218 participants answered the scale online.

Data Analysis

Preliminary Analysis

Following the data collection, the data set was reviewed to see the data entered incorrectly, if any, and to identify missing values. For this purpose, the frequency values for each item were examined and no incorrectly entered data (a frequency outside the 1-4 range) or missing values were found. Then, the data file was divided into two halves as odd and even numbered participants, so that two separate data sets were attained that were equivalent in terms of participant profile. The exploratory graph analysis (EGA) and EFA was applied to the data containing odd-numbered participants and confirmatory factor analysis (CFA) was applied to the data file containing even-numbered participants. The suggestion that it would be more accurate to perform EFA and CFA on different data sets (Dawson, 2017; Fabrigar et al., 1999) was effective in following such a path.

Subsequent to dividing the data file into two; both data sets were screened for outliers. In order to identify univariate outliers, *Z* scores were examined, and cases with Z scores outside the range [−4, 4] were accepted as outliers with reference to the boundaries suggested by Stevens (2009). In the data set where EFA was conducted, Z scores were found to be between -2.99 and 1.42, and these values were interpreted as no univariate outliers in this data set. In the data set where CFA was applied, it was determined that there was only one observation with univariate outlier (*Z*= −5.51), and after this observation was removed from the data set, multivariate outlier examinations were started. The number of multivariate outliers was established as 10 for both data sets according to Mahalanobis distances. The normality assumption was tested on the outlier free data. Skewness and kurtosis coefficients were calculated for univariate normality, and Mardia's test was checked to test multivariate normality. Table 2 presents the normality test results.

Table 2. Results of univariate and multivariate normality test

Items	Data file used in EFA		Data file used in CFA	
	Skewness	Kurtosis	Skewness	Kurtosis
EWI-1	−.78	−.40	−.24	−1.94
EWI -2	−.81	.63	−.63	.54
EWI -3	−.72	−1.20	−.70	−.79
EWI -4	−.70	.05	−.45	−.62
EWI -5	−.74	−.72	−.36	−1.87
EWI -6	−.49	−.73	−.66	.22
EWI-7	−.96	.36	−.66	−.52
EWI -8	−.69	.45	−.53	.26
EWI -9	−1.16	.18	−1.07	−.28
EWI -10	−.66	.01	−.54	−.30
EWI -11	−..74	−.45	−.72	.30
Mardia's test	780.40*	15.01*	646.62*	12.13*

*$p < .001$

The fact that the skewness and kurtosis values of the EWI's items are within the range of ±2 (Pituch & Stevens, 2016) signs that the distribution does not depart greatly from univariate normality. On the other hand, the significant results of Mardia's test implies that multivariate normality is violated.

Validity and Reliability Analysis

EGA, EFA and CFA were applied within the scope of the validity studies of the Turkish form of the EWI. EGA is a relatively new technique that was proposed within the framework of network psychometrics for identifying the number of dimensions underlying multivariate data (Golino et al., 2020). It is based on estimating a network followed by the application of a community detection algorithm (Christensen & Golino, 2021; Golino & Epskamp, 2017). In addition to the number of factors to be retained, EGA also exhibits which items are clustered together and their level of association (Golino et al., 2020).

In EFA, the factorability of the data was first tested. In this context, the Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's test result were examined. The KMO statistic was calculated as .863 and Bartlett's test of sphericity was statistically significant (χ^2=1393.809, df=55, p<.001). According to Kaiser (1970, 1974), KMO values of .70 and above indicate that the sample heterogeneity is sufficient for factor analysis (Meyers et al., 2016). In addition, Bartlett's test being significant reflects that the correlation matrix is not a unit matrix and the data are suitable for factor analysis (Bandalos, 2018). According to these criteria, it was understood that the research data were factorable.

Since the data violated the multivariate normality assumption, the principal axis factoring technique, which does not stipulate any conditions regarding the distribution of the data (Pituch & Stevens, 2016), was operated in EFA. As the number of response categories of the EWI was four, EFA was conducted based on polychoric correlation matrix, taking into account the recommendations in the literature (Kılıç, 2021; Tabachnick & Fidell, 2013). Another important issue in EFA is the method to be utilized in deciding the number of factors. Considering that it produces more accurate results about the number of factors compared to other methods (Glorfeld, 1995; Hayton et al., 2004), parallel analysis technique was used to decide the number of factors in EFA. Since the research data did not meet multivariate normality, the Satorra-Bentler robust maximum likelihood (MLM) estimator (Newman & Constantinides, 2021; Roos & Bauldry, 2022), which is robust to violation of normality, was employed in the CFA. Table 3 demonstrates the fit indices examined to evaluate the model-data fit in CFA and the recommended cut-off points for these indices.

Tablo 3. The fit indices examined in the study and the critical values for these indices

Fit indices	χ^2/df*	RMSEA**	SRMR**	CFI**	GFI**	TLI**	IFI**
Cut-off points for acceptable fit	< 3	< .08	< .10	> .90	> .90	> .90	> .90

* Marsh & Hocevar (1985), ** Pituch & Stevens, (2016)

Later than the analyses that provided evidence of validity, reliability analysis was carried out. To determine the reliability of the measurements obtained with the Turkish version of the EWI, Cronbach's alpha internal consistency coefficient was calculated, as in the original form of the scale. The discrimination power of the scale items in Turkish culture was tested over the corrected item-total correlations. Finally, the Ferguson's delta statistic (Ferguson, 1949) was calculated to obtain a discrimination coefficient for the overall scale. This statistic provides information about the degree to which individuals differ in terms of the scores they get from the instrument (Zhang & Lidbury, 2013). While calculating Ferguson's delta, the formula in Figure 1 was used (Hankins, 2008). Statistical procedures for reliability and item analysis and the Ferguson's delta statistic were conducted on 487 observations from the combination of the EFA and CFA data sets.

$$\delta = \frac{[1+k(m-1)][\,n^2 - \sum f^2\,]}{kn^2(m-1)}$$

k = Number of items
n = Sample size
m = Number of item response options
f = Frequency of each score

Figure 1. The formula of Ferguson's delta statistics

In the study, to detect multivariate outliers, assess normality and attain EGA network, the web tool designed by Kılıç (2023) was used. Ferguson's delta statistic was computed in Microsoft Excel. All other analyses in the research were performed in the JASP 0.18.1.0 program.

RESULTS

In the research, it was first tested whether the two-dimensional structure in the original version of the EWI was confirmed in Turkish culture. Since CFA results showed that the two-factor model was not confirmed, the factor structure in Turkish culture was tested by applying EGA and EFA. Figure 2a and Figure 2b illustrates the EGA result and the scree plot containing the output of parallel analysis, respectively.
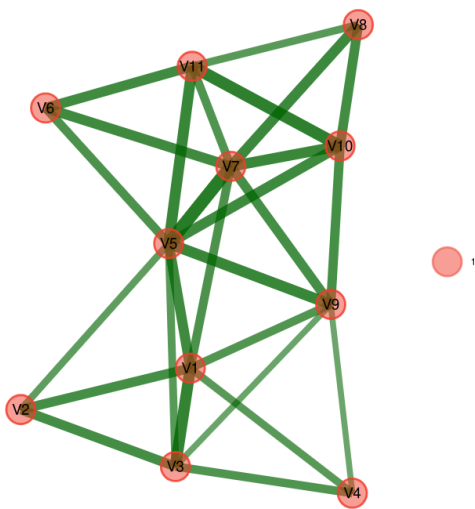
Figure 2a. The EGA results
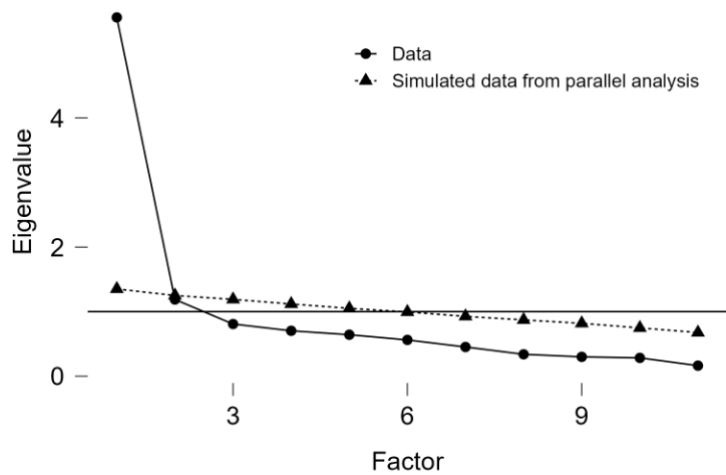
Figure 2b. The scree plot containing parallel analysis result

In parallel analysis, a random data that have the same number of observations and variables as the actual data is generated initially. Then, the eigenvalues estimated from real data are compared with the eigenvalues derived from random data and the factors whose eigenvalues are greater than random are retained (Pallant, 2020). The scree plot displays that only eigenvalue of the first factor exceed the corresponding value from the random data set. Similarly, the network model revealed by EGA, where items are represented by circles and the relationship between two circles (e.g. partial correlation) by lines (Christensen & Golino, 2021), depicts a unidimensional construct. This result infers that the Turkish form of the EWI has a single-factor structure, unlike the original one. Table 4 presents the extracted variance, and the items' factor loadings in the unidimensional structure.

Table 4. EFA results for the Turkish form of the EWI

Items	Factor Loading	Items	Factor Loading
EWI-1	.721	EWI -7	.738
EWI -2	.628	EWI -8	.616
EWI -3	.639	EWI -9	.649
EWI -4	.440	EWI -10	.733
EWI -5	.796	EWI -11	.764
EWI -6	.653	Extracted Variance: 45.80%	

As can be seen from Table 4, the variance ratio explained by the scale is 45.80%, and the factor loadings of the items vary between .440 and 796. Taking into account the single-factor structure emerged in EFA, a unidimensional model was tested in CFA. The fit indices of the unidimensional model were found as follows: χ^2/df = 2.44 (χ^2 = 107.421, *df* = 44, *p* < .001), RMSEA = .077 (90% CI [.059, .096]), CFI = .92, GFI = .92, TLI = .90 and IFI = .92. These fit indices remained within acceptable limits means that model-data fit is achieved. Figure 3 illustrates the measurement model for the unidimensional model.
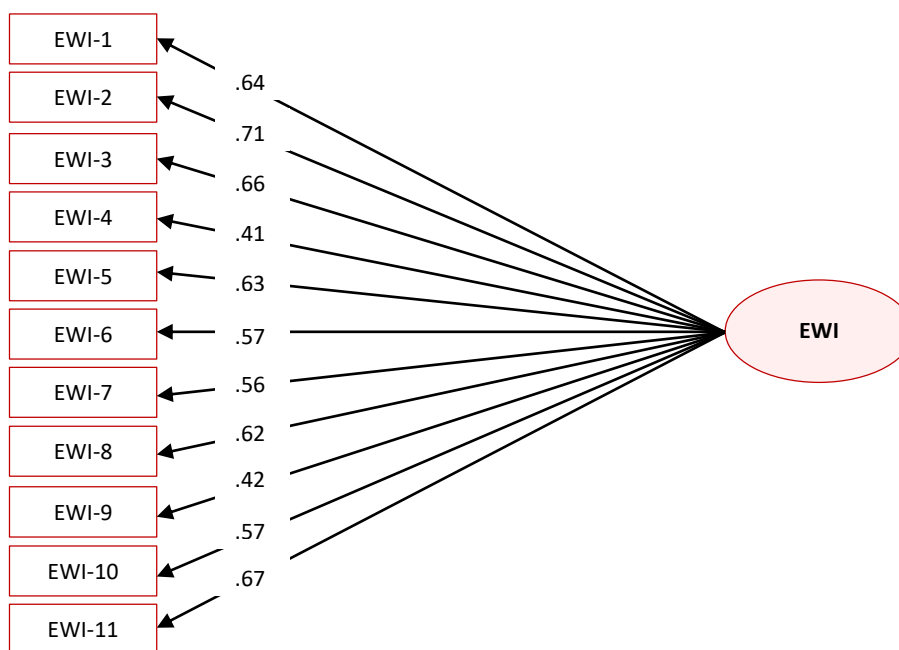
Figure 3. Measurement model of the Turkish form of EWI

Figure 3 shows that the factor loadings obtained from CFA ranged between .41 and .71. Accordingly, it can be said that all items had sufficient factor loadings. Reliability and item analysis were carried out following the analyses that provide evidence of validity. Table 5 shows the Cronbach's alpha internal consistency coefficient calculated for reliability and the corrected-item total correlations obtained as a result of the item analysis.

Table 5. Reliability and item analysis results of the Turkish form of EWI

Item Number	r_{jx}	Mean	Standard Deviation	Cronbach's alpha if item dropped
EWI-1	.560	3.552	.534	.826
EWI -2	.559	3.283	.680	.825
EWI -3	.536	3.618	.507	.828
EWI -4	.360	3.253	.714	.844
EWI -5	.587	3.593	.508	.825
EWI -6	.540	3.310	.673	.827
EWI -7	.546	3.493	.608	.827
EWI -8	.522	3.300	.651	.829
EWI -9	.419	3.688	.490	.836
EWI -10	.568	3.156	.770	.825
EWI -11	.617	3.515	.570	.821
Cronbach's alpha = .842 (90 % CI [.820, .861])				

Table 5 exhibits that corrected item-total correlations vary between .360 and .617, and the internal consistency coefficient of the measurements is .842. In addition, Table 5 provides that there are no items that will provide a clear increase in the Cronbach's alpha coefficient when dropped from the scale. Eventually, the Ferguson's delta (δ) coefficient was calculated to provide an index of the discrimination of the overall EWI and the value obtained was presented in Table 6 together with the frequencies (*f*) used to obtain this statistic. According to Table 6, the Ferguson Delta coefficient for the entire EWI in the Turkish form was found to be .95.

Table 6. Ferguson's delta coefficient for the Turkish form of EWI

Score	f	f^2	Score	f	f^2	Score	f	f^2
26	3	9	33	47	1089	39	41	1521
28	5	25	34	27	1156	40	36	1600
29	5	25	35	35	1225	41	33	1681
30	4	16	36	30	1296	42	25	1764
31	10	100	37	47	1369	43	24	1849
32	22	484	38	31	1444	44	62	1936
Total	49	659	Total	213	759	Total	249	10351

$$\sum f^2 = 18589$$

$$k=11, n=487, m=4 \text{ and } \sum f^2 = 18589 \Rightarrow \delta = \frac{[1+k(m-1)][\,n^2-\sum f^2\,]}{n^2 k(m-1)} = \frac{[1+11(4-1)][\,487^2-18589\,]}{487^2 \times 11 \times (4-1)} = .95$$

DISCUSSION AND CONCLUSION

In this study, the 11 item EWI developed by Oguntayo et al. (2023) to determine anxiety caused by environmental risks on individuals was adapted into Turkish. At the beginning of the adaptation process, it was tried to reach a Turkish form linguistically equivalent to the original scale by utilizing experts' opinions. In line with the experts' feedbacks, a culture-specific change was made in the content of one item of the scale. Validity and reliability analyses of the adapted form were conducted within the framework of classical test theory in the paper. Primarily, it was tested whether the two-factor structure in the original version of the scale was valid in Turkish culture. CFA results showed that the two-dimensional structure was not confirmed. Therefore, the data file was randomly divided into two halves. EGA and EFA was applied to the first half, and the structure revealed in EFA was tested through CFA in the second half. Both the EGA, and the parallel analysis results conducted within the scope of EFA disclosed a single-factor structure. A field expert studying on environmental education, who was consulted about the factor solution of the EWI's Turkish form, also stated that the unidimensional construct is reasonable considering the measured trait and the items in the scale.

In EFA, the variance explained by the unidimensional structure was acquired to be 45.80%. Different researchers suggested various criteria about what the explained variance ratio should be. Bayram (2010) and Büyüköztürk (2010) state that the explained variance ratio should not fall below 30%. According to Aksu et al. (2017), on the other hand, the explained variance should be at least 40%. The extracted variance in EFA meets these criteria. When the factor loadings reported in the EFA are examined, values ranging between .440 and .796 were encountered. According to Tabachnick and Fidell (2013), an item should have a factor loading of at least .32 in order to remain in the scale. Likewise, Brown (2015) and Hair et al. (2019) defined values between .30 and .40 as the minimum respectable factor loading. Based on these boundaries, it can be asserted that there is no item that may pose a threat to the construct validity of the EWI's Turkish form. These EFA results were also supported by the CFA outputs. As a result of CFA, it was found that the factor loadings of all items were higher than .40 and the fit indices were within acceptable limits specified in the literature. These results reflect that the Turkish form of the EWI serves the target of measuring environmental worries of teacher candidates.

In the study, the Cronbach's alpha internal consistency coefficient of the measurements obtained with the Turkish form of the EWI was found to be .842. In addition, it was seen that the reliability coefficient estimated was almost identical to that in the original form of the scale. There is no exact value that can be given to the question of what the minimum reliability coefficient should be in order to say that the measurements are reliable. Because the lower boundary to be taken into account for reliability is affected by various factors. The first of these is the context, namely the purpose for which the measurement results will be used. For example, high reliability values such as .80 or even .90 are expected to be reached in medical measurements and high-stakes tests. In cases where the decisions to be taken have relatively less importance for individuals, values of .70 and above are considered sufficient for reliability (İlhan & Çetin, 2023). An important factor that affects which value should be taken as a cut-off point when it comes to internal consistency reliability is the scale length (O'Rourke & Hatcher, 2013). The internal consistency coefficient is a function of the number of items in the instrument and generally tends to increase as the number of items increases (Urbina, 2004). For this reason, a value of .60 instead of .70 is considered adequate in instruments with a small number of items (Sipahi et al., 2010). Accordingly, the data collected with the Turkish form of the EWI are sufficiently reliable.

Item analysis revealed that the item correlations of the EWI ranged between .360 and .617. Item correlation is one of the statistical indicators of item discrimination. Item correlations above .30 mean that item discrimination is good (Field, 2009). Thus, it can be asserted that there were no items in the Turkish form of the EWI that were outside the latent trait intended to be measured and all items had adequate discrimination. In parallel to this, no item was found in the Turkish form of the scale that would increase the internal consistency coefficient markedly if removed. Finally, the Ferguson Delta statistic for the EWI's Turkish form was determined as .95. The Ferguson Delta statistic can take values ranging between 0 and 1. The recommended threshold for this statistic, which corresponds to .93 in a normal distribution, is .90 (Kline, 1993). Therefore, it is possible to say that the Turkish version of the EWI is capable of distinguishing respondents with different levels of environmental worry from each other.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

When the outputs of the analyses carried out to investigate the psychometric properties of the EWI are taken together, it is concluded that the scale provides valid and reliable measures in the study sample. However, the current paper has certain limitations and further researches are needed to overcome these limitations. First of all, in this study, the psychometric qualities of the Turkish form of the EWI were examined on teacher candidates. Correspondingly, the age range of participants in the current study was narrower than the group for which the original form of the scale was developed. In this sense, the validity and reliability of the instrument can be tested on different groups in future studies. Furthermore, the validity evidence presented in the present study was restricted to EFA and CFA, and reliability evidence was limited to Cronbach's alpha internal consistency coefficient. In the future, different evidence regarding the validity and reliability of the scale can be examined. Specifically, convergent and divergent validity evidence and test-retest reliability of the scale can be investigated. Using the EWI, data can be collected from different groups and the measurement invariance of the scale can be tested in terms of variables such as gender, age groups, education level, etc. Evidence for the validity of scale validity can be enriched by conducting mixed method studies in which the data collected by means of the EWI are supported by qualitative data.

Declaration of Conflicting Interests

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Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

The approval was obtained from Dicle University Social and Human Sciences Ethics Committee for the compliance of the study with current ethical standards (approval letter dated 11.10.2023 and numbered 580293).

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APPENDIX: Turkish Form of the Environmental Worry Index

	Hiç Katılmıyorum	Katılmıyorum	Katılıyorum	Tamamen Katılıyorum
1. Artan hava, su, toprak ve gürültü kirliliğini düşününce endişeleniyorum.	◯	◯	◯	◯
2. Çevremde yaşanan sel felaketlerinden dolayı endişeleniyorum.	◯	◯	◯	◯
3. Çevrenin çöplerle kirletilmesi beni endişelendiriyor.	◯	◯	◯	◯
4. Bulunduğum bölgenin trafik yoğunluğu ve kalabalık oluşu ile ilgili düşünceler beni endişelendiriyor.	◯	◯	◯	◯
5. Doğal afetler ve dünya kaynaklarının giderek tükenmesi hakkındaki konular beni endişelendiriyor.	◯	◯	◯	◯
6. Bazı hayvan türlerinin neslinin tükenmesiyle ilgili düşünceler beni endişelendiriyor.	◯	◯	◯	◯
7. Yaşadığım yerde su ve/veya yiyecek kıtlığına ilişkin bir duyum aldığımda endişeleniyorum.	◯	◯	◯	◯
8. Küresel düzeydeki düşük ya da aşırı yağış raporlarına karşı çıkılması beni endişelendiriyor.	◯	◯	◯	◯
9. Depremler, kasırgalar ve diğer çevresel felaketler beni endişelendiriyor.	◯	◯	◯	◯
10. Ne zaman ozon tabakasının inceldiğine dair bir şeyler duysam endişeleniyorum.	◯	◯	◯	◯
11. Orman yangınları ve karbondioksit açığa çıkması beni endişelendiriyor.	◯	◯	◯	◯

A Learner-Centred International Perspective on the Advantages of Distance Thesis

Uzaktan Tezin Avantajlarına Yönelik Öğrenen Merkezli Uluslararası Bir Bakış

Ömer UYSAL[1]

Abstract

Purpose: The research aims to specify attitude towards DT as well as advantages/strengths/opportunities of DT based on views of international learners in the times of the coronavirus or similar necessary conditions.

Design/Methodology/Approach: Qualitative data and qualitative data analysis techniques were need to reach the purpose of the research. Therefore, the study which was conducted to determine the views of international learners about advantages/strengths/opportunities of DT was designed by the qualitative model. Totally 14 international learners participated the research from different countries. An online form was administered to international learners in Turkey to collect data for the research questions. Qualitative descriptive analysis was used to analyze the data.

Findings: The findings consist of two subjects as the attitude towards distance thesis and the advantages of distance thesis. Attitudes of international learners towards DT are very positive that a great majority of the them confirm idea of DT (%85.70) and most of them (%78.57) want to apply DT in case of necessity like coronavirus. The advantages of DT are determined as follows: Flexibility, time saving, cost saving, access information in digital world, chance for working learners, uninterrupted supervision, communication with online meeting, working with digital information-applications-tools-technologies, learning diversity, getting a degree from university at a distance, collaboration with peers and experts from different institutions, support for modernization of universities, contribution to internationalization, achievement of self-management skill, not to being in the crowd.

Highlights: In the literature, no study was found that addressing advantages of distance thesis for graduate programs. In line with the opinions of international learners, the advantages of distance thesis were determined in the research. It has been revealed that international learners have a positive attitude towards distance thesis and they want to apply for distance thesis in times of pandemic or similar necessary conditions. This article can inspire new researches, new projects on distance thesis and the determination of the distance thesis framework in our country.

Öz

Çalışmanın amacı: Araştırma, koronavirüs veya benzeri gerekli durumlarda uluslararası öğrencilerin uzaktan teze yönelik tutumlarını ve uzaktan tezin avantajlarına/güçlü yönlerine/fırsatlarına yönelik görüşlerini belirlemeyi amaçlamaktadır.

Materyal ve Yöntem: Araştırmanın amacına ulaşabilmek için nitel verilere ve nitel veri analiz tekniklerine ihtiyaç duyulmuştur. Uluslararası öğrenenlerin uzaktan tezin avantajları/güçlü yönleri/fırsatları hakkındaki görüşlerini belirlemek amacıyla yapılan çalışma nitel olarak tasarlanmıştır. Araştırmaya farklı ülkelerden toplam 14 uluslararası öğrenci katılmıştır. Araştırma sorularına yönelik veri toplamak için Türkiye'deki uluslararası öğrencilere çevrimiçi bir form uygulanmıştır. Verilerin analizinde nitel betimsel analiz tekniği kullanılmıştır.

Bulgular: Uluslararası öğrencilerin uzaktan teze yönelik tutumlarının çok olumlu olduğu görülmekle birlikte büyük çoğunluğu (%85,70) uzaktan tez fikrini onaylamakta ve çoğu (%78,57) koronavirüs gibi bir zorunlu durumlarda uzaktan tez uygulaması istemektedir. Uzaktan tezin avantajları şu şekilde belirlenmiştir: Esneklik, zaman tasarrufu, maliyet tasarrufu, dijital dünyada bilgiye erişim, çalışan öğrenenlere şans, kesintisiz denetim, çevrimiçi toplantı ile iletişim, dijital bilgi-uygulamalar-araçlar-teknolojiler ile çalışma, öğrenme çeşitliliği, uzaktan üniversite diploması almak, farklı kurumlardan akran ve uzmanlarla işbirliği yapmak, üniversitelerin modernleşmesine destek olmak, uluslararasılaşmaya katkı sağlamak, kendi kendini yönetme becerisi kazanmak, kalabalığın içinde olmamak.

Önemli Vurgular: Literatürde lisansüstü programlar için uzaktan tezin avantajlarını ele alan bir araştırmaya rastlanmamıştır. Araştırmada uluslararası öğrencilerin görüşleri doğrultusunda uzaktan tezin avantajları belirlenmiştir. Uluslararası öğrencilerin uzaktan teze karşı olumlu bir tutum içinde oldukları ve salgın ya da benzeri gerekli durumlarda uzaktan tez başvurusu yapmak istedikleri ortaya çıkmıştır. Bu makalenin ülkemizde uzaktan tez yazımı konusunda yeni araştırmalara, yeni projelere ve uzaktan tez çerçevesinin belirlenmesine ilham kaynağı olabileceği düşünülmektedir.

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INTRODUCTION

Distance education was started by sending a message to others by smoke, pigeon, letter newspaper, etc. By developing technology like television, internet, mobile applications, etc. distance education becomes more powerful to achieve learning objectives. Distance learning technologies contribute to face-to-face education in the universities (Bilgiç, 2021) in terms of out of school activities, learning environment, learning applications, out of school interactions, synchronous communication, e-exercises, e-books, etc. Today many disciplines use distance education like medical, engineering departments, nursing, chemistry, etc. not only bachelor but also postgraduate programs. We see that all levels of formal education institutions should be ready for applying distance learning during the coronavirus or another pandemic. There are a lot of difficulties emerging with the coronavirus in universities and institutions. One of them is how to manage the thesis process both for the supervisor and supervisee. Distance thesis (DT) is crucial and obligatory for that kind of difficult process.

Briefly, DT means preparing a thesis remotely using Information and Communication Technologies (ICT) as the internet, online applications, web tools, emails, video conference programs, online technologies, etc. between supervisor and supervisee without communicating face-to-face. In the literature, distance learning experts do many researches about distance learning in terms of pros and cons, advantages, benefits, strengths, opportunities and solutions (Arkorful & Abaidoo, 2014; Croft et al., 2015; Dağgöl Dişlen & Akcayoğlu İşpınar, 2023; Gilbert, 2015; Moore & Tait, 2002; Oliveira et al., 2018; O'Donoghue et al., 2004; Sadeghi, 2019) as well as a few for DT (Andrew, 2012; Gray & Crosta, 2019; Maor et al., 2016).

There is a high demand for distance graduate programs. Due to uncertainties, legal obstacles, negative perceptions, problems caused by instructors or administrators, quality issue, technical inabilities, lack of infrastructure and no road map for DT, almost all of the distance graduate programs opened are without thesis in Turkey as so in the world (İzmirli, İzmirli & Çankaya, 2019). So, DT is one of the value-added issues for distance learning and distance graduate programs. DT is one of the latest research topics in distance learning (Aitken et al., 2020; Huet & Casanova 2020; İzmirli, İzmirli & Çankaya, 2019; Nasiri & Mafakheri, 2015; Partridge et al., 2016; Stein & Sim, 2020), emerges some advantages inherently. After the determination of the advantages of distance learning in the literature, the researches can be focused to determine the *advantages of DT* with views of international learners.

The UNESCO Institute of Statistics (2020) underlined that 5.5 million international learners were all around the world in 2018 as compared with 2 million in 2000. International learners make enormous contributions and value to host countries' universities and society beyond financial terms (Tran, 2020) and they especially prefer to enroll in graduate programs for an academic career. In the near future, DT can be a factor in choosing a graduate program for international learners. So, views of international learners finding out advantages of DT can contribute to the researches those are drawing the framework of DT (Gray & Crosta, 2019; Maor et al., 2016). Also, supervisors and supervisees can apply DT in HE Institutions delivering face-to-face education in the times of coronavirus by following the DT framework.

Purpose of the Study

The research aims to specify attitude towards DT as well as advantages/strengths/opportunities of DT based on views of international learners in the times of the coronavirus or similar pandemic. Research questions include short answer, multi-choice, and open-ended types of questions. The following research questions will be examined in order to reach the aims:

Short answer or multi-choice questions of the research are shown below:

1. Where is your country?
2. What is your gender?
3. What is your department?
4. What is your education level?
5. How many online/distance courses have you taken so far?
6. It is possible to perform a distance thesis?
7. Do you want to use distance thesis method in order to continue your thesis during no face-to-face meeting with the supervisor because of coronavirus or another pandemic?

Open-ended questions of the research are shown below:

8. What are the advantages/strengths of the distance thesis as compared with the face-to-face thesis?
9. What kind of opportunities do you have by distance thesis as compared with face to face thesis?

Limitations of the Study

It is stated in the international literature that there are few studies on distance thesis in the world (Aitken et al., 2020; Huet & Casanova 2020). There are a very limited number of postgraduate education programs with thesis and there is no research on how learners view the subject in our country (İzmirli, İzmirli & Çankaya, 2019). Within the scope of the study, data were collected from 12 international learners studying at postgraduate level in Turkey and 2 Turkish postgraduate learners who provide academic counselling to international learners. The research is limited to two questions about the advantages of distance thesis.

METHOD

Research Model

There are 2 open-ended questions in the research. Within the scope of the research, in addition to the options offered, unlike survey research, it is necessary to collect in-depth information from the participants about the advantages of preparing theses remotely (Yıldırım & Şimşek, 2008). So, qualitative data and qualitative data analysis techniques were need to reach the purpose of the research. Case study is a qualitative research approach that aims to reveal information about a specific situation, identify situations and themes related to the situation (Creswell, 2009; Merriam, 2013). Therefore, the study which was conducted to determine the views of international learners about advantages/strengths/opportunities of DT was designed by the case study which is one of the methods of qualitative model. Within the scope of the research, it was tried to determine the differences and similarities in the perspectives, opinions and solution suggestions of each of the participants on the research topic. In the light of the opinions obtained, an in-depth and comprehensive analysis was made regarding the advantages of distance thesis.

Study Group

International learners in Turkey consist of the population of the research. Due to difficulties such as analyzing the data, reaching the population, time and cost, etc. the researcher chooses convenience sampling among nonprobability sampling techniques. Convenience sampling facilitates reaching the participants and collect data from the environment where close and known to the researcher (Creswell, 2009). Totally 14 international learners answered the questions from different countries. Table 1 presents the demographic information of the participants.

Table 1. Demographic information of the participants

	Frequency	Percent (%)
Gender		
Female	3	21.43
Male	11	78.57
Country		
Afghanistan	3	21.43
Bangladesh	1	7.14
India	3	21.43
Kirgizstan	1	7.14
Macedonia	1	7.14
Madagascar	1	7.14
Nepal	1	7.14
Tajikistan	1	7.14
Turkey	2	14.30
Field		
Architecture	1	7.14
Communication	1	7.14
Education	2	14.30
Engineering	7	50.00
Finance	1	7.14
Sociology	1	7.14
Turkish Language	1	7.14
Education Level		
Master Thesis	5	35.71
Master Graduate	2	14.30
PhD Course	1	7.14
PhD Thesis	5	35.71
PhD Graduate	1	7.14
Total	14	100

As seen in Table 1, participants consist of 3 females (%21.43) and 11 males (%78.57) of international learners. 3 Participants are from Afghanistan (%21.43), 3 from India (%21.43), 2 from Turkey (%14.30), and 1 from Bangladesh, Kirgizstan, Macedonia, Madagascar, Nepal, and Tajikistan (%7.14). Fields of the participants consist of 7 Engineering (%50), 2 Education (%14.30), and 1 from Architecture, Communication, Finance, Sociology, and Turkish Language (%7.14). According to the education level there are 5 participants (%35.71) in the master thesis, 5 participants (%35.71) in the PhD thesis and 2 participants (%14.30) of Master Graduate. There is a 1 participant (%7.14) of PhD graduate and PhD course as well.

Only 2 participants have not taken distance courses up to now. 2 participants took just 2 distance courses. The other 10 participants took more than 3 distance courses. Due to taking distance courses, the majority of the participants (%85.71) can be stated that know about distance education.

Data Collecting

An online form was administered to international learners in Turkey to collect data for the research questions. The online form consisted of 7 short answer or multi-choice questions and 2 open ended questions. Short answer questions represented independent variables of the research. Open-ended questions were to reveal the views of international learners about advantages/strengths/opportunities of DT as compared with face-to-face thesis. Expert opinions were received to provide content and face validity for the online form and research questions. Themes for the advantages of the distant thesis were found by the researcher. Then the found themes were examined, evaluated, and checked by 2 field experts for the reliability of the coding. After the control, all researchers came together and shared their suggestions for revision through the exchange of ideas and finalized the coding in consensus considering distance learning literature. The data was collected between July and August in 2022 by way of online form. The address of the online form was sent to social media of UDEF (Federation of International Student Associations) Academy and YUDER (Yunusemre International Student Association) and the online form was filled out by 14 international learners with the help of UDEF Academy and YUDER.

Data Analysis

Qualitative descriptive analysis was used to analyze the data. Simple statistical techniques were used for independent variables of the research to find the frequencies and percentages of them. Due to the similarity of the answers towards DT for two open ended questions in terms of advantages/strengths and opportunities, data analysis was conducted with gathering under a single roof as advantages/strengths/opportunities of DT. Qualitative descriptive analysis was used for open-ended questions to analyze and find out the answers to the questions. In this method, findings are indicated with direct quotations to demonstrate what participants think about the topic (Yıldırım and Şimşek, 2005). In the finding part, the findings were illustrated by the citation from views of the participants like [P1, P2, etc.].

Trustworthiness

Trustworthiness criteria are grouped under four main headings: credibility, dependability, confirmability and transferability (Başkale, 2016; Yıldırım & Şimşek, 2005). In this study, the following measures were taken to ensure trustworthiness:

Credibility: In this research; prolonged involvement, member checking and peer debriefing were conducted to ensure credibility. In the context of prolonged involvement, the researcher has known the participants for a long time. As part of member checking, participants stated that the research findings accurately expressed their views. In the context of peer debriefing, two independent researchers good at qualitative research helped for finding out themes of the research reliably. After the control, the researchers gave the final shape to the themes of the research in consensus.

Dependability: Within the scope of the research, data was collected from a total of 14 participants who were postgraduate learners from different countries and departments, and the collected data were compared with each other.

Confirmability: As part of conformability, the data of the research were recorded digitally. The purpose and process of the research are clearly stated. The data were analyzed using the descriptive analysis technique and the findings were obtained. The themes obtained as a result of data analysis are presented in the findings section. To demonstrate the confirmability of the research, the participants' own statements are included in the findings section instead of the researcher's opinions.

Transferability: Participant characteristics were given in Table 1 and participants were determined by purposive sampling method.

Research Procedures

There are more distance graduate programs with non-thesis than distance graduate programs with thesis in Turkey. Today, millions of learners have enrolled to distance undergraduate programs. They could want to enroll distance graduate program with thesis after graduation. There are thousands of international learners in Turkey. There is also a Covid-19 Pandemic Reality. In times of Covid-19 Pandemic, it is difficult to make progress on thesis for not only international learners but also domestic learners. After thinking about the conditions, aim and questions of the research were determined. Method part was clearly planned and organized after determination of aim and research questions. During the preparation process, literature review was carried out. Relevant international learners filled out data collection tool which developed as online form. The data was analyzed by qualitative descriptive analysis by considering validity and reliability. Two independent researchers good at qualitative research helped for finding out themes reliably. After the control, the researchers gave the final shape to the themes in consensus. The most important part of the research was to find out themes of advantages of distance thesis. Then, themes were explained by relating with literature review by the researcher of the paper and all the parts of the paper were completed.

FINDINGS

The findings consist of two subjects as the attitude towards distance thesis and the advantages of distance thesis. There are two questions in the research to identify the attitudes of the participants towards distance thesis. In addition to them, there are two questions in the research to specify the advantages/strengths/opportunities of distance thesis through the views of participants.

Attitudes Towards Distance Thesis

Attitudes are crucial to adopt a new method. If the attitudes are positive, participants will get used to adopt the new method easily. Also, positive attitudes make it easy to increase motivation and increasing motivation can provide positive effects regarding to academic performance, volition and course interest which elements can be a key for overcoming challenges in distance learning environment (Uçar & Kumtepe, 2020). The attitudes of the participants towards DT are shown in Table 2.

Table 2. Attitudes of the participants towards distance thesis

	Frequency	Percent (%)
Idea of Distance Thesis		
Yes	12	85.70
No	2	14.30
Distance Thesis in case of Necessity		
Yes	11	78.57
No	3	21.43
Total	14	100

According to Table 2, 12 participants confirm that it is possible to perform DT as well as 2 participants do not confirm. Similarly, 11 participants accept that they want to use DT method to continue their thesis during no face-to-face meeting with the supervisor because of coronavirus or another pandemic. But 2 participants do not want to use DT method in the same process as seen in Table 2. The answers of the majority of the participants are "Yes" for both variables idea of distance thesis (%85.70) and distance thesis in case of necessity (%78.57). One of the participants gave "Yes" answer for the idea of DT and "No" answer for DT in case of necessity. The participant explained the oppositeness like that shown below:

"Traditional methods for preparing thesis can change. So, leaners should be ready for DT in order to keep up with the times. But I am traditional man. I do not want to write distance thesis because I want to meet advisor face to face and I want to get advice face to face to complete my thesis properly" [P2].

Analysis for Distance Thesis

Analysis of DT includes themes in terms of advantages/strengths/opportunities of DT. DT was derived from distance education. So, all the themes about distance thesis are connected to distance education. The study was focused on the advantages/strengths/opportunities of DT by descriptive analysis of collected data.

Advantages/Strengths/Opportunities of Distance Thesis

After doing descriptive analysis, themes for advantages/strengths/opportunities of distance thesis were found out as seen in

Table 3. Themes for advantages/strengths/opportunities of distance thesis

Themes	Frequency
• Flexibility	8
• Time saving	7
• Cost saving	4
• Access information in digital world	5
• Chance for working learners	6
• Uninterrupted supervision	3
• Communication with online meeting	3
• Working with digital information-applications-tools-technologies	4
• Learning diversity	2
• Getting a degree from university at a distance	2
• Collaboration with peers and experts from different institutions	3
• Support for modernization of universities	1
• Contribution to internationalization	3
• Achievement of self-management skill	3
• Not to being in the crowd	2
• No advantage	4

DT provides learners to be flexible for preparing the thesis. Learners can study anytime, anywhere, and anyplace to prepare distance theses with the advantage of online distance education (Dye & Torstein, 2008; Karadeniz, 2009; Oliveira et al., 2018; Taşkın, 2009; Veletsianos & Houlden, 2019). DT can be one of the applications of online distance education. Views of some participants about "flexibility" are as follows:

"Greater flexibility... Could study whenever, wherever. Could learn at your own pace… but can study whenever you have time and your job schedule allows it." [P7].

"We can open out laptop or smartphone wherever we are and be in communication." [P1].

"We can decide when and where we study." [P8].

Time-saving and cost-saving are classical advantages of not only distance learning (Oliveira et al., 2018; Twigg, 2003; Wall et al., 2006) but also DT. Digital materials and contents such as thesis proposal, feedback, etc. can be shared between supervisee and supervisor free of charge within seconds and with just a click. Views of some participants about "time and cost-saving" are shown below:

"Could save time and money." [P7].

" … We save a lot of time because we don't have to be at a certain place..." [P1].

" … distance thesis can be written for making good use of time as the time is very precious." [P2].

Distance learners are supposed to have digital literacy skills. Those skills can progress in distance learning process as well (Maor & Curie, 2017) While they are learning at a distance, they are aware of how to access information in digital world. Because they can access all the required information at a distance with using ICT throughout the distance program (Arkorful & Abaidoo, 2014; Sampson et al., 2014; Uçar, 2020). There is no need to go library of the different universities to examine thesis about research topic. Distance learners are becoming specialist for accessing related information from digital datacenters and digital resources such as databases, e-journals, e-libraries, websites, e-books etc. relevant to their distance courses or DTs. They can do literature review easily and reach related information for all the components of DT such as introduction, method, finding, result and discussion, reference through ICT (Stein & Sim, 2020). When necessary information gathered, it is getting easy to write DT. One participant referred to "access information in digital world" by underlining accessibility.

Almost all learners have to work after graduation or receive fund from the research councils or other funding resources, and it seems like that. Carpenter et al. (2012) stated that of 6,161 Generation Y doctoral learners in the sample 94% were studying full-time in their research. Learners need alternatives to go on their educational process in post graduate programs especially in the knowledge era. After enrolling the distance master program and completing the courses, learners can start to prepare their thesis as well as having a job (Brace-Govan & Clulow, 2001; Feasley, 1983; O'Donoghue & Singh, 2001; Wall et al., 2006). It is a big chance for working learners. Views of participants about "chance for working learners" are as follows:

"You do not need to leave your employment position but can study whenever you have time and your job schedule allows it." [P7].

"For working learners it is good to have distance thesis." [P12].

"working during day and studying during night" [P14].

Unfortunately, most of the theses have been delayed during the coronavirus. Because there was no face-to-face meeting between supervisor and supervisee. Higher Education (HE) Councils and Institutions of the Universities announced interruption of face-to-face theses and they recommended to use distance learning techniques to provide uninterrupted supervision. It means HE Councils and Institutions confirmed that DT can be prepared in times of coronavirus or another pandemic by using distance learning techniques. Because learners need feedbacks about questions on their theses from supervisors to make progress with the theses (Albion & Erwee, 2011; Gray & Crosta, 2019). Taking feedback in case of necessity from supervisors can enhance learners' engagement (Zheng et al., 2020) in not only face-to-face thesis process but also DT process. Online meetings were recommended for communicating between supervisors and supervisees continuously together for making an agreement about distance theses as well as continuous feedbacks. A sample from views of participants about "uninterrupted supervision" is shown below:

" … Especially during the times of crisis when meeting in person is not possible, online meeting comes as a handy solution so that the collaboration on a project or supervision of learners can continue without any interruption." [P1].

Online meeting (lecture) is one of the most effective components of the distance education (Chen & Thomas, 2020). It gives a chance to meet instructors and fellows together. Online meetings provide crucial achievements in the context of communication and interaction for distance learning as well as DT (Barnes, 2000; Crosta et al., 2015; Huet & Casanova, 2020). After developing online meeting program, it can be said that distance learning can be as effective as face-to-face learning. Because, integration of class and lessons emerged in distance learning environment with support of online meetings. Synchronous applications such as online meeting eliminate lack of asynchronous applications. Distance learning became more powerful when the integration of

synchronous and asynchronous applications was completed. One of the most useful activities in DT process is to have an online meeting of supervisor and supervisee (Andrew, 2012; Butcher & Sieminsky, 2009; Maor & Curie, 2017; Maor & Fraser, 2015; Manyike, 2017). Online meetings provide supervisors and supervisees to have a meeting anywhere, anytime as well as building strong relationship in the scope of DT (Aitken et al., 2020; Andrew, 2012). A view of one participant about "communication with online meeting" is as follows:

"Online meetings offer the comfort of our private space so we can focus more on the agenda at hand... ...Especially during the times of crisis when meeting in person is not possible, online meeting comes as a handy solution so that the collaboration on a project or supervision of learners can continue without any interruption. Online meetings can be necessary for learners working on their theses from a different city than where the advisor is...." [P1].

Today, the components of distance or online education are designed and produced with the help of ICT. That means all of them are digital such as the books are transformed to e-books. So, learners follow digital information-applications for their theses (Carpenter et al., 2012). It is easy to copy, past, edit and send the digital information and features of the digital information provide many advantages/strengths/opportunities for learners. As Sussex (2008) underlined one of them is the record opportunity. Online meetings between supervisor and supervisee for thesis can be recorded easily and watched repeatedly, e-mails between supervisor and supervisee are stored automatically by time info and a stored e-mail can be read whenever it needs. Digital applications-tools are another resources for DT such as Doctoralnet, Form@doct, PSVSP, CoTiques, Scrivener, Klok, #phdchat etc. (Bennett & Folley, 2014; Dowling & Wilson, 2017; Loureiro et al., 2010; Maor et al., 2016; Maor & Fraser, 2015). Maor & Currie (2017) demonstrated that working with Web2.0 applications make thesis supervision more participatory and collaborative. Similarly, advantages of ICT for learning can be thought as advantages of DT because of ICT usage in the DT process (Barnes, 2000; Carpenter et al., 2012; Hamada, 2011; Loureiro et al., 2010; Zvavahera & Masimba, 2019). Stein and Sim (2020) stated that advance level use of ICT for both supervisor and supervisee can provide high quality supervision for DT. A view of one participant about "working with digital information-applications-tools-technologies" is shown below:

"You can watch the lesson again and again." [P4].

"The development of technology and online programs are the big opportunities to write distance theses" [P3].

Internet, one of the crucial components of the distance education is the information bank of the world. Thanks to internet, learners can reach all the permitted information about their theses in the world as well as national information resources. At this point open access should be supported by relevant institutions and all of the people are encouraged to contribute to open access. Because not only distance learners but also face-to-face learners should access all the required information, tools and materials via ICT (Harsasi, 2015; Picasso & Phelan, 2014). Distance learners can find relative e-books, papers, statistics, reports etc. about their distance theses from different databases in the world. For example, more than 5 million theses from universities in nearly 100 countries can be accessible from ProQuest Dissertations & Theses Global. Number of theses grows by 200,000 each year. Also, they can enroll for MOOCs, online courses from top of the universities in the world. So, this advantage provides learning diversity and it is a big chance for learner. A view of one participant about "learning diversity" is as follows:

"...Could learn from any university in the world... You can communicate with other people around the world who are taking the same course as you..." [P7].

Learners want to do master or doctorate after finishing a bachelor program. According to statistics of HE Council of Turkey, there are 2.071.925 learners in distance bachelor programs and 9757 learners in distance master programs with non-thesis. There is no distance doctoral program with thesis or non-thesis in some of the countries. After finishing distance bachelor programs, thousands of learners can do master with thesis or non-thesis at a distance to get a degree. If researchers and experts of distance learning set the framework of distance thesis properly (Gray & Crosta, 2019; Maor et al., 2016), then the number of distance master and doctoral programs with thesis can be increased. Therefore, international learners can enroll distance master or doctoral programs with thesis in the universities all over the world. The advantage provides learners to get a degree with thesis from university at a distance. Another advantage of getting a master degree with thesis permits to apply for instructor positions in the universities or to Re&De expertise in public or private institutions. For example, there are 153.000 Re&De experts and 112.000 research specialists in Turkey. The target of authorized organization is to being worked totaly 300.000 Re&De experts and 200.000 research specialists in Turkey in the scope of vision 2023 (The Ministry of Industry and Technology 2019). For that reason, getting a degree from distance master program with thesis can be good idea to be able to work as a Re&De expert or research specialist in public or private institutions. A view of one participant about "getting a degree from university at a distance" is shown below:

"...Could get a degree from any university without leaving on that country... "[P7].

Thesis jury consists of 3-5 field experts. They can facilitate the preparation of the thesis with their experience. Sometimes the field expert can be in different city or even in different country. If the learner enrolls formal institution, it will be more difficult to invite the field expert as a member of the thesis jury. But if the learner enrolls distance institution then the invitation will not be difficult. At the same time, the field expert coming from different place will share his/her experiences, give crucial feedback to learners and facilitate the thesis with increasing the its effectiveness. Those kind field experts give confidence to learners who

need correct advisory for their theses. DT provides learners to invite field experts from other institutions who will be member of thesis jury. That is a great collaboration to carry out innovative DT. It is a big advantage that everyone wants to catch whether preparing DT or face-to-face thesis. This time, distance learners are lucky for collaborating with experts all around the world towards DT. Experts of distance learning support to establish online communities to strengthen collaboration between all stakeholders in distance learning (Bozkurt & Sharma, 2020; Evans, 1995; Loureiro et al., 2010; Maor et al., 2016). It is worth to examine a research that Locke and Reece (2005, pp:120-121) gave some samples about collaboration on distance learning efforts. Not only field experts but also fellows can contribute to DT as in the process of face-to-face thesis (Aghaee & Hansson, 2013; Carpenter et al., 2012). So, online supervision communities working as research support service can be built to enhance collaboration between supervisor, supervisee and fellows (Bennett & Folley, 2014; Crosta et al., 2015; Huet & Casanova, 2020; Manyike, 2017; Partridge et al., 2016). A view of one participant about "collaboration with peers and experts from different institutions" is as follows:

"…Could learn from any university and/or instructor in the world… You can communicate and interact not only with the professor through virtual means but also with other people around the world who are taking the same course..." [P7].

"…online meeting comes as a handy solution so that the collaboration on a project or supervision of learners can continue… Online meetings can be necessary for learners working on their theses from a different city than where the advisor is…." [P1].

DT can be carried out properly with ICT like distance learning. The institution must build infrastructure for operating DT as well as preparing supervisors and supervisees effectively in terms of pedagogy and research skills (Huet & Casanova, 2020). The institution also must follow the innovations as well as supporting for modernization to utilize convenient equipment ranging from blackboard learning system to distance thesis supervision (Maor & Fraser, 2015; Paudyal, 2006; Zvavahera & Masimba, 2019). For that reason, DT can be an opportunity to support for modernization of the relevant universities. A view of one participant about "support for modernization of the universities" is shown below:

"University should be modernized for distance thesis." [P5].

Learners from all over the world can take courses from universities or different Massive Open Online Courses (MOOC) platforms with distance learning. In times of coronavirus in 2020, 20 million learners registered to Coursera and total number of learners reached to 65 million, 8 million learners registered to edX and total number of learners reached to 32 million, 4 million learners registered to Future Learn and total number of learners reached to 13.5 million. According to Class Central statistics (March 15th - May 15th, 2020), hundred thousands of learners from different countries from around the world became members of Class Central MOOC Platform as seen in Figure 1 (Central Class, 2020).

Locale	Countries	Cities	Languages	Org	Hostnames
The United States	3,739,688	+999%			
India	1,626,664	+806%			
The United Kingdom	902,026	+999%			
Canada	664,279	+999%			
Thailand	587,858	+999%			
Turkey	308,363	+999%			
Australia	300,106	+817%			
Germany	287,357	+999%			
Nigeria	282,397	+648%			
Italy	218,134	+999%			

Locale	Countries	Cities	Languages	Org	Hostnames
Bangkok, Thailand	333,890	+999%			
Lagos, Nigeria	177,316	+57%			
Mumbai, India	165,196	+999%			
Pune, India	147,778	+999%			
Hyderabad, India	129,131	+781%			
Bengaluru, India	124,535	+438%			
Istanbul, Turkey	119,743	+999%			
Singapore, Singapore	107,880	+999%			
Toronto, Canada	102,865	+999%			
Delhi, India	93,373	+86%			

Figure 1. Members of Class Central from around the world in times of Covid (Central Class, 2020).

The statistics show how distance learners contribute to internationalization in the world. Learners want to study with an expert from another country for their theses if they need. Learners can interview with experts from all over the world to find out answers of research questions in their theses as well as doing an international research. Learners can make discussion about the theses with other learners from around the world. So the advantage makes international relations more powerful and increases international collaborations. Partridge et al. (2016) stated that distance doctoral partnership having DT provides the opportunity to advance research agendas and to build strong international connections and partnerships. Distance learning communities are typically more diverse in terms of cultures, religions and nationalities (Huet & Casanova, 2020; Zvavahera & Masimba, 2019), so DT can contribute to internationalization. These are a couple of samples towards DT how to contribute internationalization. International learners can prepare their theses in their homeland with DT even if they registered a formal master or doctoral program in case the study topic is proper. A view of one participant about "contribution to internationalization" is as follows:

"Could take courses and learn from any university and/or instructor in the world…   …You can communicate and interact not only with the professor through virtual means but also with other people around the world who are taking the same course as you…" [P7].

DT can be difficult for some types of learners. If a learner who has insufficient motivation and insufficient self-study skills, then DT may be not for him/her. Learners must have some personal features and skills towards learning motivation, learning strategy, self-efficacy, digital literacy, lifestyle factors for successful distance learning (Broadbent & Poon, 2015; Rurato, 2011; Sadeghi, 2019; Wang et al., 2008; Yıldırım et al., 2014). Learning especially in online distance learning needs discipline (Butcher & Sieminsky, 2009; Oliveira et al., 2018). Learners who take learning responsibilities themselves must make a plan, prepare a schedule, determine their learning strategies and give decisions etc. for distance learning process to complete their theses successfully. Learners can improve self-management skill in the process. A view of one participant about "achievement of self-management skill" is shown below:

"You learn how to manage yourself" [P9].

People are warned about staying at home in times of coronavirus. The motto against coronavirus is like "Life fits home" in Turkey. Almost all formal educational institutions from preschool to graduate programs in the world have stopped face-to-face learning/teaching process and started distance learning/teaching process all around the world within the scope of struggling coronavirus. Because it has a big risky that virus can be infected especially in the crowd. Distance learners are no need to go out and interact with mess for DT. For this reason, it is one of the advantages of DT. A view of one participant about "not to being in the crowd" is as follows:

"Because of Covid pandemic it is better to do distance thesis to avoid the interaction with masses while travelling." [P12].

Learners have different features and attitudes. Some of the learners like something as well as the others may not. The truth complies with nature of the humankind. Two participants stated that there is no advantage even they took some distance courses because of their negative attitudes against DT. One of them suggested other learners to use DT if their characteristics is convenient for distance learning. He said he is traditional person so, DT is time loss for him. Two more participants stated that there is no advantage although they have positive attitude to write DT. Believing that DT is no simpler than face-to-face thesis could be the reason of the theme "No advantage".

DISCUSSION CONCLUSION AND RECOMMENDATIONS

Today most of the distance learning activities based on communication and collaboration can be performed similar with face-to-face learning activities. Face-to-face learning integrated with distance learning is getting turned into blended learning. So, especially in times of pandemics such as coronavirus, distance learning is being important for face-to-face education institutions as well. Not only distance education institutions but also face-to-face education institutions can apply DT in this pandemic process. In the research, attitudes towards DT and advantages of DT were tried to specify for learners, supervisors and HE Instutions. According to the research, the results about attitudes towards DT and advantages of DT can be expressed respectively as follows:

- Attitudes of international learners towards DT are very positive that a great majority of the them confirm idea of DT (%85.70) and most of them (%78.57) want to apply DT in case of necessity like coronavirus.
- The advantages of DT are determined as follows: Flexibility, time saving, cost saving, access information in digital world, chance for working learners, uninterrupted supervision, communication with online meeting, working with digital information-applications-tools-technologies, learning diversity, getting a degree from university at a distance, collaboration with peers and experts from different institutions, support for modernization of universities, contribution to internationalization, achievement of self-management skill, not to being in the crowd.

In the literature, there are several researches about distance supervision (Aitken et al., 2020; Albion & Erwee, 2011; Andrew, 2012; Butcher & Sieminsky, 2009; Evans, 1995; Huet & Casanova, 2020; Maor et al., 2016; Nasiri & Mafakheri, 2015; Partridge et al., 2016; Paudyal, 2006; Sussex, 2008). Some of the researches underlined challenges and how to overcome the challenges of DT in order to increase the quality of DT in terms of distance supervision (Andrew, 2012; Butcher & Sieminsky, 2006; Huet & Casanova, 2020; Nasiri & Mafakheri, 2015; Partridge et al., 2016; Paudyal, 2006).

Regarding DT, the literature on postgraduate supervision at a distance is still very limited and more research is required for actual performance of the suggested strategies as stated Nasiri & Mafakheri (2015). After understanding the importance of the topic, the researcher decided to research advantages of DT according to views of international learners as well as taking attention of HE Institutes towards DT for learners who stop writing face to face thesis in the times of coronavirus. The other reason towards the research is to encourage opening distance graduate programs with thesis in the HE Institutions where the infrastructure is ready. The target is to being opened much more distance graduate programs to cultivate many Re&De experts towards not only for academy but also for other public and private sectors in accordance with information age.

In the research, specifically advantages/strengths/opportunities of distance thesis was elaborated with views of international learners enrolled to face to face graduate programs as well as utilizing relevant information in the researches abovementioned. In the research, result of attitude towards DT was supported by some other researches either which showed positive attitude

(Andrew, 2012; Butcher & Sieminsky, 2006; Partridge et al., 2016). Experts should take into account online research communities for attitude towards DT. Online research communities can have very positive effect for attitude towards DT because of availability for teacher presence, cognitive presence and social presence towards distance learners (Crosta et al., 2015; Garrison et al., 2000; Partridge et al., 2016).

The results of the research towards themes for advantages of DT were supported by some other researches. Andrew (2012) stated that there are some advantages of distance supervision similar with this research such as the flexibility of the remaining place, access subjects, communication with online meeting, record of supervisory moment, supported with e-community. Paudyal (2006) specified the advantages of DT supervision as the themes such as flexibility of the remaining place, cost saving, time saving, collaboration with experts in different institutions, use of ICT, access information in digital library, technology support, practice of virtual learning. Use of ICT is seen a special issue for DT supervision in the literature (Bennett & Folley, 2014; Dowling & Wilson, 2017; Maor & Currie, 2017; Maor et al., 2016; Loureiro et al., 2010; Stein & Sim, 2020; Sussex, 2008; Zvavahera & Masimba, 2019). According to the researcher and some of the researches in the literature (Barnes, 2000; Carpenter et al., 2012; Hamada, 2011; Loureiro et al., 2010; Zvavahera & Masimba, 2019) the advantages of ICT for both face to face and distance learning can be thought as the advantages of DT because of ICT usage in the DT process.

Distance learners should have some skills like self-directed, self-motivated, digital information literacy, ICT literacy, online communication skills, intrinsic motivation, internal locus of control etc. (Akgün Özbek, 2015; Dabbagh, 2007; Fırat et al., 2018; Özdamar-Keskin et al., 2015; Wang et al., 2008). Those skills provide distance learners to utilize advantages of DT as well as facilitating DT process. Otherwise, DT process can be tough to complete.

The advantages of DT can contribute to drawing the framework of DT with a few researches having same purpose (Gray & Crosta, 2019; Maor et al., 2016) as well as determining for accreditation and quality assurance standards of DT. Also, HE Institutions can support to carry out DT in case of necessity and proper by following the DT framework for distance learners and face-to-face learners. A couple of recommendations can be shared related to the research to increase visibility for advantages of DT as follows:

- The research can be repeated with supervisors having experience for distance learning or distance supervision.
- International learners can write their master thesis at home country remotely with the help of distance supervision by support of the faculty after finishing face-to-face master courses (Paudyal, 2006). Also, two distinct doctoral level distance graduate programs completed 9 DT between 2008-2016 and completed 200+ DT between 1997-2009 should be taken into account for distance graduate programs with thesis (Butcher & Sieminsky, 2009; Partridge et al., 2016). These kinds of samples can be a model for international learners how to being applied DT through distance graduate programs and face-to-face graduate programs in the case of necessity. A new DT model could be created with being synthesized similar successful samples of the distance graduate programs with thesis.
- A significant majority of learners want to continue their studies through the online teaching mode until the COVID-19 cases are under control (Gope, Gope & Gope, 2021). Emergency remote teaching is an obligation during the pandemic or similar outbreaks as stated Bozkurt & Sharma (2020). Faculty members, experts must overcome the obligation that learners of graduate programs can write their thesis without pausing. So, DT could be a solution not only international learners but also all the learners who stop writing thesis in face-to-face graduate programs because of the pandemic or similar outbreaks.
- Online research communities can help distance learners not only nationally but also internationally for communication and collaboration about DT (Bennett & Folley, 2014; Huet & Casanova, 2020; Loureiro et al., 2010). So, online research communities can be established towards distance learners both domestic or international in order to complete DT properly.
- Countries carrying out distance graduate programs with non-thesis towards international learners should take into account the views of international learners on DT.

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Statements of publication ethics

I/We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Ethics Committee Approval Information

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| Research Article / Araştırma Makalesi |

A Content Analysis of the Numbers and Operations Learning Area-themed Articles Published in Turkey Related to Their Topic Trends and Results

Türkiye'de Yayımlanan Sayılar ve İşlemler Öğrenme Alanı Temalı Makalelerinin Konu Eğilimlerine ve Ulaşılan Sonuçlarına İlişkin İçerik Analizi [1]

Rüveyda KANDAL[2], **Fatih BAŞ**[3]

Abstract

*Purpose:*This research aims to explore the level/case determination and experimental, related to any variable, articles, which have been conducted on the numbers and operations learning area in mathematics education and published in the educational journals in Turkey, within the scope of their topic trends and results.

Design/Methodology/Approach: Within the scope of the research designed with the descriptive content analysis method, 301 articles were determined and the obtained results were analysed with the content analysis method.

Findings: The result is as follows: In the articles, which were focused on the level/situation determination, mainly the skill articles such as various misconceptions/ errors/ difficulties/ difficulties in fractions/operations with fractions and natural numbers/operations with natural numbers or problem posing skills, mental calculations/ arithmetic operations skills were examined. In the articles on problem posing related to fractions, it was determined that the conceptual difficulties were common and the students overgeneralised about the concept and operations of fractions. In addition, it was observed that the participant had low skill levels of problem posing and problem-solving related to the operations with fractions and natural numbers. In the articles, whose study focus was experimental, mostly the achievement articles in the form of mathematics/academic/student/learning, number/rhythmic counting, and problem-solving success with operations, for fractions and natural numbers, were discussed. When the results of the articles conducted in this scope were analysed, it was determined that the independent variables in the research increased the achievement or performance of the mentioned dependent variables.

Highlights: It was mostly focused on the articles aimed at determining the level or situation in the form of misconceptions/errors/difficulties about fractions and natural numbers in the reviewed articles. Considering this, further studies will be conducted, and academic studies examining the experimental, relational and predictive situations to eliminate misconceptions/errors or difficulties can be carried out within the scope of this subject.

Öz

Çalışmanın amacı: Türkiye'de, matematik eğitiminde, sayılar ve işlemler öğrenme alanında yapılan ve Türkiye'deki eğitim dergilerinde yayımlanan herhangi bir değişkene yönelik düzey/durumun belirleme ile deneysel odaklı makaleleri; konu eğilimleri ve sonuçları kapsamında incelemektir.

Materyal ve Yöntem: Betimsel içerik analizi yöntemi temel alınarak tasarlanan araştırma kapsamında 301 makale belirlenmiş ve ulaşılan veriler içerik analizi yöntemiyle analiz edilmiştir.

Bulgular: Çalışma odağı düzey/durum belirlemeye yönelik olan makalelerde ağırlıklı olarak kesirler/kesirlerle işlemler ve doğal sayılar/doğal sayılarla işlemlere yönelik çeşitli kavram yanılgısı/hata/zorluk/güçlükler veya problem kurma becerisi, zihinsel hesaplama/aritmetik işlem becerisi şeklindeki beceri makaleleri ele alınmıştır. Kesirlere yönelik problem kurma makalelerinde daha çok kavramsal boyutta güçlükler yaşandığı, kesir kavramına ve işlemlere yönelik öğrencilerin aşırı genelleme yaptıkları belirlenmiştir. Bununla birlikte katılımcıların kesirler ve doğal sayılarla işlemlere yönelik problem kurma ve problem çözme beceri düzeylerinin düşük olduğu görülmüştür. Çalışma odağı deneysel nitelikte olan makalelerde ise daha çok kesirler ve doğal sayılara yönelik matematik/akademik/öğrenci/öğrenme, sayı/ritmik sayma ve işlem ile problem çözme başarısı şeklindeki başarı makaleleri ele alınmıştır. Bu kapsamda yürütülen makalelerin sonuçları analiz edildiğinde ise; genel olarak araştırmalarda yer alan bağımsız değişkenlerin belirtilen bağımlı değişkenlerdeki başarıyı veya performansı artırdığı belirlenmiştir.

Önemli Vurgular: İncelenen makalelerde daha çok kesirler ve doğal sayılarla ilgili yaşanan kavram yanılgısı/hata/güçlük şeklinde düzeyi veya durumu belirlemeye yönelik makalelerde yoğunlaşıldığı buradan hareketle de yapılacak olan yeni çalışmalarda bu konu kapsamında yanılgı/hata veya güçlüklerin giderilmesine yönelik deneysel, ilişkisel ve yordama durumlarının ele alındığı akademik çalışmalara yer verilebilir.

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INTRODUCTION

Individuals having competencies integrated with the knowledge and skills that they will need in every field is one of the priorities of today's education system. In the Mathematics Curriculum, which consists of various competencies such as digital competency, learning to learn, communication in the mother language, communication in foreign languages etc, "Mathematical competency" is explained as the individuals' ability to use and ask for mathematical thinking skills built on a solid arithmetic basis (The Ministry of National Education [MoNE], 2018). The necessity of prioritising the numbers that form the theme of mathematics teaching emerges as a significant factor for individuals with these competencies, especially mathematical competence, to complete mathematics education, including abstract and high-level skills (Baki,2008; Christou & Vosniadou, 2012; Güler, 2017; Vlassis, 2004). Besides, it is stated that the integration of number development with other areas of the curriculum is another remarkable point with the expression of the NTCM (2000, p. 79) as "A student who works with numbers should be able to associate his/her work with other mathematics subjects. For instance, operational fluency (handling the operations correctly and quickly)… both develops students and can improve students' knowledge of data, knowledge of patterns that support the development of rhythmic counting, and algebraic thinking, shape and space, and the number that helps students develop estimation skills" (Van De Walle, 2013).

This importance and necessity that the numbers have also made them come to the forefront in the curricula and studies published from the past to the present. Thus, when the curricula developed by the MoNE between 2005 and 2018 were analysed, it was determined that the most outcomes and class time were given to the Numbers and Operations learning area (İlhan & Aslaner, 2019; MEB, 2005, 2009, 2013, 2015, 2018). The Numbers and Operations learning area consists of the various sub-learning areas such as numbers, sets of numbers and operations with them, relations between numbers, fractions, ratios and proportions, etc. (MoNE, 2018). Within the scope of all these sub-learning areas, it was noticed that there were many studies on various topics such as natural numbers and operations with natural numbers (Albayrak et al., 2019; Ercive & Narlı, 2019; Paydar & Doğan, 2021; Tuluk & Akyüz, 2019), fractions and operations with fractions (Altıparmak & Palabıyık, 2019; Topçu & Gürefe 2020; Özer et al., 2020), decimal notation (Işık et al., 2012; Karataş et al., 2021), percentages (Erdem et al., 2018; Yapıcı & Altay, 2017), multipliers and multiples (Karakuş & Yeşilpınar, 2018), sets (Biber & Tuna, 2016; Yücesan, 2011), integers and operations with integers (Berkant & Yaren, 2020; Bozkurt & Polat, 2011; Erdem et al., 2015; Kiraz & Işık, 2020; Şengül & Zengin, 2015), rational numbers and operations with rational numbers (Altun & Çelik, 2018; Gürbüz & Birgin, 2008; Macit & Nacar, 2019; Yenilmez & Yıldız, 2018), ratio and proportion (Deveci, 2021; Güler & Didiş Kabar, 2017; Şengül & Erdoğan, 2017), exponential expressions (Güzel & Yılmaz, 2020; İymen & Duatepe Paksu, 2015; İymen İkizoğlu & Duatepe Paksu, 2016) ve köklü ifadeler (Aksu et al., 2013; Aydoğdu, 2020; Toluk Uçar, 2015).

Handling the general tendencies related to a subject in specific terms is regarded as significant even in terms of shedding light on further studies in addition to seeing how the studies tend to be (Cohen et al., 2007; Erdem, 2011). Considering this, it is thought that investigating the knowledge of the participants about the trends and current situations of the studies related to their fields with content analysis will contribute much to the literature (Falkingham and Reeves, 1998). In this scope, it was noticed that there are some studies (Arı & Demir, 2020; Kutluca et al., 2018; Ulutaş & Ubuz, 2008; Yaşar & Papatğa, 2015; Yıldız Altan et al., 2021) in the literature investigating the general trends related to mathematics education. In addition, it has been determined that there are studies that investigate the trends related to a specific topic such as metacognition (Baş and Özturan Sağırlı, 2017; Kandal and Baş, 2022), technology-supported education (Bayram, 2019; Tatar et al., 2013; Kutluca et al, 2016), mathematical model and modelling (Albayrak & Çiltaş, 2017; Birgin & Öztürk, 2021; Yenilmez & Yıldız, 2019), mathematics anxiety (Toptaş & Gazel, 2018), realistic mathematics education (Tabak, 2019), problem-solving (Coşkun & Soylu, 2021) and problem themed (Özturan Sağırlı & Baş, 2020).

Within the light of these reviewed studies, no studies have been encountered related to determining the level/situation in the numbers and operations learning area in mathematics education and a study in which experimentally handled research was analysed and evaluated. In light of all these expressions, with this study, it was aimed to present the trends and results of the topics of the articles to researchers and educators as a whole by examining the articles in which the level/situation for the learning of numbers and operations in Turkey was determined and experimentally handled, and to contribute to mathematics education by forming the basis for new studies to be conducted in this scope. Considering this purpose, the following research questions were asked:

1. What are the subject trends and results of the level/situation determination articles published in education journals in Turkey for preschool, primary and secondary school levels with the theme of numbers and operations learning area in mathematics education in Turkey?

2.What are the subject trends and results of the experimental articles published in education journals in Turkey for preschool, primary and secondary school levels with the theme of numbers and operations learning area in mathematics education in Turkey?

METHOD

It was aimed to review the articles on the numbers and operations sub-learning theme, which have been conducted on mathematics education and published in Turkey in terms of their topic trends and results. In this context, the study was designed based on a descriptive content analysis method considering its topic and purpose. Descriptive content analysis, which is among the content analysis types, in which a general trend is specified by investigating and arranging the quantitative and qualitative research, put forth separately, thus provides a significant reference to further studies in the literature (Cohen et al., 2007; Çalık & Sözbilir, 2014; Selçuk et al., 2014).

Data Collection

During the data collection process, firstly the faculties of education journals, social sciences institution journals in Turkey, and 124 private institutions and organisations' journals, which can be viewed online, in Turkey were determined. 1617 volumes and 5021 issues were examined in total by including all the issues of 2020 of these journals in the process. In the second part of the data collection process, each issue was handled separately. The articles were analysed according to the sub-learning areas and functions that take place in the curriculum with the keywords as numbers, natural numbers, integers, four operations and/or skills, arithmetic, arithmetic operations, ratio-proportion, sets, factors and multiples, proportional reasoning, fractions, operations with fractions, rational numbers, operations with rational numbers, exponential expressions and square roots. In addition, the articles which include the words such as verbal problems, problem-solving and problem-posing were examined according to the outcomes of the numbers and operations learning area. In this stage, the articles with foreign samples were excluded from the research. In the third stage of the data collection process, it was aimed to classify the articles by considering the numbers and operations learning and sub-learning areas in the scope of the 2013 preschool teaching curricula and 2018 primary and secondary school Mathematics Course Curriculum. For this purpose, it was observed that there were articles covering the secondary education program among the recorded articles. Since the secondary and high school functions were within the scope of a different learning area and the numbers and algebra in the high school curriculum were together in a learning area, the articles which were related to the high school curriculum were excluded from the research. At the end of this research, a total of 301 articles were recorded and prepared for data analysis.

Data Analysis

A content analysis method was used in the reached data analysis in the study. The obtained data are presented to the reader by processing unnoticed concepts and themes in the content analysis more deeply with descriptive analysis (Yıldırım & Şimşek, 2018, p. 242). The data analysis process of the experimental and level/situation articles handled related to the numbers and operations learning area consisted of two parts: the analysis of topic trends and reached results. In the first stage of the data analysis related to the articles' topic trends, 301 reached articles were coded according to the sub-learning areas that take place in two different levels as the primary and secondary school within the scope of numbers and operations learning area primarily in the secondary school curriculum. Based on the template prepared by Baş and Özturan Sağırlı (2017), the articles were examined according to their methods within the scope of two study focuses: experimental and level/situation. In the last stage of the data analysis related to the topic trends, the articles that take place within the scope of each study focus were analysed within the scope of the determined categories as achievement, skill, misconception, misconception/complexity/difficulty/error, behaviour, persistence, perception, affective features, opinion/thought/thought process, strategy/method, competence, perception/image/schema/representation type, teaching/procedure quality, readiness level and others. During the data analysis process related to the categories constituted within the scope of the study focuses, the features which have also been mentioned above such as achievement, skill, misconception etc. were taken into consideration. For instance, the articles which were reviewed in terms of the achievement level and situation in the "Operations with Natural Numbers" sub-learning area were examined by determining various sub-headings related to achievement such as problem-solving achievement, problem posing achievement, number sense performance and number detection achievement and handled within the scope of the category of achievement. Throughout this analysis process, a draft list was created as the categories under each study focus would be the main title and the codes under the categories would be the sub-titles. The codes under the categories were stated in the finding section. The created study focus and category list are presented in Figure 1.
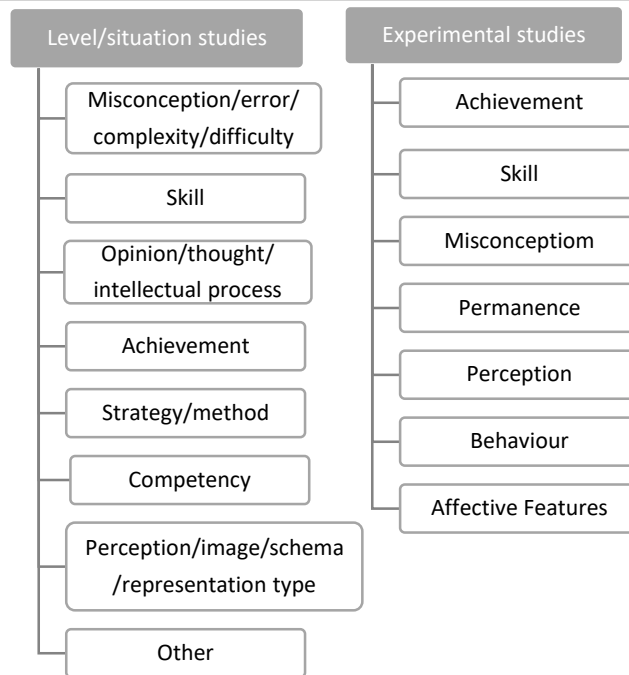
Figure 1. Study focus and category list used in the data analysis process

The analysis process which was performed by using the study focus and category list in Figure 1, was carried out as follows.

1. In the process, among the expressions that take place in the purpose, problem and sub-problems of the articles, only those related to the numbers and operations learning area were subjected to the analysis. For instance, the article, carried out experimentally, with the heading of "The Effect of Mathematics Teaching with Caricatures on the Students' Academic Achievements and Attitudes", was evaluated in the category of achievement since the effect of teaching with caricatures within the scope of Multipliers and Multiples sub-learning area on the academic achievements of the student in the learning area of numbers and operations was examined. The part of attitude towards mathematics was excluded from the analysis since it lay beyond the scope of the numbers and operations learning area.

2. During the analysis process, sometimes the same article topics were analysed under different categories. For instance, an article whose basic aim was to "investigate the explanations of primary and secondary school mathematics teachers' misconceptions and their views on the underlying causes" was coded under two different categories as misconceptions and opinions.

3. During the process, the analysis was made by considering the sub-problems rather than the aims of the articles. For instance, when the article, whose purpose was to "investigate the effect of number sense-based teaching on the students' self-competencies and performances for mathematics" was analysed by considering its aims, the sub-problems of the study were taken into consideration to clarify the situation mentioned with the "self-competency or performance related to mathematics." In this context, from the sub-problems of the article as "Is there a significant difference between number sense, mathematics self-efficacy, number sense self-efficacy, the realisation of mathematics in daily life, problem-solving achievement and mathematics achievement of sixth-grade students who have or have not undergone a number sense-based teaching process?", the problems that included the self-competencies related to number sense, problem-solving achievement and mathematics achievement were analysed.

4. In the analysis of the articles, codes and categories were created by considering how the concepts were used in the articles. For instance, the article named " Intuitive development of primary school students in the concepts of integer", is realised to be examined within the scope of both categories of achievement and skill at first sight. However, when the content of the article was reviewed, it was noticed that the primary school students' intuitive mathematics skills for integers, ordering in integers, and adding and subtracting in integers were studied and in this scope, it was understood that it was necessary to analyse the article in the skill category within the scope of the integers and operations in integers sub-learning and the coding was performed in this direction.

5. During the analyses, it was realised that each article was analysed within the scope of its topic and sometimes an article was examined within the scope of more than one sub-learning. In this context, the code and category analysis related to different sub-learning areas within the scope of the same article was performed. For instance, in the article named "the approaches of pre-service mathematics teachers to the possible student mistakes about exponential and radical numbers", the pre-service teachers' approaches to errors that students may have in terms of both exponential and radical numbers, as well as their opinions and solution suggestions about the causes of errors were analysed. The article was analysed with the categories as misconception/error/problem/difficulty and image/perception/opinion/thought/schema and by coding separately both to the exponential expressions and square root expressions sub-learning areas.

In the stage that constitutes the second part of the data analysis process, the articles analysed according to their methods related to the numbers and operations learning area were examined according to their results. In this stage, to analyse the articles within the context of their results, while the results of the qualitative studies such as case, opinion, perception, strategy/method related to the level/situation articles within the scope of the study focus determined in the topic part were coded by taking into consideration directly, the results of the experimental articles were coded as there is/no difference, there is/no effect. Accordingly, whether the studies referring to the same results were encountered in similar studies or not was determined first. When the studies with the same result existed, they were presented first. For instance, in the studies in which the effect of class level on the students' number perception, estimation and problem-solving achievement were investigated, and when it was seen the class level affected these three different achievement significantly, this situation was presented as "It was observed that the class level significantly affects these three separate achievements, and with the increase in class levels, student performances towards these concepts also increase." In addition, it was paid attention to the content of the subject part of the articles when the findings related to this section were expressed.

In the process of collecting, examining and analyzing data regarding each sub-problem in the study, we worked with an academician who is an expert in the field of qualitative methods, and arrangements were made within the scope of the processes in line with their feedback and suggestions.For instance, in the S316 coded research, whose method was not mentioned, the data related to the secondary school fifth graders' problem-posing skills were subjected to descriptive analysis after collecting with the help of problem-solving and posing activity papers. By considering the topic, problem, data collection tools and data analysis, it was analysed with the case study code in the qualitative category by reaching a consensus.

In the analyses, the coding and analysis process was repeated after waiting 8 weeks by the researcher for the reliability of the coding. The fit rate of the obtained results and codings to the earlier coding was found as 93%. The parts which were coded separately were clarified by taking the professional's opinion and the findings were made ready to report.

FINDINGS

The articles examined in the field of numbers and operations were analysed within the scope of the two study focuses such as level/situation determination and experimental and of all the sub-learning areas. Because the high number of sub-learning fields made the presentation of the findings difficult, the findings were presented as follows in codes and categories of the study focus. In addition, to reflect the purposes of the researchers in findings as much as possible, the terms they included were tried to be presented as they were.

Findings related to the topic trends and results of the level/situation determination-focused studies

Within the context or a part of the 212 (70%) articles which were examined, the level or situation of a feature in the numbers and operations learning area was tried to be determined. The codes and categories used in the articles examined in this scope are presented in Figure 2.

Misconception/error/complexity/difficulty category	Achievement category
Problem posing (14)	Problem solving achievement (8)
Pointing on number line (7)	Problem posing achievement (6)
Problem solving (7)	Number sense/feeling performance (4)
Application for operations (6)	Forming/reinforcing knowledge achievement(3)
Order (6)	Performance of using knowledge and skill operationally/conceptually (2)
Fraction-rational number-integer relationship (3)	Modelling/model using performance (2)
Modelling verbal problems (3)	Academic achievement (2)
Reading-writing numbers/digit value (2)	Performance for multiplication and division (1)
Part-whole relationship (2)	Number perception achievement (1)
Skill category	**Strategy/method category**
Problem posing skill (10)	Problem solving/posing strategies (9)

Mental calculation/arithmetic operation skill (5)	Mental calculation/estimation strategies (6)
Mathematical realisation/discrimination (4)	Proportional reasoning strategies (4)
Problem solving skill (3)	(in fraction/decimal fractions) İnformal strategies for multiplication and division (2)
Proportional reasoning skill (3)	(in sorting with fractions) Reference point strategies (1)
Mathematical modelling skill (3)	Adidactic teaching method (1)
Mathematical association/relational thinking (2)	**Competence category**
Ability to switch between representations (2)	Pedagogical knowledge and context knowledge competency (14)
Number sense skill (2)	Competency to identify and correct misconception/difficulty/error (7)
Problem classification skill (1)	Problem posing competency (2)
Skill of using in daily life (1)	**Perception/image/schema/representation type category**
Metacognition skill (1)	Perception for number and number sets/comprehension(5)
Abstraction skill (1)	Perception for set concept/ schema (3)
	Fraction/rational number concept image (3)
Opinion/thought/intellectual process category	Division operation (in rational numbers) / perception of process choice (in verbal problems) (2)
Thoughts/opinions/intellectual processes for teaching/method/activity/evaluation process (11)	Problem solving/rational-irrational representation type (2)
Opinion/point of view for problem posing-solving achievement/type (7)	Sense of infinity (1)
Opinions about misconception/difficulty(3)	**Category of other**
Opinions for mathematical modelling/using (3)	Verbal problem type (2)
Thoughts/opinions for the concept of infinity (2)	Fraction model (1)
Opinion for caunting and the concept of number (1)	

Figure 2. Codes and categories handled in level/situation articles

As presented in Figure 2, it is seen that the articles examined related to level/situation determination in the numbers and operations learning area consisted of 8 categories as misconception (53), skill (37), opinion/thought/intellectual process (28), achievement (27), strategy/method (25), competency (22), perception/image/schema/representation type (16) and other (3); and each category consists of different codes. Each of the codes and categories created in the articles was examined under different heading.

1.Misconception/error/complexity/difficulty category: It was determined that the feature which was studied most was misconception. The sub-learning areas that the articles take place in the scope of the category are the operations with fractions (16), fractions (11), operations with natural numbers (7), addition in natural numbers (3), subtraction in natural numbers (3), multiplication in natural numbers (3), division in natural numbers (2), natural numbers (2), decimal notation (2), exponential expressions (1), square root expressions (1), integers (1) and operations with integers (1). The content of the category and the results of the articles under the category are explained below separately under each code in the category.

1.1. When the results of the articles handled with code Problem Posing (14) are analyzed, it is generally seen that the conceptual dimension of division is ignored in dividing fractions. There is more difficulty at the conceptual level in posing problems for dividing fractions than in posing problems for multiplication. It was determined that there were deficiencies in attributing meaning to, multiplication in whole number fractions, dividing two fractions and fraction numbers. Besides, it was determined that there were difficulties arising from reasons such as conceptual difficulties, teachers' habits in the teaching process, difficulties in language, lack of data in general in the focus of the errors in problem posing studies related to the addition and subtraction in

fractions. In addition, it was noticed that except for the problem-posing activities of symbolic expressions, the error, which was seen to ignore the part-whole relationship, continued in problem posing activities for open-ended verbal stories. Moreover, it was determined that the problems experienced in the problem posing studies that necessitate four operations in natural numbers originated from the logic error, deficiencies in using of language, posing inconvenient problems and using incomplete data.

1.2.When the results of the articles examined with the pointing on the number line (7) code, it was determined that the errors or difficulties encountered in fractions were due to the reasons such as moving along the integers on the number line as much as the number in the denominator and taking the number in the denominator, ignoring the minus in negative rational numbers and showing its place on the number line like a positive number, and drawing a number line containing only natural numbers. It was determined that in pointing decimals in the number line the students had the misconceptions such as ignoring the comma, treating the part of the number after the comma as an integer, starting to count intervals on the number line from the wrong place.

1.3. When the results of the articles examined with the problem solving (7) code were analysed, it was determined that the students had difficulties in using real life situations in problems that require comparing and ordering in fractions and concrete object representations in problem solving. On the other hand, it was observed in 2 articles that the mistakes made by pre-service teachers and secondary school students while solving non-routine problems involving ordinal numbers are generally +/-1 error type (the problem result for ordinal numbers is calculated as incorrectly as +1 or -1) and that the pre-service mathematics teachers made ± 1 error type mostly in type I problems (problems that can be solved by modelling correctly by adding or subtracting two numbers). It was found that the primary school students had difficulties in solving the arithmetic verbal problems that required multiplication and division, they usually determined their operation preferences according to the keywords in the problem, generalised the rules of addition and subtraction instead of multiplication and division, and had difficulty in understanding the rule of multiplying by 0 and 1, continuing the operation without shifting digits. Moreover, it was observed in an article that the secondary school mathematics teachers had problems in application of the operation priority rule in problem solving.

1.4. When the results of the articles examined with the ordering (6) code, in the articles on fractions and decimal notation, it was determined the students made various errors as they thought that the fraction with a large denominator was large, that the students who wanted to equate the numerator and denominator only expanded the numerator or denominator, considered the number of fractions as a whole and sorted according to the total size of the numerator and denominator, or sorting the numerator and denominator among themselves. Besides, it was determined that the errors in the ordering for decimal notation were caused by the students' ignoring the comma and perceiving the part after the comma as an integer.

1.5. When the results of the articles with the code of application related to operations (addition (7), subtraction (6)and multiplication(6) operation) were analysed, it was observed that the most important learning difficulties of the students in the subjects related to addition-subtraction and multiplication in fractions were to think about the numerators and denominators of the fractions separately and to apply the rules they had learned about fractions to later subjects (for example, adapting the rule of addition to multiplication). In addition, it was determined in an article that the teachers had difficulties in teaching what negative integer means, subtraction of integers, and using counting stamps. In an article related to the expressions with exponents and square roots, the reasons for making mathematical mistakes were that teachers had mathematical concept errors, did not talk about the meaning of definitions and did not encourage students to ask questions, as well as students' unwillingness towards the lesson.

1.6. When the results of the articles examined with the fraction-rational number-integer relationship (3) code were analysed, it was determined that the students had misconceptions as dividing a number by 0 (thinking of 0 as an absorber) or division of 0 by a number (in the case that the number is not a rational number), scope for the set of numbers (thinking that rational numbers do not include integers and natural numbers), and the fraction line necessity (a number must have a fractional line or numerator and denominator for it to be a rational number).

1.7. When the results of the articles examined with the modelling verbal problems (3) code were analysed, it was determined that the students had problems in modelling verbal problems, discriminating the necessary information in problem solving and setting correct relationship in forming the given information in general. In addition, it was observed that the students focused only on the numeric data in problem solving and had difficulties in drawing correct diagram in the process.

1.8. When the results of the articles examined with the Reading-writing numbers/digit value (2) code were analysed, it was determined that the students had difficulties in reading and writing numbers, grouping numbers and writing groups according to place values after grouping numbers.

1.9. When the results of the articles examined with the part-whole relationship (2) code were analysed, it was determined that the students had misconceptions as symbolising a whole that is not divided into equal parts with a fractional expression, or that fractional expressions have equal magnitude without considering the reference size.

2.Skill category: The sub-learning areas of the articles in this category are the operations with natural numbers (11), operations with fractions (10), ratio and proportion (7), fractions (4), addition operation in natural numbers (4), subtraction operation in natural numbers (3), multiplication operation in natural numbers (3), natural numbers (2), division operation in natural numbers (1), rates (1) and sets (1). The content of the category and the results of the articles in the category were explained separately under each code which takes place in the category.

2.1. When the results of the articles examined with the <u>problem posing skill (10)</u> code were analysed, it was determined that the participants' basic operation, operations with fractions and problem posing skill levels for sets skills were low in general. It was also found in an article, in which the participants' problem posing skill related to the four operation was high, that the students were able to set verbal story problems mainly related to addition and subtraction. In addition, it was noticed that in an article both the teachers and the pre-service teachers mostly succeeded in posing problems such as combining / combining with result unknown / separation with change unknown / separation with result unknown / without change unknown.

2.2. When the results of the articles examined with the <u>mental calculation/arithmetic operation skill (5)</u> code were analysed, it was determined that the readiness levels of the primary school students related to the arithmetic operation skills were sufficient; however, the cardinal value principle, which is one of the counting principles, was less developed compared with the other principles in preschool children. Besides, it was encountered in an articles carried out with adults that the individuals who got and did not get formal education had similar mental calculation skills in addition and subtraction, and partially different in multiplication and division.

2.3. When the results of the articles examined with the <u>mathematical realisation/discrimination skill (4)</u> code were analysed, it was expressed in the articles conducted with pre-service teachers on operations with fractions and fractions that the pre-service teachers' skills in identifying and discriminating students' knowledge, learning strategies and misconceptions were high. It was referred in an article related to the topic of ratio-proportion that the students could not discriminate the additive and multiplicative ratio-proportion problems.

2.4. When the results of the articles examined with the <u>mathematical modelling skill (3)</u> code were analysed, it was observed that the pre-service teachers had not used the mathematical models related to fractions regularly and their model using levels decreased in time.

2.5. When the results of the articles examined with the <u>problem solving skill (3)</u> code were analysed, it was found that the participants' problem solving skill levels were low in general. As the students' class levels increased, their transitions from arithmetic solutions to algebraic solutions (although it was positive, this change and development was low) were low; they had difficulty in understanding the problems without solutions rather than the non-routine problems.

2.6. When the results of the articles examined with the <u>proprotional reasoning skill (3)</u> code were analysed, it was determined that while the students were able to solve the problems related to the ratio-proportion problems, they were not able to explain these problems and their skills of recognising inversely proportional relationships were lower than the skills of recognising directly proportional relationships.

2.7. When the results of the articles examined with the <u>mathematical association/relational thinking skill (2)</u> code were analysed, it was determined that the students mathematical association skills were low in an article conducted related to the topic of ratio-proportion. On the other hand, in a different article carried out with the secondary school students related to the operations with natural numbers, it was determined that the students were able to make the associations between the operations of addition-subtraction, addition-multiplication and multiplication-division by using commutative, distributive and associative properties.

2.8. When the results of the articles examined with the <u>transition between representatives skill (2)</u> code were analysed, it was observed that the students were more successful in using different representatives in addition/subtraction operations in fractions. In addition, it was found that the students were more successful in transitions between numeric-numeric, model-model and numeric-model transitions even in both operation types more than the other transitions.

2.9. When the results of the articles examined with the <u>number sense skill (2)</u> code were analysed, it was determined that the students' number sense was quite low and they tended to use rule-oriented solutions instead of using number sense in solving their problems about percentages in general.

2.10. When the results of the articles examined with the <u>problem classification skill (1)</u> code were analysed, it was observed that the students' problem classification skills related to the proportional reasoning problems were at a moderate level.

2.11. When the results of the articles examined with the <u>skill of using in daily life (1)</u> code were analysed, it was observed that the students, who did not apply to the primary school mathematics related to addition and multiplication in natural numbers in daily life, continued as if they used the materials in their solutions even in the situations in which they did not have materials (paper-pencil). In addition, it was determined that those, who preferred using the mathematics given in school in daily life practices, made calculations with easier and more proper solutions by grouping the given.

2.12. When the results of the articles examined with the <u>metacognition skills (1)</u> code were analysed, it was determined that the metacognitive skills that the students used in the solutions of the problems related to fractions most were orderly as the monitoring, estimating and planning skills.

2.13. When the results of the articles examined with the <u>abstraction skill (1)</u> code were analysed, it was determined that the students used the knowledge that they generated within the scope of the first problem in the next problem and they were able to abstract the linear relationship information correctly at a certain level in the process of creating linear relationship information for ratio-proportion.

3.Opinion/thought/intellectual process category: The sub-leraning areas of the articles which have been conducted within the scope of this category are; fractions (7), operations with fractions (6), operations with natural numbers (3), operations with integers (3), natural numbers (2), rational numbers (2), operations with rational numbers (2), multipliers and multiples (2), addition operation with natural numbers (1), subtraction with natural numbers (1), multiplication operation with natural numbers (1), division operation with natural numbers (1), decimal notation (1), rates (1), ratio and proportion (1), square root expressions (1) and exponential expressions (1). The content of the categories and the results of the articles under the categories are explained separately under each code in the relevant category.

3.1. When the results of the articles examined with the thoughts/opinions/intellectual processes for teaching/method/activity/evaluation process (11) code were analysed, it was determined that the participants claimed positive opinions for the applied teaching model/method/activity. It was detected that in a school in which the university model was used increased the interest towards mathematics related to the fractions, similar activities developed within the scope of the Babil counting system might be an effective mean of teaching, in the subject of rates studied with the information exchange technique, a majority of the students had positive thoughts related to the IET (Information Exchange Technique). In addition, the students expressed related to the learning environment based on the conceptual change approach that the courses became more entertaining, they understood the subject better and enabled to learning by doing in some parts of the course. The students' intellectual processes during the stages were investigated in an article in which the project work related to the fractions and decimal fractions. It was stated in the project that the factors such as acting together, using time well, producing products and presenting the product that is offered to individuals by working with a group are also crucial in addition to the intellectual process for the students.

3.2. When the results of the articles examined with the Opinion/point of view for problem posing-solving achievement/type (7) code were analysed, it was stated that, in the articles related to four operations in natural numbers and addition and subtraction operations in fractions, the problem posing enabled to the students' better comprehension and structuring a subject, operations and problem cognitively. At the same time, it was determined that the detudents developed positive attitude towards the course. In addition, it was noticed that problem posing had a significant place in teachers' self-evaluations and they exhibited positive point of view towards problem posing. Besides, it was stated in the articles that the majority of teachers took the children's mental developments into account in the verbal problem sorts presented to them. It was claimed by the teachers that some verbal problem types were not included as they were not suitable to the children's ages, characteristics of development and the functions in the curriculum.

3.3. When the results of the articles examined with the opinions about misconception/difficulty (3) code were analysed, it was observed that the teachers stated that the students had difficulties in some subjects and had false learnings in general. These subjects which were mentioned were expressed as presenting and modelling fractions on the number line, understanding the concept of fractions, four operations on fractions, comparing rational numbers and four operations on rational numbers. In this context, they claimed that the order they followed and the models they used while teaching the subjects were different. In addition, the pre-service teachers stated that teachers play a more active role in the formation of false learnings in students in an article on square root expressions.

3.4. When the results of the articles examined with the opinions for mathematical modelling/using (3) code were analysed, all of the teachers claimed that the modellings related to the natural numbers and integers enabled the subjects to be understood better, permanent and eye-catching by visualising them. However, they expressed that model using was time consuming and not suitable for every function. In addition, especially the teachers stated that modelling with counting stamps in four operation in integers could be used as a concretising and complementary material, but it was not an adequate material.

3.5. When the results of the articles examined with the thoughts/opinions for the concept of infinity (2) code were analysed, it was realised in two articles conducted with the students that most of the students claimed that the rational numbers were infinite and some of them tended to explain the infinity of rational numbers with the concepts of limitlessness and continuity. When the students' thoughts about the infinity of open intervals were considered, it was referred that a mojority of students expressed that there was an infinite element in the given open interval, but they could not explain the reason for this, and some of them associated the concept of countability with the infinity of this interval. Besides, when the students' intuitive thinking about comparing infinite sets was examined, it was realised that they thought that the infinite sets could also be equivalent based on the equivalence on finite sets.

3.6. When the result of the article examined with the opinion for caunting and the concept of number (1) code was analysed, it was emphasised by the pre-service teachers that the number and duration of the activities conducted related to the subject should be increased.

4.Category of achievement: The sub-learning areas of the articles under this category are operations with natural numbers (8), operations with fractions (8), addition/subtraction/multiplication/division operations with natural numbers (3), exponential expressions (3), ratio and proportion (3), decimal notation (3), integers (3), operations in/with rational numbers (2), multipliers and multiples (1) and operations with integers (1). The content of the category and the results of the articles under the category are explained below by analysing separately under each code.

4.1.When the results of the articles examined with the <u>problem solving achievement (8) code</u> were analysed, the participants' achievement levels were examined in six articles related to the operations with natural numbers, in two articles related to the proportional and non-proportional problems. In general, it was observed that while the pre-service teachers and the secondary school students could solve the routine problems, their achievement levels were low in solving the nonroutine problems. In addition, while it was observed that the students were more successful in solving the verbal problems in which a coherent language was used, on the other hand, that they were not able to distinguish the proportional and non-proportional problem situations was found in an article.

4.2. When the results of the articles examined with the <u>problem posing achievement (6) code</u> were analysed, it was found that the students were able to pose routine problems related to different meaning which four operations include in general in problem posing articles related to four operations. In an article conducted with the mathematics teachers related to the operations with fractions, it was realised that the teachers were able to pose routine problems at the knowledge level more. Moreover, in an article carried out with the fifth graders, it was detected that the students' problem posing levels related to the addition and

4.3. When the results of the articles examined with the <u>number sense/feeling performance (4) code</u> were analysed, it was observed that the performance of the students and pre-service teachers was generally low in articles investigating the number senses relevant to the exponential expressions, decimal notation, fractions and rational numbers. In addition, it was determined that the participants used the written calculation method instead of estimation and interpretation in solving the problems.

4.4. When the results of the articles examined with the <u>forming/reinforcing knowledge achievement (3) code</u> were analysed, it was observed that students were able to form the concept of GCD-LCM and integer, and they were able to both create and use the knowledge of proportionality constant in three articles conducted within the framework of cognitive actions in the form of recognition, use, creation and reinforcement (RBC+C Abstraction Model).

4.5. When the results of the articles examined with the <u>performance of using knowledge and skill operationally/conceptually (2) code</u> were analysed, it was determiend that the students showed higher performance in addition to compound and integer fractions compared with the multiplication and subtraction operation. It was stated that the performances differed according to the fraction types and they showed the lowest performance in integer fractions in the questions in which the concept of fraction and its types were examined. In addition, it was noticed that the students could not made the transitions between the steps properly in the operations with multiple steps.

4.6.When the results of the articles examined with the <u>modelling/model using performance (2) code</u> were analysed, it was found that both the teachers and the students were more successful in the modelling with counting stamps of the addition operation with integers compared to the subtraction, multiplication and division operations. Similarly, it was determined that while pre-service teachers were successful in using all models (area, region and length models) in addition and subtraction operations with fractions, they could not demonstrate the same achievement in multiplication and division operations.

4.7. When the results of the articles examined with the <u>Academic achievement (2) code</u> were analysed, it was stated in the article in which the students' academic achievements were explored within the scope of the Kassel Project Algebra Test (KaPAT) scores, the students' academic achievement levels were quite low. In addition, in another article in which the students' academic achievements were investigated in the subject of ratio-proportion, it was seen that the students had a moderate level of achievement.

4.8. When the result of the article examined with the <u>performance related to multiplication and division operation (1) code</u> was analysed, it was observed that most of the pre-service teachers correctly determined the location of the comma used in multiplication and division operations with decimal notations.

4.9. When the result of the article examined with the <u>performance related to number perception achievement (1) code</u> was analysed, it was determined that the number perception levels of the students increased in parallel with the increase in the secondary school grade level, but the achievement level of the students was low in general.

5.Strategy/method/teaching category: The sub-learning areas of the articles within the scope of this category are the operations with natural numbers (7), ratio and proportion (5), addition operation with natural numbers (4), subtraction operation with natural numbers (3), multiplication/division operation with natural numbers (2), fractions (2), decimal notation (2), multipliers and multiples (2) and operations with integers (1). The content of the category and the results of the articles under the category are discussed separately under each code in the category and explained below.

5.1. When the results of the articles examined with the <u>problem solving/posing strategies (9) code</u> were analysed, it was noticed that the students and pre-service teachers created few and informal solutions (counting based solutions or solutions with traces of counting) even in the problems with small numbers in solving the nonroutine problems including ordinal numbers. The answers in the studies that included addition and subtraction, one after the other or side by side were coded as the formal strategy. It was found that the table and list making strategies were used, in addition to the operational solutions, in the solution of the daily life problems, the problem-solving strategies used by students at different stages determined by non-routine and DTT (Didactic Teaching Theory) were handled more systematically after the activity. It was determined that the problem solving strategies discussed were the strategies of reasoning, trial and error, pattern search, systematic list making, and problem simplification strategies. It was emphasised that the 6 year-old-group students made models by commonly using the ready materials in problem solving. In addition, since the primary school students posed flexible problems which necessitates addition-

subtraction operation easier and they were faster, it was observed that they preferred to use numbers that are 10 and multiples of 10, and that they solved their own problems correctly. In an article, it was found that the teachers could use number sense strategies at a moderate level while solving number sense problems, and in the number sense article for pre-service teachers, it was concluded that the pre-service teachers had low number perception and they tried to solve problems with more rule-based methods.

5.2. When the results of the articles examined with the <u>mental calculation/estimation strategies (6) code</u> were analysed, it was determined that, among the operational estimation strategies, rounding, grouping, using matching numbers, rearranging, using front-end numbers, and algorithmic computing strategies were used. In the mental calculations for addition and subtraction, it was observed that the students mostly used the strategy of "add by dividing into tens and ones", and the strategy of "dividing numbers by referencing them" the least. In subtraction operation, it was found that the students used the strategy of "decrement by ten" at most, and at least "subtraction tens and units".

5.3. When the results of the articles examined with the <u>proportional reasoning strategies (4) code</u> were analysed, it was determined that the strategies which were generally used by the students were equivalent fraction, unit ratio, part-part or part-whole, increment, change multiplier, ratio table and in and out multiplication algorithm. Among these determined strategies, it was seen that the inside out algorithm was preferred the most; and the 8th grade students used more various strategies than the 6th and 7th grade students.

5.4. When the results of the articles examined with the <u>(in fraction/decimal fractions) informal strategies for multiplication and division (2) code</u> were analysed, it was determined the pre-service teachers orderly used the methods of fraction conversion, memorisation and exponential expression within the scope of the rule-based strategies in the multiplication operations with decimal notations. In addition, it was observed that orderly the pre-post, reference and rounding methods were preferred within the scope of the computational estimation-based strategies. It was determined in the division operations with decimal notations that the pre-service teachers used the rule-based strategies of converting to fractions, expanding fractions, memorisation and exponential methods, respectively, and they preferred pre-post and reference methods, respectively, from the computational estimation-based strategies.

5.5. When the result of the article examined with the <u>(in sorting with fractions) reference point strategies (1) code</u> was analysed, it was observed that the students generally drew shapes or number lines, equalised denominators, and sometimes turned to decimal fractions while comparing or sorting fractions. Besides, it was found that the use of reference points in the form of half, whole and closeness to zero was very little in comparing fractions.

5.6. When the result of the article examined with <u>the adidactive teaching method (1) code</u> was analysed, it was observed that the basic conditions of the adidactic environment (DDT) can be met, and an environment in which the concept of ratio and proportion was discovered by the students themselves with the stages of responsibility, action, verification and institutionalisation in this method design.

6. <u>Competency category:</u> The sub-learning areas of the articles within the scope of this category are fractions (7), operations with fractions (5), operations with natural numbers (3), rational numbers (3), division operation with natural numbers (2), decimal notation (2), natural numbers (1), multiplication operation in natural numbers (1), sets (1), operations with integers (1), operations with rational numbers (1), ratio and proportion (1) and square root expressions (1). The content of the category and the articles' results under the category are discussed separately under each code in the category and explained below.

6.1. When the results of the articles examined with the <u>pedagogical knowledge and content knowledge competency (14) code</u> were analysed, it was determined in 5 articles conducted with teachers and pre-service teachers on fractions that most of the teachers and pre-service teachers did not have the sufficient knowledge level about the different meanings of fractions, models and operations with fractions. Even in natural numbers which is the basic number set, the pre-service teachers had difficulty in giving a proper definition, applied to highly abstract explanations in the topic of division with zero; however, it was concluded that they had insufficient content knowledges from their abstract explanations. Similarly, it was noticed that the participants were insufficient in understanding and explaining the mathematical meaning of the algorithm of the division operation related to the digit concept. It was claimed in an article that the teachers wrote wrong or deficient definitions in general related to the universal and infinite sets, and in an article, mostly the pre-service mathematics teachers studying at the first class in university were insufficient in showing the rational and irrational numbers on number line. In addition, an article in which pre-service science and mathematics teachers were able to conceptualize rational numbers at a higher level than pre-service primary school teachers.

6.2. When the results of the articles examined with <u>the competency to identify and correct misconception/difficulty/error (7) code</u> were analysed, it was concluded that the pre-service teachers were insufficient to identify the wrong information and misconceptions of the students in finding the appropriate model for dividing the given fraction into two, dividing it into parts and examining the effect of dividing on fractions, whether zero is an integer and when determining integers, information about number sets and questions about square root expressions. In addition, it was detected that that they could partially see the misconceptions of students about showing fractions and decimals on the number line. Moreover, it was stated in an article conducted with the primary school and mathematics teachers that most of the teachers could not fully explain the reasons for various pedagogical misconceptions (zero added to the number after the comma has no effect and adding zero to the number when multiplying by 10), especially about multiplying the number by 10. In this scope, it was found in another article which was

examined that teachers could determine student understandings about the concept of zero and interpret the reasons for these understandings from different perspectives.

6.3. When the results of the articles examined with the <u>problem posing competency (2) code</u> were analysed, it was determined that the pre-service teachers were able to create problems related to ratio-proportion and four operations in natural numbers from the rearrangement questions. It was determined that they used the value substitution and context techniques mostly in the problems created. Besides, it was concluded that the pre-service teachers did not have the same competency in the semi-structured and free problem posing situations within the scope of the same subject.

7. <u>Perception/image/representation type/schema category:</u> The sub-learning areas of the articles under this category are square root expressions (4), natural numbers (3), sets (2), rational numbers (2), addition/subtraction/multiplication and division operation with natural numbers (1). The content of the category and the articles' results under the category are discussed separately under each code in the category and explained below.

7.1. When the results of the articles examined with the <u>Perception for number and number sets/comprehension (natural number, rational number, irrational number, real number) (5) code</u> were analysed, it was determined that most of the participants in the articles carried out the pre-service teachers made overgeneralisation with limited number of samples (such as √2, √3, e and π), tried to explain the irrational number concept, "even the rooted numbers are irrational." In additon, it was detected that both the students, who could make proper explanations related to the rational and irrational numbers and those who could not, had smattering knowledge about the cardinalities of these number sets. In addition, it was observed that the pre-service teachers used the types of representation they associated with these numbers according to their past experiences rather than definitions and formal information while determining any given real number as a rational or irrational number. In 2 articles conducted with the students, it was observed that the students had perceptions as there is a very close relationship between the students' number concepts and the way they are written, the numbers in which only the square root sign is used are irrational, the numbers written with a fraction line are rational, or the numbers written using commas are decimal numbers. Moreover, it was realised that the students regarded only the positive ones as number among the integers; the rate of perceiving negative, rational and irrational numbers as number decreased.

7.2. When the results of the articles examined with the <u>perception/schema related to set concept) (3) code</u> were analysed, the relationship between mathematical world and daily life of the pre-service teachers related to the set concept and representation was taken into consideration. It was realised that the pre-service teachers did not show the achievement they showed in the definition of the set, they emphasised the shape surrounding the set rather than the way the elements were expressed in the set representation, and they had misconceptions related to the purpose of using the shapes that symbolise the set.

7.3. When the results of the articles examined with the <u>fraction/rational number concept image (3) code</u> were analysed, it was claimed in two articles carried out with the pre-service teachers and students that the students generally had the part-whole, division and numerator-denominator concept images; the pre-service teachers mostly used the part-whole concept image. In an article conducted within the scope of the rational numbers, it was observed that the students followed the explanations in books more and they used the interpretation of part-whole.

7.4. When the results of the articles examined with the <u>Division operation (in rational numbers) / perception of process choice (in verbal problems) (2) code</u> were analysed, most of the students claimed that they did not look for meaning in the operations that they did the division process based on the algorithm or they attributed wrong meaning to the operations. In addition, when they were asked to do division operation with figure, it was observed that most of the students could not associate teh concept of fraction with division operation. In addition, it was determined that students who generally chose the operation correctly in problems without keywords perceived the keyword addition as subtraction; in problems with keywords and the subtraction keyword as addition.

7.5. When the results of the articles examined with the <u>Problem solving/rational-irrational representation type (2) code</u> were analysed, the students generally used the representations as picture (drawing and figure), symbolic and colloquial representations in solving the problems related to putting in order and comparing. In the article on the representation forms of rational and irrational numbers, it was claimed that pre-service teachers showed rational numbers mostly in fraction form, did not use different representations much, and expressed irrational numbers in decimal form.

7.6. When the result of the article examined with the <u>sense of infinity (1) code</u> was analysed it was determined that the concept of sense of infinity was expressed by the students as "without end", "continuing" and "endless" and the students perceived this concept of a structure with no end.

8.<u>Category of other:</u> This category consists of two codes as the verbal problem type (2) and fraction model (1). The articles in the verbal problem type code discussed the verbal problem types offered to the students by teacher or activity book. One of the articles consisted of the verbal problems types presented by teachers or educational materials in the field of natural numbers sub-learning for preschool students; an the other consisted of the verbal problems types presented to primary school students for four operations within the scope of the sub-learning area of addition/subtraction/multiplication/division with natural numbers. In the code of fraction model, the fraction models which were preferred most, are explained in the explanations of the teachers about the concept of fraction. The results of the articles under the category are discussed under the code in the category and explained below.

8.1.When the results of the articles examined with the <u>verbal problem type (2) code</u> were analysed, the article carried out with the preschool students indicated that both teachers and mathematics activity books offered the result-unknown problem types to children and ignored the other problem types. In the article, in which the verbal problems types that classroom teachers present to students for addition, subtraction, multiplication and division were examined, it was stated that there were situations in which the amount of results is not known from the joining and separation problems related to addition and subtraction, the part-part-whole problems were the situations in which the part is not known, and the comparison problems are the types of problems for the situations which the difference is not known. Moreover, the problem types which was presented most related to multiplicaiton and division were the co-group problems, repeated addition, fair sharing, division of measurement and repeated subtraction, and multiplication problems from comparison problems
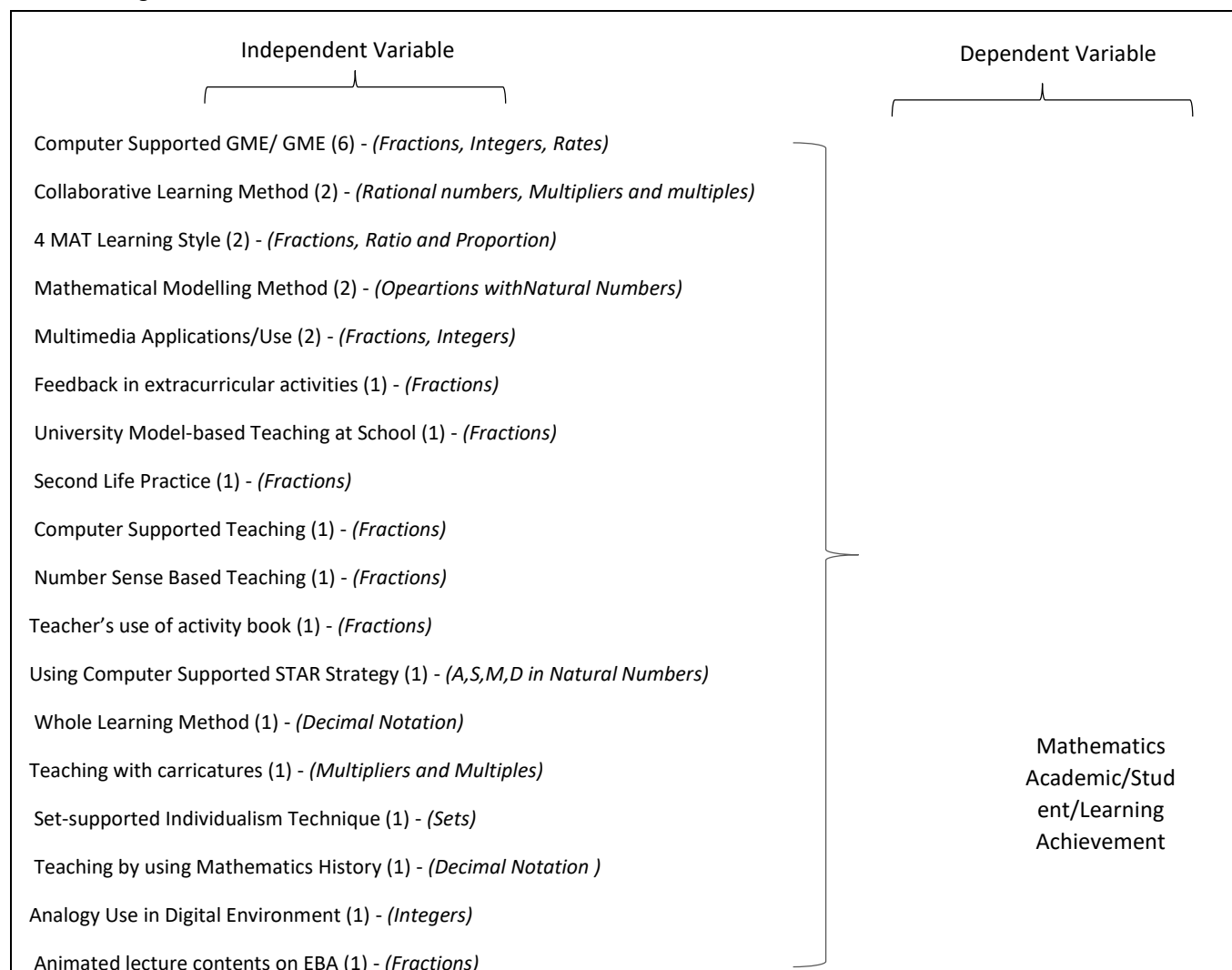
8.2. When the result of the article examined with the <u>fraction model (1) code</u> was analysed, it was determined that the set, area and length model were the most preferred models by the teachers and the model selection in teaching fractions were different between the infrastructures of the fractions.

Findings related to the subject trends and results of the experimental focused articles

It was determined that 62 (20%) of the reviewed articles within the framework of the numbers and operations learning area were experimental. The articles reviewed in this scope consist of seven categories as achievement (36), skill (12), misconception (3) behaviour (2), permanency (3), perception (3) and affective features (3), and different codes under these categories. Each of the code and category used in experimental articles was analysed under different heading and are presented below.

1. <u>Achievement category:</u> In the articles conducted experimentally, the feature which was studied most as the dependent variable was achievement. The sub-learning areas of the articles in this category are addition operation in natural numbers (4), subtraction operation in natural numbers (4), operations with fractions (4), multiplication operations with natural numbers (2), natural numbers (3), operations with natural numbers (3), fractions (3), division operation with natural numbers (2) and decimal notation (1).

The findings related to the dependent and independent variables used in the articles under the category of achievement are presented in Figure 3.

Independent Variable	Dependent Variable
Computer Supported GME/ GME (6) - *(Fractions, Integers, Rates)*	
Collaborative Learning Method (2) - *(Rational numbers, Multipliers and multiples)*	
4 MAT Learning Style (2) - *(Fractions, Ratio and Proportion)*	
Mathematical Modelling Method (2) - *(Opeartions withNatural Numbers)*	
Multimedia Applications/Use (2) - *(Fractions, Integers)*	
Feedback in extracurricular activities (1) - *(Fractions)*	
University Model-based Teaching at School (1) - *(Fractions)*	
Second Life Practice (1) - *(Fractions)*	
Computer Supported Teaching (1) - *(Fractions)*	
Number Sense Based Teaching (1) - *(Fractions)*	
Teacher's use of activity book (1) - *(Fractions)*	Mathematics Academic/Student/Learning Achievement
Using Computer Supported STAR Strategy (1) - *(A,S,M,D in Natural Numbers)*	
Whole Learning Method (1) - *(Decimal Notation)*	
Teaching with carricatures (1) - *(Multipliers and Multiples)*	
Set-supported Individualism Technique (1) - *(Sets)*	
Teaching by using Mathematics History (1) - *(Decimal Notation)*	
Analogy Use in Digital Environment (1) - *(Integers)*	
Animated lecture contents on EBA (1) - *(Fractions)*	

Using a Memory Booster Hint (1) - *(Operations in Natural Numbers)*

Teaching Through Invention (1)-*(Addition/Subtraction in Natural Numbers)*

Teaching Based on Multiple Intelligences Theory (1) - *(Integers)*

Information Exchange Technique (1) - *(Rates)*
Concept Map Supported Education (1) - *(Square root expressions)*
Socioconstructivism (1) - *(Fractions)*

Lecture-Teaching Through Discovery (1)

Teaching by Problem Posing (1)

Problem solving achievement

Musical game events (1)

Teaching with Game (1)
Using the parsed form of numbers (1)

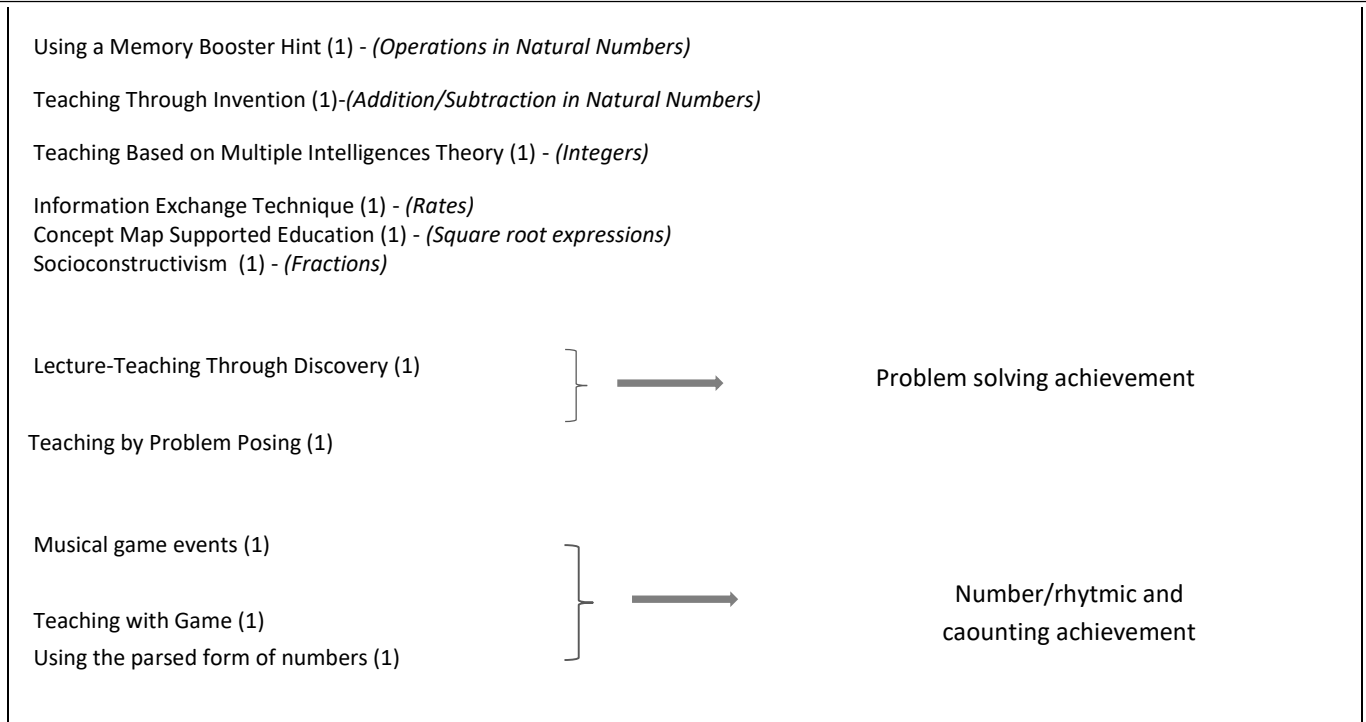Number/rhytmic and caounting achievement

Figure 3. Dependent and İndependent Variables in Achievement Articles

As it is presented in Figure 3, it was determined that mathematics/academic/student/ learning achievement was examined as the dependent variable in plenty of experimental achievement articles (86%).

This is followed orderly by number/rhythmic counting and operation achievement (8%) and problem-solving achievement (6%). The results of the articles under this category were analysed separately under each code in the category and are explained below.

1.1.When the results of the articles examined with the <u>mathematics Academic/Student/Learning Achievement (34) code</u> were analysed, it was determined that the independent variables in the articles increased the achievement or the performance in the dependent variables mentioned in the codes. In two articles in which the effect of education with caricatures in multipliers and multiples subjects and IET (Information Exchange Technique) used in the course in the subject of rates, it was found that no significant difference emerged between the academic achievements of the students in the experimental and control groups.

1.2. When the results of two articles examined with the <u>problem-solving achievement (2) code</u> were analysed, no significant difference was found between the two methods in terms of routine problems in the article examining the effect of direct expression and discovery teaching on square root expressions on problem-solving achievement. Besides, it was concluded that a significant difference was encountered in favour of teaching through discovery in terms of the achievement of solving nonroutine problems. The article examined the scope of decimal notation, it was found that the problem posed by teaching affected the problem-solving achievement of the students with different number perception levels.

1.3. When the results of the articles examined with the <u>number/rhythmic counting and operation achievement (3) code</u> were analysed, it was observed that the achievement of the preschool students in the experimental group in which the number and operation concept teaching was given with musical activities increased. similarly, in another article, in which the education with games was applied, the rhythmic counting and performance related to four operations of the primary school students increased. Moreover, it was determined that the achievement of primary school students in addition and subtraction increased in the teaching made by using the solved form of numbers.

2 <u>Skill Category:</u> The sub-learning areas of the articles in this category are operations with natural numbers (7), subtraction with natural numbers (6), natural numbers (3), operations with natural numbers (3), multiplication operation with natural numbers (2), division operation with natural numbers (2), fractions (2), integers (2), ratio and proportion (2) and rates (1).

Findings related to the dependent and independent variables applied under the skill category are presented in Figure 4.
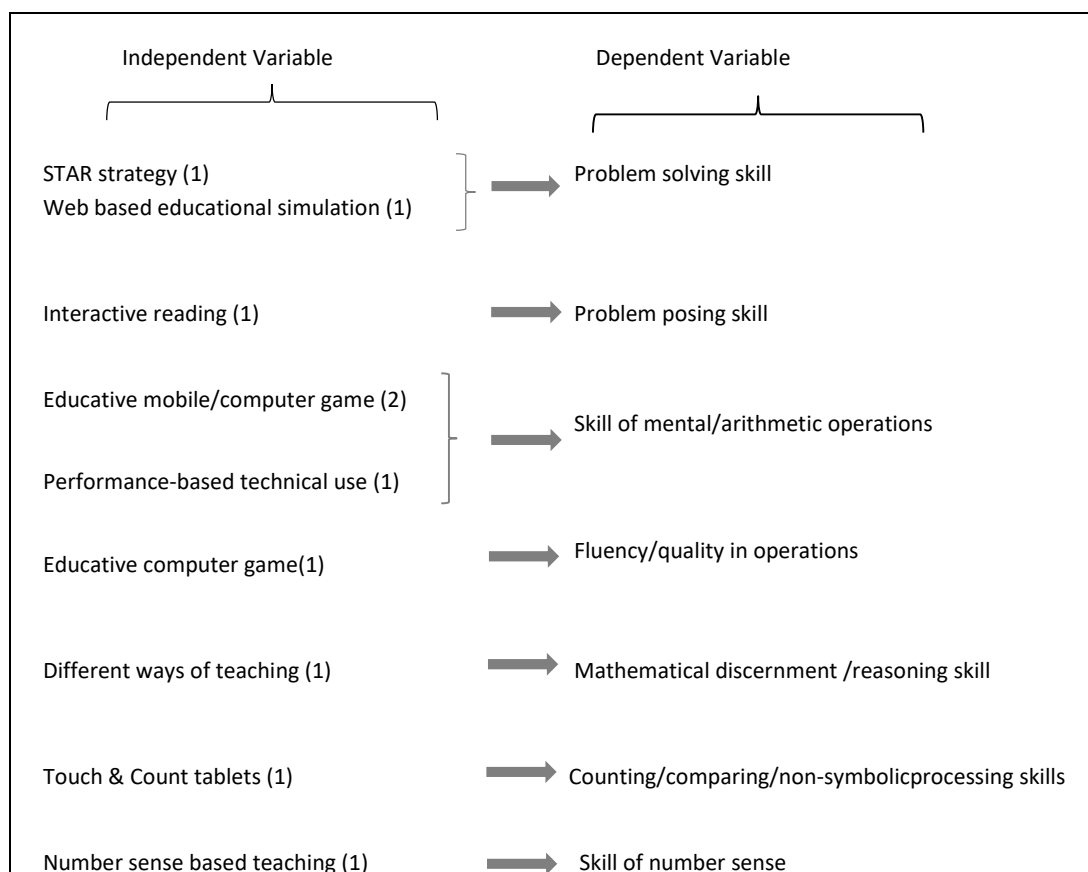
Figure 4. Dependent and Independent Variables in Skill Articles

As it is presented in Figure 4, it is observed as the dependent variable in the experimental skill articles that mostly problem posing/solving and the skills of mental/arithmetic operation were examined. The results of the articles under this category are explained separately below under each code in the category.

2.1. When the results of the articles examined with the problem-posing/solving skill (3) code were analysed, it was expressed that the students were able to make sense of and solve verbal problems for four operations with ratio and proportion, respectively in the educational environment in which Web-Based Educational Simulations and the STAR strategy in computer-aided mathematics lessons were used. In addition, in an article, it was concluded that interactive reading creates a significant difference in the problem-posing skills of the students for the four operations.

2.2. When the results of the articles examined with the skill of mental/arithmetic operations (3) code were analysed, it was determined in one of the two articles, in which the effects of mathematical computer and mobile games on mathematics education were investigated, that these games developed the students' skills of mental operations, in another article that it did not affect the students' basic arithmetic operations skills. In an article, with the educational materials used, it was observed that preschool children could easily perform mathematical skills (arithmetic processing skills) such as finding the number of objects in a group and comparing two groups in terms of scarcity and abundance.

2.3. When the results of the articles examined with the fluency/quality in operations (2) code were analysed, it was stated that the use of performance-based techniques increased the fluency in the addition process of the students, and the tendency of the students who played the educative computer game to perform complex addition operations increased.

2.4. When the results of the articles examined with the mathematical discernment/reasoning skill (2) code were analysed, it was determined in an article that, it was seen that children were able to perform different reasoning strategies with the educational materials used. It was observed that the students' mathematical discernment level increased significantly in the collaborative learning environments in which different learning environments were explored.

2.5. When the results of the articles examined with the counting/comparing/ non-symbolic processing skills (1) code were analysed, it was observed that the touch & count tablets had a positive effect on the counting, comparing and sorting skills of preschool children between 48-60 months.

2.6. When the result of the article examined with the number sense skill (1) code was analysed, it was claimed that the number sense-based teaching process had a positive effect on the number sense skills of the students.

3. <u>Misconception category</u>: the sub-learning areas of the articles under this category are fractions (1), operations with fractions (1), rational numbers (1), operations with rational numbers (1) and square root expressions (1). Findings related to the dependent and independent variables used in the articles under the category of misconception are presented in Figure 5.
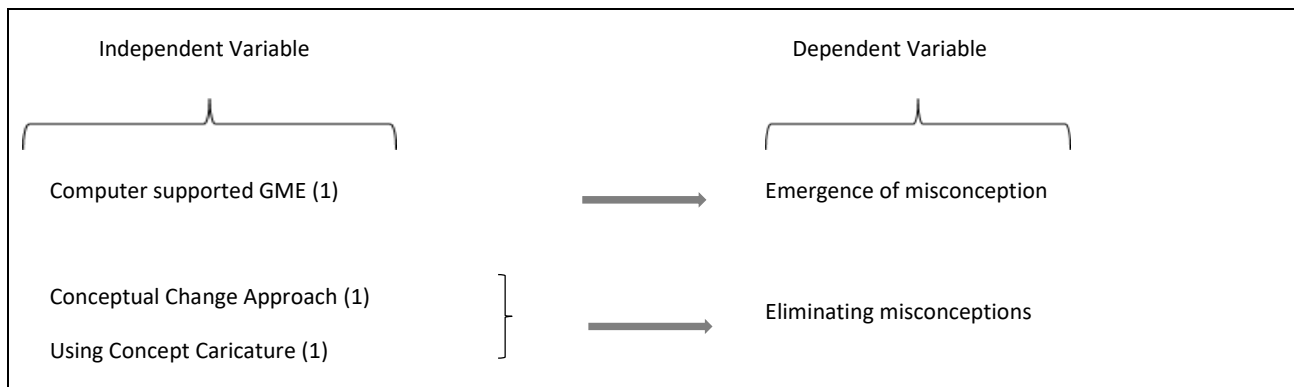

Figure 5. Dependent and Independent Variables in the Articles of Misconception

As it is presented in Figure 5, it is seen that eliminating the misconception variable is the most examined variable as the dependent variable in the experimental misconception articles. The results of the articles under this category are explained separately below under each code in the category.

3.1. When the result of the article examined with the <u>emergence of misconception (1) code</u> was analysed, misconceptions were found in some of the students in both groups after the article in which the computer-assisted Realistic Mathematics Education Approach for operations with fractions and fractions was discussed. However, it was observed that the students in the experimental group had less misconception than the other group.

3.2. When the results of the articles examined with the <u>eliminating misconception (2) code</u> were analysed, it was realised that the conceptual change approach and concept caricature used in the articles were effective in eliminating students' misconceptions about/ with rational numbers/operations and square root expressions, respectively.

4. <u>The category of permanence</u>: This category consists of articles investigating the effects of variables such as teaching method/model and strategy on the learning permanence of participants within the scope of different sub-learning domains. This category consists of 1 code as learning permanency/permanency level (3). The sub-learning areas of the articles under this category are fractions (1), decimal notations (1) and ratio and proportion (1).

Findings related to the dependent and independent variables used in the articles reviewed under the category of permanency are presented in Figure 6.
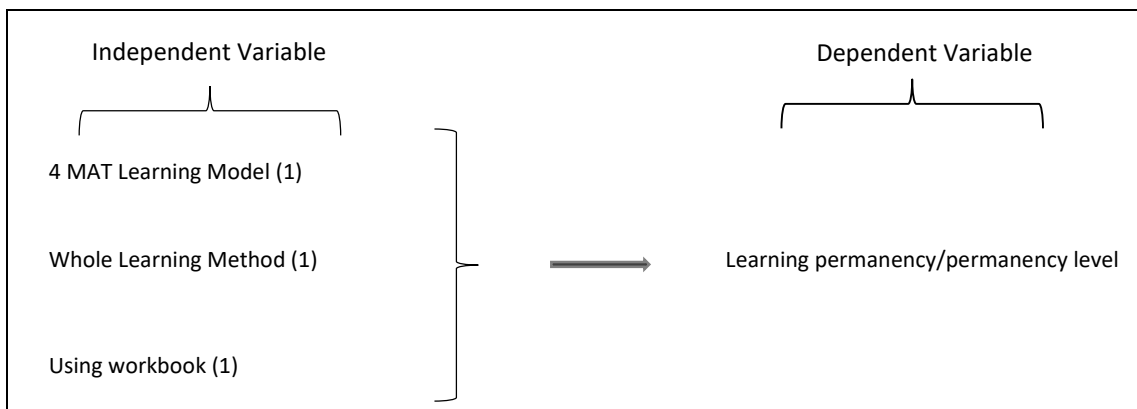

Figure 6. Dependent and Independent Variables ın Permanency Articles

As it is presented in Figure 6, there are the variables as 4 MAT Learning Model, Whole Learning Method and workbook use by teachers are the independent variables in the articles which are experimental and conducted to investigate the permanency levels of the participants. The results of the articles under this category are explained below by applying the code under the category.

4.1. When the results of the articles examined with the <u>learning permanency/permanency level (3) code</u> were analysed, it was determined that the teaching carried out within the scope of ratio and proportion based on 4MAT learning style model ensured the permanence of learning. In another article in which the whole learning method was used, it was detected that the permanence level of decimal notation in the experimental group was higher than that of the control group. Besides, it was determined that the auxiliary books used in the teaching of fractions are more effective than the teaching with the textbook.

5. <u>Perception category</u>: The sub-learning areas of the articles within the scope of this category are natural numbers (2), operations with integers (2), integers (1) and decimal notation (1).

Findings related to the dependent and independent variables used in the articles reviewed under the category of perception are presented in Figure 7.
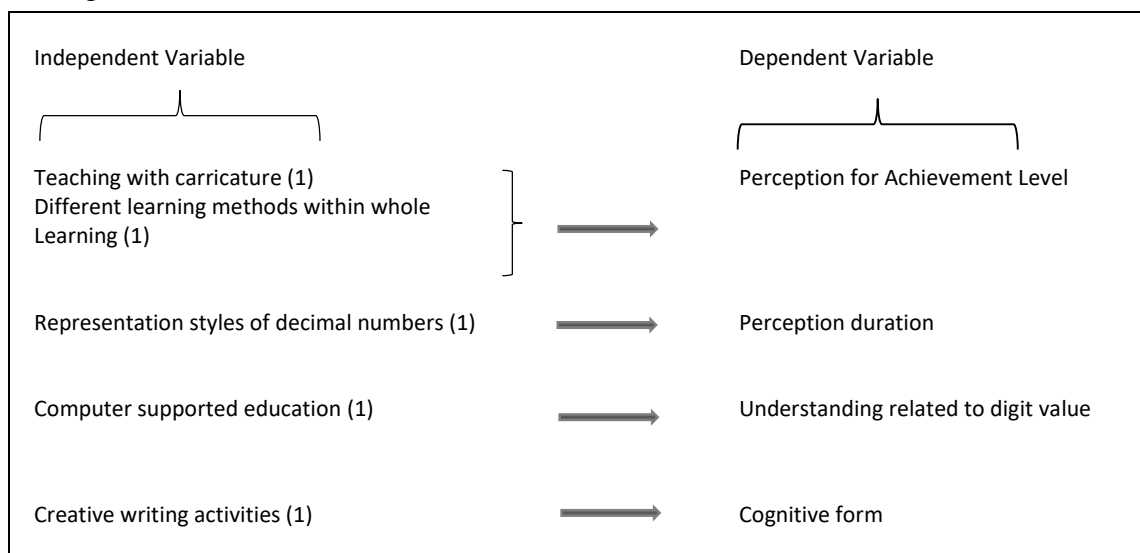

Figure 7. Dependent and Independent Variables in Perception Articles

As it is presented in Figure 7, there are the variables such as teaching with caricatures, different teaching methods (teaching by the invention, dramatization, question and answer, teaching with games and puzzles) within the scope of whole learning, computer supported education, creative writing activities and decimal notation representation styles as the independent variable in the descriptive perception articles. The results of the articles under this category are explained below by exploring separately under each code.

5.1. When the results of the articles examined with the perception related to achievement level (2) code were analysed, it was observed that teaching with different teaching methods (invention method, dramatisation, question-answer, teaching with games and puzzles) in line with the whole learning principles for integers and operations with integers had a positive effect on the students' perceived achievement levels in mathematics. Similarly, it was claimed that teaching with caricatures increased students' perceived mathematics achievement levels for integers and operations.

5.2. When the result of the article examined with the perception of cognitive structure in numbers (1) code was analysed, it was determined that creative writing activities did not create a significant difference between the pre-and post-scores determined by considering the mathematical concepts and relationships related to numbers in the mind maps of pre-service mathematics teachers.

5.3. When the result of the article examined with the understanding related to digit value (1) code was analysed, it was determined that instruction including computer-assisted educational material improved the digit value comprehension of primary school 3rd-grade students.

5.4. When the result of the article examined with the perception duration (1) code was analysed, it was found that the different representations of decimal numbers (table and graphic) were more effective in determining decimal numbers and detecting the largest of these numbers in the shortest time, showing these numbers with graphics.

6. Affective feature category: The sub-learning areas under the articles within the scope of this category are fractions (2), decimal notation (1), integers (1), rates (1) and ratio and proportion (1).

Findings related to the dependent and independent variables used in the articles reviewed under the affective features are presented in Figure 8.
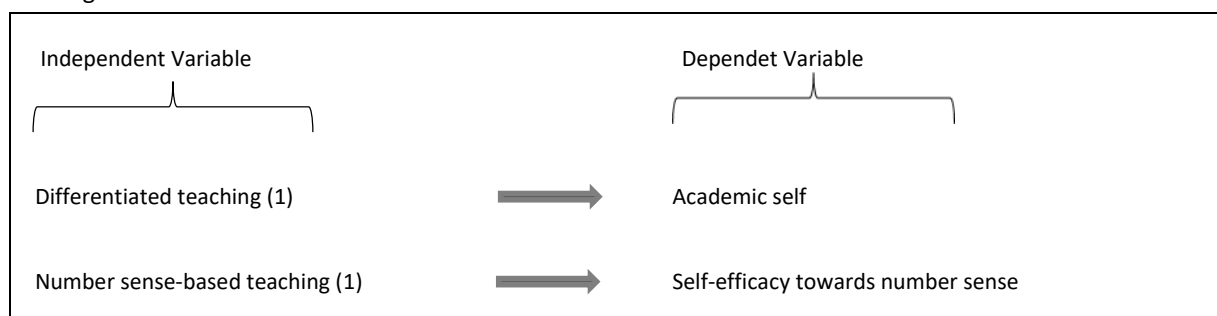

Figure 8. Dependent and Independent Variables ın Affective Feature Articles

As it is presented in Figure 8, there are variables in the form of differentiated and number sense-based teaching as independent variables in the articles examining the experimental effective features. the results of the articles under this category are explained below by examining separately under each code in the category.

6.1. When the result of the article examined with the <u>self-efficacy towards number sense (1) code</u> was analysed, it was claimed that the number sense-based teaching did not create a significant difference in students' self-efficacy towards number sense.

6.2. When the result of the article examined with the <u>academic self (1) code</u> was analysed, it was concluded that the differentiated teaching program for gifted and talented students increased the academic self-esteem of the students within the scope of fractions.

7. <u>Category of behaviour:</u> Within the scope of this category, u kategori kapsamındaki makalenin yer aldığı alt öğrenme alanları ise doğal sayılar (1), Doğal sayılarla toplama işlemi (1), doğal sayılarla çıkarma işlemi (1), doğal sayılarla çarpma işlemi (1), doğal sayılarla bölme işlemi (1) ve kümeler (1) şeklindedir. Bu kategori altında yer alan makalenin sonucu kategori içinde yer alan kod altında ele alınarak aşağıda açıklanmıştır.

7.1. When the result of the article examined with the <u>achievement of target behaviour (1) code</u> was analysed, it was observed that the level of students' achievement of target behaviours for sets and numbers in the program was higher in the group in which the learning-teaching environment was organised by the researcher (the teacher's plans, activity and game cards, in the learning environment where the follow-up tests were prepared by the researcher) than in the other group (the learning environment planned by the teacher).

DISCUSSION AND RECOMMENDATIONS

In this section of the research, the results reached related to the subject trends and results of the articles on experimental and level/situation determination conducted in the numbers and operations learning area in Turkey are presented within the scope of the research problem. In addition, the prominent results of the research are summarised in this section in order not to repeat the findings section.

It was determined that a great number of articles reviewed within the scope of the numbers and operations learning area, consisted of the level/situation determination articles. That the number of level/situation determination articles which have been reviewed being high, can be interpreted as the researchers may have had difficulty in providing a valid environment or adequate criteria for other research methods. The features discussed in the articles published in this context are, in the order most commonly studied, misconception, skill, opinion/thought/intellectual process, success, strategy/method, competence and perception/image/schema/representation type.. The sub-features discussed under these features and the results of the articles made in this context can be summarised as follows within the scope of sub-learning areas:

It was determined that the most studied feature in the level/situation determination articles is a misconception and the sub-learning areas studied under this feature were orderly as fractions/operations with fractions and natural numbers/operations with natural numbers, the articles conducted on the other sub-learning areas were few. The topic trends in these sub-learning areas were problem-posing, problem-solving, pointing on the number line, ordering and applications related to four operations. This is orderly followed by the fraction-rational number-integer relations, modelling verbal problems, reading-writing numbers/digit value and misconception/error/challenges/difficulties the students, pre-service teachers, and teachers experienced related top art-whole relations. It was expected situation that misconceptions came forth in the obtained results to provide meaningful learning in fractions and other subjects (Soylu, 2008), to develop problem-solving skills and to learn advanced subjects such as algebra (Işık & Kar, 2012) in the light of the literature examined. That is, this situation is also supported by foreign literature stating that students' thinking style, reasoning and problem-solving skills in mathematics education are focused on as well as mistakes and misconceptions (Heinze, 2005; Henningsen & Stein, 1997).

When the results of the articles conducted for misconception were analysed, it was observed that ,in problem-posing articles about operations with fractions/fractions, there were conceptual difficulties (Işık, 2011; Işık & Kar, 2012), in problem-posing articles about operations with natural numbers/natural numbers, posing problems for operations other than the desired four operations, not being able to answer, problems such as using incomplete data, using decimal numbers instead of natural numbers, writing exercises and posing problems for different subjects were experienced during problem posing (Arıkan and Ünal, 2013; Kılıç, 2013). In the problem-solving articles, it was determined that the students experienced difficulties in solving problems that require comparison and ordering in fractions and ordinal number problems for four operations. Besides, it was observed that students had various misconceptions and difficulties in ordering fractions, pointing them on the number line, and operating on fractions by over-generalising and specialising (Soylu & Soylu, 2005; Biber et al., 2013).

It was determined that the second most studied feature in the level/situation determination articles was the skill and the most studied sub-learning areas in skill articles were the operations with natural numbers and operations with fractions. The sub-studied features which were studied most in the skill articles were determined to be problem posing, mental calculation/arithmetic, mathematical noticing/discriminating, modelling, proportional reasoning and problem-solving skills. It can be claimed that problem-posing is characterised as a skill related to problem-solving and is seen as an important skill as well as problem-solving (Kojima et al., 2015), and it also plays a significant role in improving academic achievement and mathematical comprehension (Solórzano, 2015).

When the results of the articles conducted on skills were analysed, it was noticed that the participants' (students, teachers and pre-service teachers) problem-posing and problem-solving skills were low in the studies related to operations with fractions, operations with natural numbers and sets (Akçay and Ardıç, 2020; Albayrak et al., 2006). It can be claimed that this situation originated from the reasons such as the difficulties experienced in the conceptual dimension for fractions and natural numbers, teachers' habits in the teaching process, logic errors, poor use of language, posing inappropriate problems and using incomplete data (Kar and Işık, 2015; Kılıç, 2013; Özer et al., 2020). Besides, it was observed in the articles investigating proportional reasoning skills that while solving the problems related to ratio-proportion, the students could not define these concepts and their skills of recognising inversely proportional relationships were lower than the skills of recognising directly proportional relationships (Toluk Uçar and Bozkuş, 2016). It is thought that the proportional reasoning skill is extremely complicated and difficult skill affects this situation (Cramer et al., 1993; Pittalis et al., 2003). In the articles investigating primary school students' arithmetic operation skills, it was realised that the students' readiness levels were sufficient; however, the cardinal value principle, one of the counting principles, was less developed than the other principles in preschool children. Finally, in the modelling articles, it was claimed that the teachers did not use the mathematical models on fractions regularly and their model use levels decreased over time. All these situations are indicators that the teachers did not have enough knowledge about models or did not get modelling education related to the topic at and after the postgraduate level.

The sub-learning areas examined in the articles, in which the features such as opinion/thought/thought process related to determining level/situation, are fractions and operations with fractions sub-learning areas. The sub-features examined within the scope of opinion/thought/ thought process are as thoughts/opinions/ thought processes related to teaching/method/activity/evaluation process, misconceptions/opinions about difficulty, views on mathematical modelling/modelling use, view/perspective on problem posing-solving achievement/type, infinity and counting-number concepts thoughts/opinions.

When the results of the articles conducted within the scope of opinion/thought/thought process were examined, it was noticed that the participants had positive opinions related to teaching/method/activity/evaluation process on fractions, integers and rates subjects (Işık & Kar, 2013; Özdemir & Göktepe Yıldız, 2015; Tanışlı & Sağlam, 2006). This result of the research can be claimed to be supported by various research in the foreign literature (Clark, 2012; Huntley & Flores, 2010; Leikin & Zaslavsky, 1997). Similarly, it was noticed that in addition that the participants claimed positive opinions in the articles examined within the scope of the thoughts for mathematical modelling/model use, opinion/viewpoint for problem posing-solving achievement/type (Çelik & Çiltaş, 2015), there were also articles suggesting that the materials used in the modelling articles were not sufficient (Bozkurt & Polat, 2011). This situation can be an indicator that the contents of the materials used in courses by teachers are limited or they can not go beyond the use of similar materials.

In the articles in which the achievement feature related to level/situation determination was investigated, the sub-learning areas which were studied most were operations with natural numbers and operations with fractions. The sub-features examined in the achievement articles were respectively problem-solving, problem posing and number sense/feeling performance or achievement.

When the results of the articles conducted within the scope of achievement were analysed, it was observed that the participants mostly could solve the routine problems and had low achievement levels in solving the nonroutine problems. It can be thought that this situation originated from the that the non-routine problems cannot be solved with a known method or formula, that they are the problems that require the student to analyse the data carefully, make a creative attempt, and use one or more strategies in its solution (Polya, 1985). Similarly, even in the problem-posing articles, it was noticed that the participants could pose the problems at the level of knowledge at most and they had a low problem posing achievement levels. Besides, it was noticed that the number sense use achievement of the participants related to the exponential and rational numbers was at a low level (Bayram & Duatepe-Paksu, 2014; İymen & Duatepe–Paksu, 2015; Yenilmez & Yıldız, 2018). This situation may be an indicator that the participants preferred rule-based strategies to number-sense strategies in solving the problems. This can be interpreted as the students or pre-service teachers are directed to rule-based memorisation rather than guessing or interpreting the question solutions that will lead to the correct answer in the education given during the process from primary school to undergraduate level.

The most studied sub-learning area in the articles discussing the strategy/method feature for level/situation determination has been determined as operations with natural numbers. The sub-feature examined in the strategy/method articles was determined as the problem-solving/posing strategy.

When the results of the articles related to the problem-solving strategies which came forth within the strategy/method articles were analysed, it was observed that the participants used few informal strategies in the solution of the problems with small numbers (Dinç Artut & Tarım, 2006; Dinç Artut & Tarım, 2009). This result of the research can be claimed to be supported by the research result conducted by Verschaffel et al., (1999). Besides, it was observed that they used table and list-making strategies in addition to the operational solutions in the solutions of daily life problems (Güler & Didiş Kabar, 2017), and they used the strategies respectively as problem simplification, trial and error, systematic list making, pattern search and reasoning in solving the non-routine problems (Gök & Erdoğan, 2015).

It was determined in the articles, in which the competency feature related to level/situation determination was analysed, that the sub-learning areas which were studied most were fractions and operations with fractions. The sub-features examined in the

competence articles were in order of pedagogical knowledge and content knowledge competency, misconception/complexity/difficulty/error determination and elimination competency and problem posing competency. It can be claimed that content knowledge is of great importance in effective mathematics teaching and that this knowledge is given to the students with an appropriate pedagogical approach is among the indispensables of effective teaching in concentrating on pedagogical knowledge and content knowledge competency in articles (Shulman, 1986 and 1987; Manouchehri, 1998)

When the results of the articles, in which the competency feature was examined, it was determined that the participants had not had enough knowledge levels on fractions and operations with fractions (Özkaya & Konyalıoğlu, 2019; Zeybek Şimşek, 2020), natural number and number sets (Ercire & Narlı, 2019), universal and infinite sets (Yazıcı & Albayrak, 2019), and they had knowledge deficiencies in the definition of concepts such as the perception of infinity and the arrangement of rational and irrational numbers on the number line (Çevikbaş & Argün, 2017).

The deficiency experienced in this scope is considered a significant insufficiency in terms of mathematics education. Thus, it is emphasised in the literature that definitions and explanations that play a role in shaping students' concept images have great importance in terms of mathematics education (Vinner, 2002; Edwards & Ward, 2004; Zazkis & Leikin, 2007; Leikin & Zazkis, 2010). Besides, it was noticed that the teachers and pre-service teachers were deficient in terms of determining the students' mistakes in fractions, number sets, operations related to natural numbers and square root expressions or using the appropriate method in eliminating these mistakes (Kubar & Cakiroğlu, 2017; Özkaya et al., 2013; Yavuz Mumcu, 2016), it was determined that they were able to partially identify student misconceptions about representing fractions and decimals on the number line (Girit & Akyüz, 2016), and in an article, that the teachers were able to determine students' understandings about the concept of zero (Bütün & Erdoğan, 2020).

That the teachers or pre-service teachers were insufficient in determining and eliminating the misconceptions that their students had related to number sets, operations related to natural numbers and square root expressions might be an indicator that the participants could not internalise the concepts related to the topic entirely. In addition, while the participants were observed to be successful in creating problems related to ratio, proportion and four operations with natural numbers, they were deficient in semi-structured and free problem-posing situations (Albayrak et al., 2006; Bayazit & Kırnap Dönmez, 2017).

It was determined that the most studied sub-learning area in the articles on the perception feature for the level/situation determination was analysed, was the square root expressions. The sub-features examined most in the perception articles are perception/understanding related to number and number sets (natural number, rational number, irrational number, real number), perception/schema for set concept and the image of fraction/rational number concept.

When the results of the articles in which the perception feature was examined, it was claimed that most of the participants defined the irrational numbers in a limited way and by using generalisations, established a very close relationship between the concepts of number and number and the way numbers are written (Baştürk, 2015), had misperceptions in describing the concept of set, described the concept of infinity as "endless", "continuing" and "unending" (Narlı & Narlı, 2012), they tried to adapt the methods they applied for finite sets to infinite sets as well in comparing the infinite sets (İpek et al., 2009). In parallel with this result of the research, studies were also encountered in the foreign literature (Duval, 1983; Falk et al., 1986). In addition, it was determined that the images of the fraction concept were division, part-whole and numerator-denominator concept images, respectively (Macit and Altay, 2020). This result of the research was also claimed by the studies conducted by Kieren (1993) and Lamon (2007).

It was noticed that the most conducted articles, which were carried out after the articles on determining the level/situation in the field of numbers and operations learning, were the experimental articles (62, 20%). The features, which were studied most in the experimental articles, were determined orderly as achievement and skill. The fact that the concept of achievement came forth in the reviewed articles, it is used as an evaluation tool when making comparisons in national and international exams (Ertane Baş, 2019).

The most studied sub-learning areas in the experimental articles in which the achievement feature was examined were determined as fractions and natural numbers. In addition, the independent variables examined in these articles were the variables as computer-supported teaching, computer-supported realistic mathematics education, number sense-based teaching, multiple teaching environments, cooperative teaching, 4MAT learning style, university model-based teaching at school, EBA-supported animated lectures, mathematical modelling, teaching with games, knowledge exchange technique, computer-supported STAR strategy in education. When the results of the articles conducted in this scope were analysed, it was determined that the independent variables in the studies increased the achievement or performance of the dependent variables (Alkaş Ulusoy, 2020; Altıparmak & Çiftçi, 2018; Aydıntan et al., 2012; Çoruk & Çakır, 2017; Demirdöğen & Kaçar, 201; Eraz & Öksüz, 2015; Ertem & Akbaş, 2019; Yazgan & Altun, 2010; Yiğit & İpek, 2015). It was determined only in two articles, in which the effect of mathematics teaching with caricatures on the students' academic achievement (Güler et al., 2013) and the effect of ICT (Information Change Technique) used in courses in the subject of rates on the students' achievements was studied (Tanışlı & Sağlam, 2006), that whether there was a significant difference between the academic/learning achievement of the experimental and control groups. This result of the research can be claimed to be originated from the limitations of the physical environment in the studies or the level of teachers' proficiency in using these methods. In addition, in the article examining the effect of direct expression and discovery teaching on square root expressions on problem-solving achievement, there was no significant difference between the two methods only in terms of routine problems (Kablan et al., 2019).

It was found that the sub-learning areas, which were studied most in the experimental articles on skill feature, were determined to be the natural numbers and operations with natural numbers. The most examined sub-features in the skill articles studied in this scope were the problem-posing/solving skill and mental/arithmetic (do/explain) skill. The independent variables examined in the experimental articles related to skill were the STAR strategy, games, education materials, Touch&Count number tablets and number sense-based teaching. When the results of the articles were analysed, it was determined that the independent variables in the research increased the skill of the mentioned dependent variables (Aktaş et al., 2018; Erdem & Soylu, 2018; İpek & Malaş, 2013; Karal et al., 2010; Mutlu et al., 2019; Yurtbakan & Aydoğdu İskenderoğlu, 2020). Only in an article, it was seen that the effect of educative computer games on the development of basic arithmetic processing skills was not statistically significant (Kula & Erdem, 2005).

Considering all these research results, the recommendations that are thought to contribute to the literature are presented below.

It was mostly focused on the articles aimed at determining the level or situation in the form of misconceptions/errors/difficulties about fractions and natural numbers in the reviewed articles. Considering this, further studies will be conducted, and academic studies examining the experimental, relational and predictive situations to eliminate misconceptions/errors or difficulties can be carried out within the scope of this subject.

It was noticed in the experimental studies which were reviewed that applications such as the computer-supported GME or GME, 4MAT learning style, STAR strategy and Second Life were realised to increase achievement. Considering this, the number of in-class applications can be increased related to this field.

Declaration of Conflicting Interests

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Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

Ethics Committee Approval for this research was obtained from the Human Research Committee on Ethics at Erzincan Binali Yıldırım University (Reference number: E-85748827-050.06.04-57538; Date: 28/01/2021).

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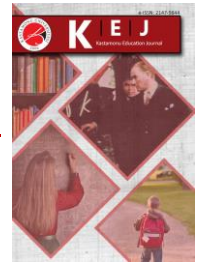
| Research Article / Araştırma Makalesi|

An Analysis of Item Bias in the PISA 2018 Reading Understanding and Memorising Strategies Questionnaire

PISA 2018 Okuduğunu Anlama ve Hatırlama Stratejileri Anketindeki Maddelerde Yanlılık İncelemesi[1]

Sebahat Gören[2], Ayfer Sayın[3], Selahattin Gelbal[4]

Abstract

Purpose: The study aims to investigate whether there is a bias among countries in the PISA 2018 application regarding the strategies for understanding and memorising in the reading section.

Design/Methodology/Approach: Six countries participated in this descriptive study: The United States, Australia, Korea, Japan, Turkey and New Zealand. The countries were categorized into four groups based on cultural and main language variables, and measurement invariance was initially tested among these groups. Measurement invariance was tested hierarchically between the stages with Multi-Group CFA (MGCFA) analysis. Subsequently, using the poly-SIBTEST method, it was determined whether the questionnaire items exhibited Differential Item Functioning (DIF) across the groups.

Findings: For the Turkey-USA comparison, which involves different cultures and main languages, expert opinions were obtained for all items including DIF. After the 20 experts, it was concluded that the DIF in three items was due to the item effect. According to expert opinions, the expectation that students in the Turkish sample find the "concentrate on the parts of the text that are easy to understand" strategy less useful. Similarly, there were no identified problems related to translation, culture, curriculum, or other factors in the "summarizing" and "reading aloud to another person" strategies. Expert opinions indicated that three items were biased. The "quickly reading through the text twice" strategy involved skimming the text before reading and reading it twice during the reading process. In the "discussing the content with another person" strategy, it was emphasized that students could misunderstand the discussion. The results showed that the "underlining important parts" strategy could be biased for students in the Turkish sample due to educational programs.

Highlights: Based on the results of this research, it is recommended to review the standards in the translation processes of not only achievement tests but also questionnaire items in international applications such as PISA, whose results are considered important.

Öz

Çalışmanın amacı: Bu araştırmanın amacı, PISA 2018 uygulamasında yer alan okuduğunu anlama ve hatırlama stratejileri anketindeki maddelerin kültür ve ana dil değişkenleri bağlamında ülkeler arasında yanlılık gösterip göstermediğinin incelenmesidir.

Materyal ve Yöntem: Betimsel araştırma türünde yürütülen çalışmaya ABD, Avustralya, Kore, Japonya, Türkiye ve Yeni Zelanda olmak üzere altı ülke dâhil edilmiştir. Ülkeler kültür ve ana dil değişkenlerine göre dört gruba ayrılarak öncelikle gruplar arasında ölçme değişmezliği test edilmiştir. Çoklu grıp DFA yöntemi ile ölçme değişmezliği okuduğunu anlama ve hatırlama stratejileri anketi için sırayla şekilsel, metrik, ölçek ve katı değişmezlik olmak üzere aşamalı olarak gerçekleştirilmiştir. Ardından gruplara göre anket maddelerinin değişen madde fonksiyonu (DMF) gösterip göstermediği poly-SIBTEST yöntemi ile belirlenmiştir. Farklı kültür ve ana dile sahip Türkiye-ABD karşılaştırmasında DMF gösteren tüm anket maddelerine göre uzman görüşü alınmıştır.

Bulgular: 20 uzmanın katıldığı çalışmasonrasında üç maddedeki DMF'nin madde etkisinden kaynaklı olduğu ifade edilmiştir. Uzman görüşlerine göre Türkiye örneklemindeki öğrencilerin "metindeki kolay kısımlara yoğunlaşma" stratejisini daha az kullanışlı bulmasının beklendik bir durum olduğu belirtilmiştir. Benzer şekilde "özetleme" ve "sesli bir şekilde başkasına okuma" stratejilerinde de çeviriden, kültürden, eğitim programından ya da başka unsurlardan kaynaklı bir problem olmadığı ifade edilmiştir. Bununla birlikte uzman görüşüne göre anketteki üç maddenin yanlılık gösterdiği tespit edilmiştir. "Metnin geneli hızlı bir şekilde iki kez okuma" stratejisinin alan yazında okuma öncesinde göz gezdirme stratejisi ile okuma sırasında iki kez okuma stratejilerini aynı anda içerdiğine vurgu yapılmıştır. "Metnin içeriğini başkalarıyla tartışma" stratejisinde öğrencilerin soru-cevap olarak nitelendirdikleri stratejide tartışma eyleminin öğrenciler tarafından yanlış anlaşılabileceği vurgulanmıştır. araştırma sonucunda ayrıca "altını çizerek okuma" stratejisinin de eğitim programlarından kaynaklı olarak Türkiye örneklemindeki öğrencilere yanlılık gösterebileceği belirlenmiştir

Önemli Vurgular: Bu araştırmanın sonuçlarına göre PISA gibi önemli uluslararası uygulamalarda sadece başarı testleri değil duyuşsal alanla ilgili anket maddelerinin de çeviri süreçlerinde standartlara uygun bir şekilde gözden geçirilmesi önem arz etmektedir.

INTRODUCTION

Contemporary education aims to raise individuals who can transform knowledge into daily life skills rather than retaining them. In this understanding, which gains momentum, especially with 21st-century skills, the ability to communicate complexly, and share and use knowledge comes to the fore (Joynes et al., 2019). For this, students need to be competent to discover various types of information, recognize and understand how to access them and think about them. The basis of all these processes is reading skills. Reading skill remains the most important skill of the century, even though digital materials are increasing in a rapidly developing world with technology (OECD, 2019a). Similarly, reading skills in the educational environment directly affect students' success not only in language courses but also in other courses. For example, for students to solve a math problem, they need to read and understand the expressions in the problem. A student with well-developed reading skills can reason by making sense of the information about historical events in a course where historical processes are examined. Studies also show that students who actively participate in reading activities have higher learning potential and higher academic achievement compared to their peers (OECD, 2019b).

The reading skills that students acquire and develop in the educational environment also form the basis of their daily life skills. In daily life, the content and price of products can be read while shopping at the market, the contract forms required for any membership can be read and the membership can be decided accordingly, comments can be read to see the opinions of others about a movie watched. In other words, reading comprehension not only supports various disciplines in the field of education but also serves to effectively solve problems in real-life scenarios (Smith et al., 2000). Drawing attention to the importance of the subject, the results of the International Adult Reading Questionnaire (IALS), which was conducted with a large group of participants in the 15-65 age group, reveal that reading skills are effective in all areas of life. The results show that there are significant relationships between individuals' reading skills their lifelong learning efforts and their employment status (Kirsch et al., 2002). All these results show that reading skills are one of the indispensable elements of the educational environment (Kirsch et al., 2002). For this reason, reading strategies (Altınkaya & Sülükçü, 2018; Karatay, 2009; Kuş & Türkyılmaz, 2010) and studies measuring students' reading skills (Çiftçi & Temizyürek, 2008; Gürsoy & Çeliköz, 2022; Kızgın & Baştuğ, 2020; Sayın & Takıl, 2023; Temizkan & Sallabaş, 2015) come to the forefront to improve reading skills because reading comprehension skills form the basis of large-scale tests as well as education.

In our country, large-scale tests such as High School Entrance Exam (LGS), Higher Education Institutions Exam (YKS), Academic Personnel and Graduate Education Entrance Exam (ALES) and Academic Personnel and Graduate Education Entrance Exam (KPSS) include reading comprehension items and literacy skills expected to be used in other subtests such as mathematics. Similarly, international monitoring practices also include items to determine reading skills. For example, the Progress in International Reading Skills Study (PIRLS) measures the reading habits of 4th-grade primary school students and their reading skills in different text types (Mullis et al., 2023). Similarly, the Program for International Student Assessment (PISA) focuses on the extent to which students can use the knowledge and skills they have acquired in daily life, and reading literacy is one of the sub-areas measured (OECD, 2019a). It is seen that the number of countries participating in large-scale applications applied internationally is increasing (Sayın & Takıl, 2017). In addition to ensuring the comparability of countries' education levels, these exams also provide each country with the opportunity to examine its education system from a critical perspective. In this way, countries aim to improve the quality of education by making necessary revisions and improvements in their education policies (Kutlu & Kumandaş, 2015). One of the main reasons for this is that international practices measure not only student achievement or competencies but also the variables that affect them. The PISA application, which is the subject of this study, includes tests to determine students' proficiency in reading, mathematics and science literacy. In addition, data on students' motivation, opinions about themselves, psychological characteristics related to learning processes, school environments and families are collected through questionnaires (MoNE, 2019). Thus, the scores obtained from the tests are scored in the light of the information obtained from the questionnaires. One of the indices used to interpret the reading comprehension scores of 15-year-old students in the PISA application is the UNDREM. To evaluate students' meta-cognitive strategies in PISA, students are given a reading task for each meta-cognitive strategy and they are asked to indicate the reading strategies they use while performing the reading task. In line with the criteria determined based on expert ratings, students' choices are given points and then these scores are standardized and the UNDREM index is produced (OECD, 2019). Within the scope of this study, it was aimed to examine the validity of the answers given to the Reading Understanding and Memorising Strategies Questionnaire Items (ST164), which include reading strategies, in the context of item bias. Considering that validity problems arise especially due to the translation of both test and questionnaire items according to the main language of the countries (Gök et al., 2014; Güner et al., 2014), this study examined the validity evidence for the questionnaire items. The study aimed to determine whether the questionnaire items showed item bias in the Turkish and USA samples with different language and cultural characteristics.

Item bias is when an item in a test gives an advantage or disadvantage to one of the subgroups to which the test is administered, regardless of the trait it is intended to measure (Zumbo, 1999). In the Test Development Standards published by AERA, APA, & NCME in 2014, fairness is defined as the third quality that should be present in tests besides validity and reliability. It means that items should be developed and administered and the results used without giving advantage to any subgroup to ensure equality of opportunity and fairness (Stone-Romero et al., 2010). Otherwise, students will be advantaged or disadvantaged just because they belong to a certain subgroup - race, ethnicity, gender, age, socioeconomic status, cultural structure. Since this

situation affects the scores obtained from the tests, it also negatively affects the decisions made based on the results and therefore needs to be examined (Zumbo, 1999). Item bias is determined in two stages: In the first stage, the differential item function (DIF) is examined. DIF can be defined as the difference in the probability of answering an item correctly among individuals who are similar in terms of the trait measured by the test but who are in different subgroups in terms of variables such as gender, socioeconomic level, and regional differences (Hambleton et al., 1991). After the DIF determination study, content analysis or expert opinion is used to determine item bias. Experts give an opinion on whether the difference in items with DIF is due to item effect or bias (Ackerman, 1992; Osterlind, 1983; Zumbo & Gelin, 2005). In this study, it was examined whether the Reading Understanding and Memorising Strategies Questionnaire Items used in the interpretation of students' reading comprehension scores showed bias according to countries. In the literature, there are studies investigating whether the test items in PISA show DIF (Çelik & Özkan, 2020; Gök et al., 2014; Zeybekoglu et al., 2023) and whether they show item bias (Göktentürk, 2021; Uzun & Gelbal, 2017). However, there are a limited number of studies on the bias of questionnaire items used in the interpretation of scores (Gündeğer, 2023; Schulz, 2008; Köse, 2015; Ünsal Özberk & Koç, 2017). This study will both determine the use of reading strategies in countries and reveal whether there is item bias towards these strategies. The problems of the research are as follows:

- Do the items in the PISA 2018 application's questionnaire on reading understanding and memorising strategies exhibit measurement invariance across cultures and main languages?
- Do the items in the PISA 2018 application's questionnaire on reading understanding and memorising strategies exhibit Differential Item Functioning (DIF) across cultures and main languages?
- In the PISA 2018 application's questionnaire on reading understanding and memorising strategies, do the items exhibiting DIF between Turkey and the United States (different main languages and cultures) also show item bias?

METHOD

Research model

The purpose of this study is to determine whether the items in the PISA 2018 reading understanding and memorising strategies questionnaire show item bias according to main language and culture. In this respect, the study is an example of a descriptive research type. Descriptive research is a type of research that aims to define the current situation and to determine the characteristics, distribution, relationships and change of the research subject (Karasar, 2008).

Participants

Countries

This research has two stages. The first stage consists of students from four countries participating in PISA 2018. PISA 2018 was conducted with the participation of 79 countries, 37 of which are OECD members, and more than half a million students (MoNE, 2019). It aimed to examine the reading strategies subject to the research in terms of main language and culture variables. In this direction, six countries participating in PISA 2018 were identified: the United States of America, Australia, Korea, Japan, Japan, Turkey and New Zealand. Four country sets were formed with these countries according to their cultural and main language characteristics. The country sets are as follows:

- Australia and New Zealand (same main language-similar culture)
- Australia and United States (same main language-different culture)
- Japan and Korea (different main language - similar culture)
- Turkey and United States (different main language-different culture)

The number of students participating in the PISA 2018 application within the scope of the research is shown in Table 1.

Table 1. Countries in the study type

Countries	f	%
Australia	11774	29,6
Japan	5837	14,7
Korea	6260	15,7
New Zealand	4674	11,7
Turkey	6678	16,8
United States of America	4558	11,5
Total	39781	100

Experts

The second participant group of this study consisted of experts. The opinions of 20 experts were consulted to determine the item bias showing DIF in the PISA 2018 reading understanding and memorising strategies questionnaire. The demographic features of the experts participating in the study are shown in Table 2.

Table 2. Demographic features of the experts in the study

Features		f	%
Experts	Turkish education	10	50
	Measurement and evaluation	10	50
Gender	Female	13	65
	Male	7	35
Profession	Master's degree	2	10
	PhD student	5	25
	Prof. Dr.	5	25
	Assoc. Prof. Dr.	6	30
	Asst. Prof. Dr.	2	10
Experience in scale development	Less than 1 year	2	10
	1-5 years	4	20
	5-10 years	7	35
	10-15 years	5	25
	15 years and above	2	10

As seen in Table 2, 50% of the 20 experts participating in the study were experts in the field of measurement and evaluation and 50% were experts in the field of Turkish education. While 65% of the experts were female, 35% were male. 10% of the experts are master's degree graduates and 25% are doctoral students. 25% of the experts are professor doctors, 30% are associate professors and 10% are assistant professors. It was stated that 10% of the experts had less than 1 year of experience in scale development, 20% had 1-5 years of experience, 35% had 5-10 years of experience, 25% had 10-15 years of experience, and 10% had 15 years or more of experience.

Data Collection Tool

In the study, student questionnaire data from the PISA 2018 application conducted by the Organization for Economic Cooperation and Development (OECD) were used. The data were obtained from the official website prepared by the OECD for PISA (http://www.oecd.org/pisa/).

The PISA Reading Understanding and Memorising Strategies Questionnaire Items (ST164) are used to identify students' meta-cognition strategies. Meta-cognition is defined as the extent to which students are aware of the strategies they use to answer questions in reading comprehension texts and their ability to use them (OECD, 2019). Studies have shown that students who are aware of their meta-cognition strategies have higher reading comprehension scores (Altunkaya & Sülükçü, 2018; Ohtani & Hisasaka, 2018; Tuna, 2016). In this direction, students are asked to indicate the strategies they use in reading tasks in PISA applications.

All items that make up the Reading Understanding and Memorising Strategies subtest are 6-point Likert type (OECD, 2019). In the Turkish form, the items consist of 6-point response ratings such as "1- Not useful at all 6- Very useful". The items in the Reading Understanding and Memorising Strategies subscale were in English in the Australian, American and New Zealand samples; Japanese in the Japanese sample; Korean in the Korean sample; and Turkish in the Turkish sample. The questionnaire items are presented in Figure 1.

		Not useful at all					Very useful
		(1)	(2)	(3)	(4)	(5)	(6)
ST164Q01IA	I concentrate on the parts of the text that are easy to understand.	☐01	☐02	☐03	☐04	☐05	☐06
ST164Q02IA	I quickly read through the text twice.	☐01	☐02	☐03	☐04	☐05	☐06
ST164Q03IA	After reading the text, I discuss its content with other people.	☐01	☐02	☐03	☐04	☐05	☐06
ST164Q04IA	I underline important parts of the text.	☐01	☐02	☐03	☐04	☐05	☐06
ST164Q05IA	I summarise the text in my own words.	☐01	☐02	☐03	☐04	☐05	☐06
ST164Q06IA	I read the text aloud to another person.	☐01	☐02	☐03	☐04	☐05	☐06

Figure 1. PISA reading understanding and memorising strategies questionnaire items (ST164)

Within the scope of the research, an expert opinion form was also used in the final stage of the research, the bias study. The expert opinion form consists of three sections. The first section includes information about the demographic characteristics of the experts. The second section includes explanations. In these explanations, (i) what item bias and its possible causes, (ii) what the PISA reading understanding and memorising strategies questionnaire and its purpose of use, (iii) in which countries the items show DIF and the purpose of the study were mentioned. In the third part of the expert opinion form, a table was prepared for the questionnaire items in which the experts could write their opinions with the answer categories so that they could mark whether there was item bias or not. Within the scope of the research, the opinions of the experts were obtained through one-to-one interviews, and item bias and the characteristics of the questionnaire were explained to each expert. Then, the opinions of the experts were collected face-to-face.

Data Analysis

In the research process, data analysis was carried out in four stages. First, the assumptions required for the analysis were checked and the data were made suitable for analysis. Missing data, outliers, univariate and multivariate normality, multicollinearity and co-variance assumptions were examined for the MG-DFA analysis (Kline, 2012; Tabachnick & Fidel, 2007). After examining the assumptions, missing data were assigned using the Expectation-Maximization algorithm (Kline, 2011), and 973 students with multivariate outliers were removed from the data set. It was determined that the assumption of equi-variance was met and there was no multicollinearity problem in the data set. Although the univariate normality assumption was met in the data set, Mardia's test didn't provide. It was determined that the multivariate normality assumption was not met. The fact that the data are ordered categorically can be shown as evidence that they cannot be normally distributed. Robust maximum likelihood estimation (robust MLE or MLR) takes into account the non-normal distribution in the data (Suh, 2015). Accordingly, MLR estimation was performed with Satorra-Bentler (S-B) correction methods.

In the second stage, measurement invariance analyses were conducted to determine whether the items showed DIF or not. Although many studies do not check the construct validity and intergroup equivalence of validity (Gregorich, 2006), measurement invariance is an assumption that should be checked before making intergroup comparisons (Vandenberg & Lance, 2000). For this reason, within the scope of the study, measurement invariance was tested with the multiple group comfirmatory factor analysis (MGCFA) method depending on the culture and main language subgroups. The factor structure of a test developed in a particular culture and language should be equivalent or similar in another culture where the test is applied (Tabachnick & Fidell, 2014). To test this, the four sub-invariance stages of structural, metric, scalar and strict invariance should be checked (Meredith, 1993). The chi-square difference test is highly affected by the sample size. However, since the difference in CFI are independent of model complexity (Cheung & Rensvold, 2002), nested models can give clearer results. The cut-off score of difference CFI was taken as 0.01. In addition to the fit statistics used in the study were RMSEA, SRMR, TLI, and CFI values which are suggested by Hu and Bentler, 1999. (CFI>0.95, TLI>0.95, SRMR<0.06 and RMSEA<0.08). But TLI value greater than 0.90 is supported as acceptable fit(Hu & Bentler, 1999). The analyses in the measurement invariance stage were conducted with the Mplus8 program for the Windows operating system. In the third stage, whether the items in the student questionnaire contain DIF or not was tested with the poly-SIBTEST method. R Studio program was used in the calculations. In the last stage, interviews were conducted with experts to determine item bias. Content analysis was performed in line with the answers obtained from the experts.

FINDINGS

In this section, for the questionnaire consisting of 6 items in the PISA 2018 Reading Understanding and Memorising Strategies Questionnaire Items, firstly, measurement invariance was examined in line with the Australia-USA, Australia-New Zealand, Japan-Korea, Turkey-USA, samples. Then, it was examined whether the items showed DIF based on these country sets. Finally, it was determined whether the items showing DIF in the USA-Turkey comparison showed bias or not.

Research model understanding and memorising strategies exhibit measurement invariance across cultures and main languages?

In the first sub-problem of the study, the answer to the question " Do the items in the PISA 2018 application's questionnaire on reading understanding and memorising strategies exhibit measurement invariance across cultures and main languages? is sought. Measurement invariance was tested in stages with the MGCFA method. Since each invariance stage is a prerequisite for the next stage, structural, metric, scalar and strict invariance tests were carried out respectively. Before proceeding to the measurement invariance stages, CFA was conducted for the single-factor structure of the questionnaire items for the all data and each country. The results of the analysis for all data are shown in Figure 1. It is recommended to conduct CFA for each group before starting measurement invariance studies (Van de Schoot et al., 2012) and this CFA model to be examined should show a good fit for each group. The model-fit indices calculated after the country-based analysis are also shown in Table 3.

Table 3. Model fit indices of the single factor structure of PISA 2018 reading understanding and memorising questionnaire by countries

Countries	χ^2	sd	RMSEA	SRMR	CFI	TLI
America (USA)	28.69	7	0.026	0.028	0.995	0.990
Australia (AUS)	153.62	7	0.042	0.016	0.989	0.977
Japan (JPN)	201.91	8	0.069	0.026	0.971	0.937
Korea (KOR)	247.97	8	0.078	0.031	0.972	0.939
New Zealand (NZL)	127.63	8	0.061	0.022	0.963	0.921
Turkey (TUR)	180.51	8	0.057	0.022	0.971	0.946

df = degrees of freedom, RMSEA= root mean square error of approximation, CFI= comparative fit index, TLI=Tucker-Lewis Index, SRMR = standardized root mean square residual.

When Table 3 is examined, it is seen that the six items in the PISA 2018 Reading Understanding and Memorising Questionnaire show a single-factor structure in the data of the six countries in the study. In all six countries, CFI values were found between 0.953 and 0.971, TLI values between 0.911 and .946, SRMR values between 0.022 and 0.038, and RMSEA values between .052 and .079. This information means that the model-data fit is good in all samples (CFI>0.95, TLI>0.90, SRMR<0.06 and RMSEA<0.08) (Hu & Bentler, 1999). After this section, the measurement invariance stages of the model in all sample pairs were tested respectively. The results are shown in Table 4.

Table 4. Model-data fit indices for measurement invariance

Countries	χ^2	df	RMSEA	SRMR	CFI	TLI	ΔCFI
AUS-NZL							
Configural invariance	225.66	14	0.043	0.016	0.988	0.974	-
Metric invariance	268.38	19	0.040	0.023	0.986	0.977	0.003
Scale invariance	324.46	24	0.039	0.026	0.983	0.978	0.001
Strict Invariance	359.59	30	0.037	0.035	0.981	0.981	0.002
AUS-USA							
Configural invariance	183.48	14	0.039	0.014	0.991	0.980	-
Metric invariance	198.36	19	0.034	0.015	0.990	0.974	0.001
Scale invariance	259.55	24	0.035	0.017	0.987	0.984	0.003
Strict Invariance	418.96	30	0.040	0.031	0.978	0.978	-0.009
JPN-KOR							
Configural invariance	482.67	14	0.074	0.029	0.972	0.940	-
Metric invariance	609.76	19	0.078	0.038	0.965	0.945	0.007
Scale invariance	1982.22	24	0.116	0.069	0.884	0.855	**-0.081**
Strict Invariance	-	-	-	-	-	-	-
TUR-USA							
Configural invariance	145.10	14	0.041	0.016	0.987	0.973	-
Metric invariance	185.04	19	0.039	0.023	0.984	0.975	0.003
Scale invariance	563.98	24	0.037	0.040	0.948	0.935	**-0.036**
Strict Invariance	-	-	-	-	-	-	-

df = degrees of freedom, RMSEA= root mean square error of approximation, CFI= comparative fit index, TLI=Tucker-Lewis Index, SRMR = standardized root mean square residual.

The examination of measurement invariance first started with configural invariance. At this stage, it was examined whether the questionnaire has the same general factor structure across countries (whether it shows a single factor structure). In summary, in this stage, which is also called configural invariance, the comparability of the structure across countries was examined. When the fit indices in Table 4 are examined, the fit statistics at the configural invariance stage are within the accepted range (RMSEA<0.08; SRMR<0.06; CFI>0.95; TLI>0.90). Only χ^2/df values were not taken into consideration since they may give biased results in large samples (Kline, 2016). From this, it can be concluded that the model provides configural invariance across countries. Then, the second stage of measurement invariance, metric invariance, was tested. In the metric invariance stage, factor and item groups in the model as well as item factor loadings were equalized across countries and invariance was tested. Factor loadings were constrained to be equal across groups, but group-specific models were estimated simultaneously by allowing other model parameters to differ across groups. When the fit statistics in Table 4 are examined, it is seen that the model fits the data at the metric invariance stage (RMSEA<0.08; SRMR<0.06; CFI>0.95; TLI>0.90). To determine whether metric invariance was achieved, the difference in CFI values were examined and it was determined that the values were within the desired range (ΔCFI<0.01). Therefore, metric invariance of the model was ensured and the scale invariance phase was started. In the scale invariance stage, in addition to item factor groups and item factor loadings, item constants were also equalized between groups and invariance was tested. Thus, the comparability of the observed variable and factor loading mean values was examined (Gregorich, 2006). At this stage, when Table 4 is examined, it is seen that the model fits the data at the scale invariance stage in the groups other than the groups speaking the same main language (RMSEA<0.08; SRMR<0.06; CFI>0.95; TLI>0.90).). It was determined that the change values in CFI values were within the acceptable range (ΔCFI <0.01) to decide whether scale invariance was achieved. Therefore, scale invariance was ensured between the model groups and the last stage of measurement invariance, which is strict invariance, was tested. In the strict invariance stage, item factor groups, item factor loadings and item constants as well as item residual variances were equalized and invariance was tested (Wu et al., 2007). Since scale invariance was not supported in the different language-same culture samples (JPN-KOR,) and different language-different culture (TUR-USA) strict invariance was tested in all but these groups. When the fit statistics in Table 4 are examined, it is seen that the model fits the data at the strict invariance stage in AUS-NZL, AUS-USA, samples (RMSEA<0.08; SRMR<0.06; CFI>0.95; TLI>0.90).The difference in CFI values (ΔCFI <0.01), which are examined to determine whether strict invariance is achieved, shows that strict invariance is achieved between the model groups. Therefore, it was determined that the questionnaire items showed a similar structure in countries matched with certain variations in terms of culture and same main language. After this determination, we proceeded to the stage of whether the questionnaire items for reading understanding and memorising strategies show DIF according to the countries.

Do the items in the PISA 2018 application's questionnaire on reading understanding and memorising strategies exhibit Differential Item Functioning (DIF) across cultures and main languages?

It was tested whether the items in the Reading Understanding and Memorising Strategies questionnaire in the PISA 2018 application showed DIF between Australia-New Zealand (same main language-similar culture), USA-Australia (same main language-different culture), Japan-Korea (different language-similar culture) and USA-Turkey (different language-different culture) according to the poly-SIBTEST method. The results are shown in Table 5.

Table 5. DIF analysis results of the reading understanding and memorising strategies questionnaire by cultures

Countries	Items	β	Level	Advantage
AUS-NZL (same main language-similar culture)	ST164Q01IA	0.010	-	-
	ST164Q02IA	0.111*	C	AUS
	ST164Q03IA	-0.008*	-	-
	ST164Q04IA	-0.132*	C	NZL
	ST164Q05IA	-0.012	-	-
	ST164Q06IA	-0.098	C	NZL
AUS-USA (same main language-different culture)	ST164Q01IA	0.078*	B	USA
	ST164Q02IA	-0.109*	C	AUS
	ST164Q03IA	0.108*	C	USA
	ST164Q04IA	0.025	-	-
	ST164Q05IA	0.024	-	-
	ST164Q06IA	-0.084*	B	AUS
JPN-KOR (different language-similar culture)	ST164Q01IA	0.139*	C	JPN
	ST164Q02IA	0.796*	C	JPN
	ST164Q03IA	-0.363*	C	KOR
	ST164Q04IA	-0.206*	C	KOR
	ST164Q05IA	0.106*	C	JPN
	ST164Q06IA	0.051*	A	JPN

TUR-USA (different language-different culture)	ST164Q01IA	0.157*	C	USA
	ST164Q02IA	0.067*	B	USA
	ST164Q03IA	0.444*	C	USA
	ST164Q04IA	-0.241*	C	TUR
	ST164Q05IA	-0.122*	C	TUR
	ST164Q06IA	-0.341*	C	TUR

*p<.05

According to the criteria proposed by Roussos & Stout (1996), $|\beta| < 0.059$ is negligible (A), $0.059 \leq |\beta| < 0.088$ is moderate (B) and $|\beta| > 0.088$ is high (C). The positive βvalue obtained indicates that the item shows DIF in favour of the reference group and the negative β value indicates that the item shows DIF in favour of the focus group (Abbott, 2007). In this direction, when the information in Table 5 is analyzed, it is seen that three items show DIF according to Australia and New Zealand, who speak the same main language and have similar cultures. According to the USA and Australia, who speak the same main language but have different cultures, 3 items show DIF. According to Japan and Korea, which have different languages and similar cultures, all 6 items in the questionnaire show DIF. However, it can be said that the DIF of the sixth item is at a negligible level; in fact, five items show DIF. Similarly, between the USA and Turkey, who speak different native languages and have different cultures, six items show DIF and all DIFs are at high levels.

In the PISA 2018 application's questionnaire on reading understanding and memorising strategies, do the items exhibiting DIF between Turkey and the United States (different main languages and cultures) also show item bias?

In the calculations in the PISA 2018 reading understanding and memorising strategies questionnaire based on Turkey and the USA, the USA was determined as the reference group and Turkey was determined as the focus group. Accordingly, it was determined that items 1, 2 and 3 of the questionnaire showed DIF in favour of the USA, and items 4, 5 and 6 showed DIF in favour of Turkey. In other words, the students in the USA sample found the strategies in the first three items of the questionnaire more useful than the students in Turkey. In the last three items of the questionnaire, students in the Turkey sample found the reading strategies more useful than students in the USA sample. To determine whether this result is an item effect or an item bias, the opinions of 20 experts were taken. The frequency and percentage values of the experts' opinions are shown in Table 6.

Table 6. Expert opinions on the bias of the ıtems in the PISA 2018 reading understanding and memorising strategies questionnaire-frequency and percentage values

Advantageous group	Items	Turkish education experts (f)	Measurement and evaluation experts (f)
USA	ST164Q01IA- I concentrate on the parts of the text that are easy to understand.	0	2
	ST164Q02IA- I quickly read through the text twice.	7	2
	ST164Q03IA- After reading the text, I discuss its content with other people.	9	4
Turkey	ST164Q04IA- I underline important parts of the text.	7	3
	ST164Q05IA- I summarise the text in my own words.	3	3
	ST164Q06IA- I read the text aloud to another person.	4	2

When the information in Table 6 is examined, it is seen that the opinions of Turkish education experts and measurement and evaluation experts differ in their views on item bias. More than 70% of Turkish education experts stated that there was bias in 4 items. On the other hand, measurement and evaluation experts generally stated that there was no bias in the items. The opinions of Turkish education experts on the questionnaire items that they stated to have item bias were analyzed by content analysis. The opinions of the experts are as follows:

For the first item of the questionnaire, " I concentrate on the parts of the text that are easy to understand.", none of the Turkish educators (0%) stated that there was no bias in the item. Twenty percent of the measurement and evaluation experts stated that there might be bias in the item. The expert coded OU3 and ME5 stated that the expression "easy part" may be relative. In line with the opinions of the experts, it is thought that the DIF in the first item of the questionnaire is caused by the item effect.

Regarding the second item of the questionnaire, " I quickly read through the text twice." 70% of the Turkish education experts and 20% of the measurement and evaluation experts stated that there was a bias in the item. The opinions of the experts on the subject are as follows. TE1 "Students generally read the texts once and then answer the questions due to the habit they have acquired in the process. For this reason, students in the Turkish sample may have found this strategy impractical, thinking that it is not correct." TE3 "Although the students found the part of reading the text quickly useful, they may have given a low score to this item because of the part of reading the text twice." ME4 "There are two judgments, individuals from different cultures may have focused on this differently." Four other experts expressed similar opinions. In line with the opinions of the experts, it can be said that there is an item bias due to the two actions in the item.

Regarding the third item of the questionnaire, " After reading the text, I discuss its content with other people." 90% of the Turkish education experts and 40% of the measurement and evaluation experts stated that there was a bias in the item. The expert coded TE1 said, "The expression "discuss" in the item is generally used in a negative sense in Turkish. Therefore, students may have given low scores to this item." Similarly, TE5 said, "I think there is a translation error in the item, the word 'discuss' is wrong." The expert coded OU9 said, "Arguing can mean good or bad in different cultures." All of the experts who stated that there was a bias in the item in question stated that the word "discuss" in this item caused a wrong connotation in the students in the Turkish sample and therefore it was biased. Accordingly, it can be said that there is an item bias in this item due to translation.

Regarding the fourth item of the questionnaire, " I underline important parts of the text.", 70% of the Turkish education experts and 30% of the measurement and evaluation experts stated that there was a bias in the item. Among the experts who expressed their opinions on this subject, an expert coded TE2 said, "In the Turkish education system, children study by underlining from primary school onwards. This strategy is very useful for them." TE4 said, "Our students like to underline words in the text." ME10 said, "Studying by underlining is a strategy that students use a lot." This situation shows that there may be a bias in the item due to the education program.

Regarding the fifth item of the questionnaire, " I summarise the text in my own words.", only 30% of both Turkish language education and Measurement and Evaluation experts stated that there was an item bias in the item. The expert coded TE4, who expressed an opinion on the subject, stated that the expression "using their own words" may confuse students. Similarly, the ME7 stated that the text can be summarized "without their own words". Considering both the DIF in favour of Turkey and the expert opinions on the item, it can be said that there is an item effect in the item.

In the sixth item of the questionnaire, " I read the text aloud to another person. ", 40% of the Turkish education experts and 20% of the measurement and evaluation experts stated that there was a bias in the item. The TE3 said, "How will this item be used in solving the reading test, it seems like there is a mistake." TE6 said, "Students may not have understood why the text would be read aloud to someone else if it is not in the classroom environment and the teacher did not ask for it." Although other experts did not express similar opinions on the subject, it was stated that the item should have worked against Turkey. However, this item showed DIF in favour of Turkey. In line with both these opinions and expert opinions, it can be stated that the item did not show bias and that the DIF was due to the item effect.

CONCLUSION, DISCUSSION AND SUGGESTIONS

This study aims to examine whether the items in the reading understanding and memorising strategies questionnaire in the PISA 2018 application show item bias according to culture and main language. In this direction, firstly, the countries including same main language - similar culture; same main language - different culture; different language - similar culture; different language-different culture comparisons were determined. For this purpose, Australia, New Zealand, USA, Japan, Korea and Turkey samples were decided and pairwise comparisons were made. Within the scope of the research, firstly, the factor structure of the questionnaire items was examined and it was determined that the items showed a single-factor structure. The findings revealed that students' Reading Understanding and Memorising Strategies questionnaire items showed a unidimensional structure.It was determined that measurement invariance was achieved in four different variations other than strict invariance. In applications that focus on comparing countries such as PISA, measurement invariance should be examined before comparison (Vandenberg & Lance, 2000). Similarly, there are studies in the literature examining measurement invariance before DIF analyses (Asil & Gelbal, 2012; Karakoç Alatli & Cokluk Bökeoglu, 2018; Tiryaki, 2018).

After measurement invariance, it was examined whether there were DIFs in the reading understanding and memorising strategies questionnaire items in PISA 2018. As a result of the research, it was determined that there were fewer DIFs in the questionnaire items in countries with the same main language, and more (all) DIFs in countries with different main languages. In applications such as PISA, there are DIF studies for the answers of students who speak different main languages and belong to different cultures (Gelbal & Uzun, 2017; Grisay et al., 2019; Gür, 2019; Kankaraš & Moors, 2014; Lee, 2009; Yildirim & Berberoglu, 2009). These results indicate that there may be a problem arising from the translation of items into different main languages. In other words, it can be thought that translation problems (also due to cultural differences) continue in multilingual applications such as PISA.

Finally, it was determined whether the questionnaire items showed bias in the Turkey-USA sample according to expert opinions. For this, the items with DIF were first analyzed. Although the perception of finding reading strategies useful after DIF was the same, it was determined that the students in the USA sample found the strategies " I concentrate on the parts of the text that are easy to understand.", "I quickly read through the text twice." and "After reading the text, I discuss its content with other people." are more useful than the students in Turkey (they scored higher on these items). Students in the Turkey sample found the strategy " I underline important parts of the text.", "I read the text aloud to another person." and " I summarise the text in my own words." more useful than students in the USA. Whether this difference (DIF) was due to item bias or item effect was examined according to expert opinion (Zumbo, 1999). For this purpose, the opinions of 10 Turkish education experts and 10 measurement and evaluation experts were taken. As a result of the research, it was determined that the opinions of Turkish education experts and measurement and evaluation experts did not overlap. The majority of measurement and evaluation experts stated that there was no item bias in the questionnaire items. This result may be although measurement and evaluation experts know the technical

concept of item bias better, they do not have sufficient knowledge in areas such as curriculum implementation, cultural differences, and reading strategy use. Since the expert opinions were taken face-to-face in the study and explanations were made about the process, it can be thought that Turkish educators gave more reliable answers in terms of subject matter expertise. Sayin and Sata (2022) also found that Turkish education experts were more reliable than measurement and evaluation experts in scoring the reading test developed by the students. These results point to the importance of expert selection and the need for a combination of subject matter and technical knowledge.

According to the expert opinions, strategies with DIF and item effects were analyzed. It was determined that the students in the Turkey sample found the strategy of concentrating on the easy parts of the text less useful than the students in the USA sample. However, summarizing the text in their own words and reading the text aloud to another person were found to be more useful by the students in the Turkey sample. In the national literature, reading comprehension strategies are classified as strategies used before, during and after reading. Strategies such as goal setting and skimming are used before reading; strategies such as fluent reading, checking the meaning, underlining, and finding the meaning of unfamiliar words are used during reading; and strategies such as summarizing, analyzing, and evaluating are used after reading (Aktas & Bayram, 2018; Demirel & Epçaçan, 2012; Temizkan, 2007). The first item of the PISA Reading Understanding and Memorising Questionnaire includes the expression "concentrating on easy-to-understand parts of the text". To improve Turkish vocabulary, teachers and students focus on the strategy of "finding the meaning of unknown words" in reading strategies (Baydik, 2011; Sevim & Söylemez, 2018). Therefore, it can be said that this strategy shows a DIF against Turkey, in other words, students find this strategy less useful than the USA sample. In contrast to this situation, some studies support that students use summarizing and sharing strategies intensively in the classroom environment. For example, Aktas and Bayram (2018) stated in their study that summarizing is the strategy that classroom teachers use the most after reading. Therefore, these strategies may have been high among the students in the Turkish sample due to the habits acquired in the process.

The majority of Turkish education specialists stated that there was bias in three items. The second item of the questionnaire, " I quickly read through the text twice." was the only item that showed DIF in all comparisons. Experts also stated that the fact that the item contains two statements, it is not clear whether it focuses on fast reading or reading twice, and that the item shows bias for this reason. In the statement " After reading the text, I discuss its content with other people.", it was stated by the experts that there might be a translation bias because the use of the word "discuss" in Turkish carries negative connotations. This situation indicates that there are some problems arising from cultural and translation characteristics. Asil and Gelbal (2012) also found that the questionnaire items showed DIF in different native-speaker countries. Similarly, Van de Vijver and Tanzer (2004) stated that the possible causes of DIF could be inadequate translations, ambiguity in the meaning of the original item, familiarity with the item content in certain cultures, or culture-specific implications related to the way the item is written. In this study, skim reading is a strategy used before reading, while second reading is a strategy used during reading (Aktas & Bayram, 2018; Yilmaz, 2008). Similarly, the word "discuss" may refer to the question-answer strategy, but it is possible to talk about a linguistic difference here.

Based on the results of this research, it is recommended to review the standards in the translation processes of not only achievement tests but also questionnaire items in international applications such as PISA, whose results are considered important. Considering the effect of reading strategies on achievement, it is recommended to compare the reading strategies in PISA questionnaires with the reading strategies applied in the educational environment. Instead of poly-SIBTEST, which was used in the process of determining DIF in this study, other methods or different subgroups can be determined and the research can be repeated. In the process of determining item bias, people who are experts in different fields can be brought together and their opinions can be obtained through applications such as the Delphi technique, panel interviews, etc.

Declaration of Conflicting Interests

Funding

Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

This research study complies with research publishing ethics. Secondary data were used in this study. Therefore, ethical approval is not required.

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| Research Article / Araştırma Makalesi|

Investigation of the Effect of Teaching the Unit "Chemistry is everywhere" by Argumentation on Academic Achievement and Some Variables

"Kimya Her Yerde" Ünitesinin Argümantasyon Yöntemiyle Öğretiminin Akademik Başarı ve Bazı Değişkenler Üzerine Etkisinin İncelenmesi

Betül Öksüzer[1], **Tacettin Pınarbaşı**[2]

Abstract

Purpose: This study aimed to investigate the effect of argumentation-oriented instruction on students' academic achievement, argumentation skills, attitudes towards chemistry, understanding the nature of scientific knowledge, science process skills and willingness to argumentation in teaching the unit "chemistry is everywhere", by comparing with the existing teaching method.

Method: The research was conducted via embedded design of mixed research method simultaneously combining quantitative and qualitative approaches. The sample consisted of 66 10th grade highschool students. Data collection tools were 'Chemistry is everywhere' Unit Achievement Test (CEAT), Attitudes Scale towards Chemistry (ASTC), Science Process Skills Test (SPST), Nature of Scientific Knowledge Test (NSKT), Argumentativeness Scale (AS), interviews and verbal-written discussion. Independent samples t-test and Mann-Whitney U test were utilized to analyze the scores of CEAT, ASTC, SPST and NSKT, while Wilcoxon test was used for the analysis of AS. The data of interviews, verbal and written discussion were exposed to content analysis.

Findings: The results of the study found statistically significant differences between the experimental and control groups' mean scores of the CEAT, ASTC, SPST and NSKT in favor of the experimental group. For the experimental group, there was a significant difference between the pre-test and post-test mean scores of AS and the students' argumentation levels mainly remained level 2 containing claim and warrant.

Öz

Amaç: Bu araştırmada "Kimya Her Yerde" ünitesinin öğretiminde bilimsel argümantasyon tabanlı öğrenme yönteminin öğrencilerin akademik başarılarına ve argümantasyon becerilerine etkisinin incelenerek mevcut öğretim yöntemi ile karşılaştırılması amaçlanmıştır. Ayrıca, öğrencilerin kimya dersine yönelik tutumları, bilimsel bilginin doğasıyla ilgili anlayışları, bilimsel süreç becerileri ve tartışmaya katılma isteklilikleri de incelenmiştir.

Yöntem: Bu araştırmada gömülü desen kullanılmıştır. Argümantasyon tabanlı öğrenme yönteminin çeşitli değişkenler üzerindeki etkisinin ortaya çıkarılması istenildiğinden karma yöntemin nicel boyutu için yarı deneysel desen tercih edilmiştir. Lise 10. sınıfta öğrenim gören iki farklı şubeden biri deney grubu diğeri ise kontrol grubu olarak belirlenmiştir. Bu araştırmada veri toplama aracı olarak; Kimya Her Yerde Başarı Testi, Kimya Dersine Karşı Tutum Ölçeği, Bilimsel Süreç Becerileri Testi, Bilimsel Bilginin Doğası Testi ile argümantasyon etkinlikleri (yazılı-sözlü tartışmalar) kullanılmış ve argüman düzeyleri Argümantasyon Değerlendirme Modeli ile değerlendirilmiştir. Uygulanan yöntemin öğrenci görüşleri açısından değerlendirilmesi amacıyla Yarı Yapılandırılmış Mülakatlar gerçekleştirilmiştir. Nicel verilerin analizinde SPSS 18.0 paket programı, nitel verilerin analizinde ise içerik analizi kullanılmıştır.

Bulgular: Deney ve kontrol grubu öğrencilerinin akademik başarı, kimyaya karşı tutum, bilimsel süreç becerileri ve bilimsel bilginin doğası testlerine yönelik ön test puan ortalamaları arasında istatistiksel olarak anlamlı bir farklılığın olmadığı, ancak grupların son test puan ortalamaları arasında ise istatistiksel olarak anlamlı bir farklılığın olduğu görülmüştür. Benzer şekilde deney grubu öğrencilerinin tartışma istekliliklerini ortaya koymayı amaçlayan tartışmacı anketi ön test ve son test puanları arasında da istatiksel olarak anlamlı bir farklılık bulunmuştur. Öğrencilerin argümantasyon seviyelerinin Seviye 3'e kadar çıktığı fakat kullanılan öğeler bakımından yüzdelik dilimin Seviye 2'de en fazla olduğu görülmüştür. Mülakatlar sonucunda öğrencilerin argümantasyon yönteminin etkinliğine yönelik görüşleri; yöntemden memnun kalma, kalıcı öğrenmeyi artırma, özgüven sağlama, tartışma isteklilikleri artırma, derse karşı ilgiyi artırma ve diğer derslerde kullanılmasını önerme, başlıkları altında kategorize edilmiştir.

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INTRODUCTION

The teacher-centered traditional method, which is widely used in our country, reduces students' sense of curiosity by getting the students used to memorizing and laziness. Therefore, it causes individuals who do not question and can not produce solutions to problems. In order for learning to take place effectively, the traditional classroom environment that students listen to what teacher says and obey the instructions is not sufficient. However, raising individuals who reach and effectively use knowledge and at the same time question the knowledge acquired occupies an important place in the world of today. Knowledge that does not have an application area is not appreciated.

In recent years, emphasis has been placed on studies emphasizing the importance of discussion in the process of learning, applying and evaluating scientific knowledge in science education. (Akdöner, 2019; Aktaş, 2017; Ceylan, 2012; Demirel, 2017; Doyğun, 2019; Gültepe, 2011; Öztürk, 2013; Yalçınkaya, 2018). These studies have shown that during the scientific discussion process, questioning and evaluating many different perspectives can help students learn science concepts in a meaningful way.

It is possible for students to acquire scientific thinking skills through their comprehension of the nature of scientific knowledge and the role of scientific inquiry and discussion. Students can reach this comprehension only by including them in the culture of science. For this, they should be enabled to experience scientific discussion, which is an indispensable component of science culture (Jiménez-Aleixandre & Erduran, 2007).

Creating an educational environment that takes into account learning based on research and scientific inquiry and realizing the idea of raising scientifically literate individuals bring out the concept of argumentation, which is among the learning processes based on scientific inquiry (Walker, Sampson, Grooms & Zimmerman, 2011). Because in the argumentation process, while students are comparing alternative theories or ideas, they put forward their claims through effective discussions and support their claims with justifications. The argumentation process provides individuals with the opportunity to express and defend their ideas comfortably in the classroom environment, it helps individuals to make decisions using data, to question their decisions, and to refute opposing claims by analyzing them.

According to Toulmin (1958), argumentation is defined, by putting forward the reasons, as the process of supporting a particular idea or a claim put forward on a subject with data, or refuting it with counter-claims. Kuhn (1992) defines argumentation as a process of proposing, supporting, criticizing and evaluating an idea about a scientific topic. According to Van Eemeren and Grootendorst (2004), argumentation can be defined as the ability to persuade the audience. According to Simon, Erduran and Osborne (2006), argumentation is defined as the process of bringing together components such as claim, data, warrant, and backing. With the implementation of argumentation models, researchers have started to develop different evaluation methods in order to analyze the arguments created. In order to determine the levels and quality of argumentations by students, an analytical framework used for assesing the quality of argumentation by Erduran, Simon and Osborne (2004) according to Toulmin's Argument Model was preferred (Table 1).

Table 1. Analytical framework used for Assesing the Quality of Argumentation (Erduran et al., 2004)

Level 1. Level 1 argumentation consists of arguments that are a simple claim versus a counter-claim or a claim versus a claim.

Level 2. Level 2 argumentation has arguments consisting of a claim versus a claim with either data, warrants, or backings but do not contain any rebuttals.

Level 3. Level 3 argumentation has arguments with a series of claims or counter-claims with either data, warrants, or backings with the occasional weak rebuttal.

Level 4. Level 4 argumentation shows arguments with a claim with a clearly identifiable rebuttal. Such an argument may have several claims and counter-claims.

Level 5. Level 5 argumentation displays an extended argument with more than one rebuttal.

Some frameworks have been developed for the argumentation-based learning method used in science classes (Osborne et al., 2004a). Among these frameworks, *Competing Theories–Cartoons*, *Competing Theories–Story, Competing Theories–Ideas and Evidence* and *Constructing an Argument* were used in this study. Small group scientific argumentation contributes to the creation of new ideas for students as a result of that students make suggestions to each other and evaluate the suggestions they receive. Various techniques can be used to create small groups and to make knowledge acquired permanent by increasing classroom interaction (Osborne et al., 2004b). In this study, beside class discussion, the techniques of "*work in pairs"*, "*pairs to fours"* and "*envoy"* are included.

It has been determined that researches on argumentation method, have focused especially on science education in recent years. Some studies on argumentation including variables examined and the results obtained are presented in below.

Koçak (2014) investigated the effects of argumentation on academic successs and critical thinking of teacher candidates, related to their solution concepts. It has been shown that the argumentation method makes a significant difference on the academic achievement of students, but does not make a significant difference on critical thinking dispositions.

Demirel (2017) conducted a research aimed to find out the effects of argumentation and PBL on students' success and various skills about mixtures. It has been shown that argumentation and PBL method is effective on students' academic achievement and scientific process skills compared to the traditional method. In addition, it was determined that the argumentation method

increased the scientific reasoning skills of the students and was more effective in increasing the scientific process skills compared to the PBL approach.

Öğreten (2014) tried to show how argumentation effects academic achievement and argument skill of students about matter. It was observed that the academic achievement of the experimental group students was higher than the academic success of the control group students, the discussion skills of the experimental group students were positively affected, and the use levels of the items in the Toulmin model in discussions increased.

Polat (2014) had a research aiming to display argumentation effects on students' achievement pertain to structure of atom. It was observed that the achievement scores of the experimental group students were higher than the success scores of the control group students.

Balcı (2015) reported a research in which argumentation was investigated in terms of its effect on achievement scores and various skills of students. It has been shown that the argumentation method has a positive effect on students' conceptual understanding, scientific process skills, self-efficacy and attitudes towards the lesson, but not on their argument-forming skills.

Doğru (2016) investigated how argumentation-based classroom activities effected pupils' academic skills. It has been shown that argumentation-based classroom activities are more effective in increasing students' academic achievement, logical thinking skills and questioning thinking perceptions.

Tola (2016) published a paper pertain to matter and heat in which the effects of argumentation was investigated. It was observed that there was no significant difference between the experimental and control groups in terms of conceptual understanding after the application, and the conceptual understanding level of both groups increased during the application. After the application, the experimental group students' scientific thinking skills and understanding of the nature of science were higher than the control group students; while it was observed that the experimental group students' scientific thinking skills and their understanding of the nature of science improved during the application, no increase was observed in the control group students.

Temiz Çınar (2016) studied the effects of argumentation on academic achievement and some skills of students about electricity. Results showed that the argumentation method has a significant effect on students' academic achievement, conceptual understanding and willingness to discuss, but it had no significant effect on critical thinking skills. In terms of argument components, it was observed that they formed arguments at the level 1 and level 2 at the highest level, and they could not create any argument at the level 5.

Aktaş (2017) had a paper aimed to show how argumentation changed students' success and their skills about force and energy concepts. It was determined that argument-based inquiry method had a positive effect on students' academic achievement and argument formation levels, but did not have a positive effect on their willingness to discuss.

Işıker (2017), in his paper investigating the effects of argumentation on some students' skills about matter, found that In the post-test averages obtained from the experimental and control groups, it was observed that there was a difference in favor of the experimental group in terms of academic achievement, attitude towards science lesson and scientific process skills.

In this study, it was aimed to examine the effect of scientific argumentation-based learning method on students' academic achievement and argumentation skills in teaching the unit of "Chemistry is everywhere" and compare it with the existing teaching method. In addition, students' attitudes towards chemistry, their understanding of the nature of scientific knowledge, scientific process skills and their willingness to participate in the discussion were also examined.

METHOD

Research Design

In this study, embedded mixed method design in the classification made by Creswell and Plano-Clark (2011) was used. In this study, as it was desired to reveal the effect of argumentation-based learning method on various variables, a quasi-experimental design was preferred for the quantitative dimension of the mixed method. The research design is given in Table 2.

Table 2. Research Pattern

Groups	Data Collection Tools Used Before Treatment		Treatment	Data Collection Tools Used After Treatment	
Experimental	•	CEAT*	Argumentation-based learning method	•	CEAT
	•	ASTC		•	ASTC
	•	SPST		•	SPST
	•	NSKT		•	NSKT
	•	AS		•	AS
				•	Interview

Control	• CEAT • ASTC • SPST • NSKT	Existing teaching approach		• CEAT • ASTC • SPST • NSKT

*CEAT: "Chemistry is Everywhere" Unit Achievement Test
ASTC: Attitude Scale towards Chemistry
SPST: Scientific Process Skills Test
NSKT: Nature of Scientific Knowledge Test
AS: Argumentativeness Scale

Sample

The sample of the research consists of 66 students from the two classes of of 10th grade in a state high school in Erzurum, in Turkey. One class was randomly assigned to the experimental group while the other formed the control group. Each of experimental and control groups consisted of 33 students by the chance. During a nine-week period, each group received an equal amount of instructional time and was provided with the same materials and assignments, apart from the argumentation-oriented activities in the experimental group. Duration of the lessons was two 50-min per week.

Research Instrument and Procedure

"Chemistry is everywhere" Achievement Test (CEAT)

By examining the chemistry course curriculum recommended by the Ministry of National Education, the learning objectives in the unit "Chemistry is everywhere" were determined. The unit consists of thirteen gains. A question bank was created with a total of 52 multiple choice items (with five options), including at least two questions for each learning objective. The created question bank was submitted to opinion of six people, two of whom were chemistry teachers and four of whom were academicians, for evaluation. Based on the feedback received, 16 of the questions were decided to be excluded from the test. The remaining 36 questions were again revised in line with expert opinions, and the necessary adjustments were made in the options or question statements. In addition, the items of CEAT was also grouped according to the levels of cognitive skills in Bloom's taxonomy. The distribution of test questions according to Bloom's taxonomy is given in Table 3.

Table 3. The distribution of test questions according to Bloom's taxonomy

Cognitive Skills	Number of Questions
Remember	3, 6, 9, 10, 15, 16, 17, 20, 22, 28, 31, 32
Understand	1, 2, 4, 7, 8, 13, 14, 19, 21, 23, 24, 25, 26, 27, 29, 33, 34, 35
Apply	12
Analyze	5, 11, 18, 30, 36
Evaluate	-
Create	-

CEAT was applied as a pilot study to a total of 68 10th and 11th grade students who had previously succeed the unit of "Chemistry is Everywhere". After the pilot application, difficulty indices and discrimination indices were calculated for the test items (0.47 and 0.49 respectively). The Cronbach alpha (α) reliability coefficient of the test was found to be 0.81. The validity of the test was ensured by a teacher and two academic staffs. The distribution of the items of CEAT according to learning objectives is shown in Table 4.

Table 4. Achievement Test Items with Learning Objectives

Item Number	Learning Objectives
1-2	Gains awareness about the limitations of available water resources in the world.
3-4-5-6	Explains the conditions in which utility water should be treated.
7-8	Discovers the main stages of the water treatment process.
9-10-11	Behaves consciously while choosing and consuming foods.
12-13-14-15	Associates the correct use of cleaning agents with their properties and functions.
16-17-18-21	Examples of usage areas of common polymers are given.
19-20	Gains awareness about the usage and recycling process of polymer materials.
22-23-24	Establishes a relationship between the main components of cosmetic materials and their functions.
25	Recognizes the terms related to drug forms in the market.

26-27	Gains awareness of the structure and correct use of stationery materials.
28-29-30	Examines the composition, functions and environmental effects of fertilizers.
31-32-33-34	Establishes a relationship between the composition of building materials and their functions.
35-36	Explains the reasons of air, soil and water pollution.

Scientific Process Skills Test (SPST)

The original of SPST was developed by Burn, Okey, and Wise (1985). It was translated and adapted into Turkish by Geban, Aşkar, and Özkan (1992). This test consists of 36 multiple-choice (with four options) questions. The five subsections that construct the test aim to test different perspectives of scientific process skills. In this test, there are questions that measure the ability to identify variables (12 questions), to define operationally (6 questions), to graph and interpret data (6 questions), to identify and state hypotheses (9 questions) and to design investigations (3 questions). The reliability coefficient of SPST was calculated by Geban, Aşkar and Özkan (1992) as $\alpha=0.81$. In this study, the reliability coefficient of the scale was found to be $\alpha=0.67$. The validity of the test was ensured by a teacher and two academic staffs.

Argumentativeness Scale (AS)

The AS was developed by Infante and Ranger (1982) in order to determine students' tendency to approach or to avoid arguments in the activities based on argumentation-based learning method. It was translated and adapted into Turkish by Kaya (2005). The scale consists of 20 Likert-type questions with 5 alternatives. The reliability coefficient (α) of the original of this test was 0.91, and the reliability coefficient of its translated form was $\alpha=0.71$ by Kaya (2005). In this study, the reliability coefficient of the scale was found to be $\alpha=0.77$. The validity of the test was ensured by a teacher and two academic staffs.

Attitude Scale towards Chemistry (ASTC)

The ASTC was prepared to measure students' attitudes towards chemistry by Geban et al. (1992). The scale consists of 15 Likert-type items including 5 alternatives "fully agree", "agree", "undecided", "disagree" and "fully disagree". The reliability coefficient of the test was found to be $\alpha=0.82$ by Geban et al. (1992) and $\alpha = 0.70$ in this study. The validity of the test was ensured by a teacher and two academic staffs.

Nature of Scientific Knowledge Test (NSKT)

The NSKT was developed by Rubba and Andersen (1978) to determine students' understanding of the nature of scientific knowledge. The test, which was developed to improve understanding of the students in the 12-15 age group about the Nature of Science, was translated and adapted into Turkish by Taşar (2006). The reliability coefficient of the test was found as $\alpha=0.71$ by Taşar (2006). In this study, the reliability coefficient of the test used was found to be $\alpha=0.81$. The validity of the test was ensured by a teacher and two academic staffs.

Verbal and Written Discussions

In each activity in which the argumentation-based learning method was implemented, the experimental group students participated in in-group and inter-groups discussions, formed their own arguments and listened to the arguments of their peers. The verbal discussions of the students in the experimental group were recorded with a tape recorder and camera during each activity. These records were later transcribed and analyzed. Written discussions are the arguments that the students stated in writing for each of the thirteen activities prepared for the experimental group students.

Interviews

At the end of the treatment, a face-to-face semi-structured interviews were carried out with a total of six students with scores of low (2), medium (2), and high (2) according to the CEAT post-test results. Prior to the interviews, students' permission to audiotape was obtained. Each interview took approximately 15 minutes.

Worksheets

At this stage, the activities to be included in the worksheets in accordance with the learning goals of the unit and the working group were determined. The activities are designed to include Toulmin's argument components (claim, data, warrant, backing and rebuttal) in line with the strategies proposed by Osborne et al. (2004a) for the argumentation-based learning method. While designing the activities, care has been taken to ensure that the relevant unit is suitable for the objectives and the students' levels. The activities were tried to be developed for students to gain different perspectives, to construct and defend their own ideas, to produce alternative thoughts, to use their high-level thinking skills and their ability to make effective discussions. As a result of expert opinions, necessary arrangements (simplicity of spelling, choice of cartoons and stories appropriate to the class level, etc.) were made and a total of thirteen worksheets were prepared, including a worksheet for each learning objective. Before moving on to the activities within the scope of the unit, an introductory activity was applied at the beginning of the treatment so that the students could better understand the argumentation-based learning method and thus be prepared for the argumentation process.

Procedure

In order to evaluate the applicability of thirteen activities prepared based on the learning goals of "Chemistry is everywhere" unit and to make the necessary improvements, a plot study was carried out with a total of 34 students consisting of 10th grade students of a high school. Teaching was carried out through classroom activities carried out with the help of worksheets in the experimental group. Worksheets were distributed to the students approximately three days before the course day so that the students could make preparations and come prepared for the lesson. Until the treatment day, the students were asked to fill in the relevant sections as a result of their research by following the instructions on the worksheet. During the application, students were asked to defend these arguments that they developed individually using different group techniques. In the following process, the students tried to defend their claims or refute the counter claims by providing scientific justifications. After the students formed their individual arguments in this way, the students who had a change of opinion as a result of the discussions were asked to express the change of opinion on the worksheets with their reasons. Thus, students' individual argumentation levels were tried to be determined by using worksheets where they formed their own arguments. In order to determine the levels and quality of argumentations by students, an analytical framework used for assesing the quality of argumentation by Erduran, Simon and Osborne (2004) according to Toulmin's Argument Model was preferred (see Table 1).

In the control group, lessons were generally started with repeating the content covered in the previous lesson and continued by giving examples of current and remarkable events and news that would attract the attention of the students about the subject to be told. Then the appropriate course materials such as audio-visual contents with the help of smart board were presented. The instructor assured students to get notes in their notebooks by emphasizing the important concepts during the lecture. At the final stage of the course, the questions in the textbook and in other sources were solved together with the students. In cases where the concepts that students have difficulty in understanding were determined, the content was repeated as a summary and the lesson was concluded.

Data Analysis

Considering the positive contributions of using different data collection tools together in terms of validity and reliability of the research, as a data collection tool in this research the followings are used; i) in the quantitative dimension of the research, CEAT was used to determine the effect of the argumentation-based learning method on students' academic achievement, ii) AS was used to determine students' willingness to argue, iii) ASTC used to determine their attitudes towards the chemistry course, and iv) SPST and NSKT were used to determine the relationship between science concepts. Also argumentation activities (written-oral discussions) were used to determine argument formation skill levels and argument levels were evaluated with the Argumentation Evaluation Model. In the qualitative dimension of the research, Semi-Structured Interview Form was used to evaluate the applied method in terms of student opinions.

The basic assumptions of this research are as follows:

• It was assumed that the students in the experimental and control groups participating in the research answered the questions in the tests, surveys, scales and interviews simultaneously and sincerely.

• It was assumed that no variables (familial, personal, environmental, etc.) other than the argumentation-based learning method and the current teaching method affected the changes in the dependent variables of the students in the experimental and control groups.

• It was assumed that the experimental group and control group students participating in the research did not interact with each other.

• It is assumed that the practitioner approaches both groups impartially throughout the study.

• During the treatment, it was assumed that the experimental group students wrote down all their thoughts while expressing oral and written discussions.

• It was assumed that all scales applied during the research process were applied under standard conditions in both groups.

Analysis of the quantitative data was carried out by SPSS 18.0 package program, and content analysis was used in the analysis of qualitative data. Independent t-test was used in cases where the pre-test and post-test scores of CEAT, ASTC, SPST and NSKT applied to the experimental and control group students showed normal distribution and otherwise, The Mann-Whitney U test was used. AS pre-test and post-test scores did not follow a normal distribution and so the Wilcoxon Signed-Ranks test was used. Significance level was taken as 0.05 in the analysis of all test results. The verbal discussions and the written discussions in the worksheets were divided into items according to the Toulmin model, and the argumentation levels (Level 1 to 5) according to the analytical framework used for assesing the quality of argumentation, by Erduran et al. (2004) were determined. Content analysis was carried out in the analysis of semi-structured interview data.

FINDINGS

CEAT

Table 5. Independent Groups t-Test Results of CEAT Pre-Test and Post-Test Scores

	Group	N	X	S	sd	t	p	η^2
Pre-test	Experimental	33	13.0	2.384	64	1.283	.204	
	Control	33	12.33	1.796				
Post-test	Experimental	33	20.96	4.311	64	7.449	.000	.68
	Control	33	14.72	2.139				

Independent groups t-test was conducted due to the normal distribution of CEAT pre-test and post-test scores. t test results for the CEAT are given in Table 5. It is seen that there is no statistically significant difference between the CEAT pre-test mean scores of the experimental and control groups (t (64) = 1,283; p> .05), but there is a statistically significant difference between the CEAT post-test mean scores of the groups. (t (64) = 7.449; p <.05). Accordingly, the fact that the CEAT post-test mean score (X_E =20.97) of the students in the experimental group is higher than the mean score (X_C=14.73) of the students in the control group show that this difference is in favor of experimental group. The effect size was found to be η^2 = 0.68 (large effect).

ASTC

Table 6. Mann-Whitney U Test Results of ASTC-Test and Post-Test Scores

	Group	N	Mean Rank	Sum of Ranks	U	p	r
Pre-test	Experimental	33	34.65	1143.50	506.500	.624	.06
	Control	33	32.35	1067.50			
Post-test	Experimental	33	38.83	1281.500	368.500	.023	.27
	Control	33	28.17	929.000			

Since the experimental and control group ASTC pre-test and post-test scores did not show normal distribution, the Mann-Whitney U test was used. Mann-Whitney U test results are given in Table 6. It is understood that there is no statistically significant difference between the experimental and control group ASTC pre-test mean scores (U = 506,500; p> .05). The effect size for the pretest scores were found as r = 0.06. Between the ASTC post-test scores there is a statistically significant difference, in favor of the experimental group (U = 368.500; p <.05). The effect size was found r = 0.27 (medium effect).

SPST

Table 7. Independent t-Test Results of SPST Pre-Test and Post-Test Scores

	Group	N	X	S	sd	t	p	η^2
Pre-test	Experimental	33	14.75	3,816	64	1.322	.191	
	Control	33	13.57	3.437				
Post-test	Experimental	33	17.87	3.689	64	2.763	.007	.31
	Control	33	15.36	3.606				

Since the SPST pre-test and post-test scores of the experimental and control groups showed normal distribution, independent groups t-test was conducted. t-test results of SPST are given in Table 7. It is seen that there is no statistically significant difference between the experimental and control group SPST pre-test mean scores (t (64) = 1.322; p> .05). However, there is a statistically significant difference between the SPST post-test mean scores of the groups (t (64) = 2.763; p <.05). This indicates that the difference is in favor of the experimental group. The effect size was found to be η^2 = .31 (small effect).

NSKT

Table 8. Independent t-Test Results of NSKT Pre-Test and Post-Test Scores

	Group	N	X	S	sd	t	p	η^2
Pre-test	Experimental	33	133.363	12.584	64	.288	.774	
	Control	33	132.606	8.336				.62
Post-test	Experimental	33	175.909	19.794	64	6.371	.000	
	Control	33	150.697	11.176				

Independent groups t-test was performed because the NSKT pre-test and post-test scores of the experimental and control groups showed normal distribution. t-test results of NSKT are given in Table 8. There is no statistically significant difference between the experimental and control group NKST pretest mean scores (t (64) =. 288; p> .05), but a statistically significant

difference between the NKST posttest mean scores (t (64) = 6.371; p <.05) in favor of the experimental group. The effect size was found as η^2=.62 (large effect).

AS

Table 9. Wilcoxon Test Result of AS Pre-Test and Post-Test Scores in Experimental Group

Pretest-Posttest	N	Mean Rank	Sum of Ranks	z	p	r
Negative ranks	1[a]	3.00	3.00	-4.882 *	.	0.84
Positive ranks	31[b]	16.94	525.00		.	
Equations	1[c]					

a. Experimental group AS posttest <Experimental group AS pretest   * Based on negative ranks
b. Experimental group AS posttest> Experimental group AS pre-test
c. Experimental group AS posttest = Experimental group AS posttest

Since the experimental group AS pre-test and post-test scores did not show normal distribution, Wilcoxon test was used and the results are given in Table 9. It is seen that there is a statistically significant difference between the experimental group AS pre-test and post-test scores (z = -4.882, p <.05). Considering the mean ranks and the sum of ranks, it is understood that this observed difference is in favor of the positive ranks, namely the AS posttest score. The effect size was r = 0.84 (large effect).

Written - Verbal Discussion

Each written discussion activity completed with an individual or group is scored with either one (1) point or zero (0) point, depending on whether the claim is scientifically feasible. The rates of 10th grade students to give correct answers to the claims in the written discussion activities individually and in groups are 75.7% and 78.3%, respectively. These values show that the percentage of correct answers in group discussions is slightly higher than in individual discussions. Table 10 below gives the total distribution of the percentage of students corresponding to the argumentation levels reached by students.

Table 10. Percentage of Students with Individual Argumentation Levels Based on Activities

	Argumentation Levels					
Activity No	Level 1 %	Level 2 %	Level 3 %	Level 4 %	Level 5 %	Total %
Activity 1	30	61	9	—	—	100
Activity 2	21.3	45.6	30.0	3.1	—	100
Activity 3	15.1	72.7	9.1	3.1	—	100
Activity 4	22.7	62.1	10.6	3.1	1.5	100
Activity 5	15.15	45.45	30.3	7.6	1.5	100
Activity 6	30.3	45.45	18.2	6.05	—	100
Activity 7	6.03	42.5	30.3	15.14	6.03	100
Activity 8	36.37	51.52	9.01	3.1	—	100
Activity 9	33.34	45.45	21.21	—	—	100
Activity 10	3.1	45.40	39.3	9.1	3.1	100
Activity 11	24.26	51.52	21.22	3.1	—	100
Activity 12	20.2	60.6	12.12	5.05	2.03	100
Activity 13	17.17	70.7	10.1	2.03	—	100

Level 2 discussions have a wide variety of items consisting of different combinations of claims, data, warrants, backings and qualifiers elements. Therefore, the percentage of this level can be expected to be high. The rebuttal plays an important role in determining the quality of the discussion, so the quality of the discussions involving the rebuttal is expected to be higher. The argumentation levels of the students remained at level 3 in the first activity, and as the activities progressed, their argumentation levels reached level 4 and 5. In this case, it can be said that the students started to use the scientific language within the activities more effectively as time progressed and so they made better quality contributions to scientific discussions by understanding the argumentation-based learning method better.

Students' views

In order to address the question of "What are students' opinions about the argumentation-based learning method?", one-on-one interviews were held with six randomly selected students from the experimental group. The interview recordings, which were made with camera footage and lasted approximately 15 minutes, were later transcribed. Within the scope of the interview, a total

of 8 questions were asked, aiming to reveal the students' feelings and thoughts about the method used. The students' answers to the questions were evaluated respectively. Codes were first created by means of content analysis, and the created codes were collected under appropriate categories. The findings obtained are presented and interpreted in detail in table 11 below. Students are numbered 1 to 6 according to the order in which the interviews were conducted.

Table 11. Students' View about Argumentation from the Interviews

Categories	Students	Sample Statements
Satisfied	S1 S2 S3 S4 S5 S6	**S1:** I am very pleased, teacher. Because the chemistry topics of grade 10 were mostly verbal, I felt them boring. But the lessons with this method were more enjoyable. **S3:** Yes, my teacher, I am very pleased. Because in this method, I started to get my self-confident. I saw that I could state my ideas to my friends with opposite ideas.
Retention of Knowledge	S1 S2 S3 S4 S5 S6	**S1:** … It was so effective on retention of knowledge. Teachers mostly conducted lessons by being took notes. This forced me to should memorize the content. But with this method I realized that there is an increase in retention time of my learning by logically discussing our ideas each other. **S5:** …this method showed that permanent and effective learning can be achieved in lessons. **S6:** …a method kept me awake. I did not immediately forget what I learned.
Self-Confidence	S3 S4 S6	**S3:** …as I learned and discussed, my self- confidence increased. **S6:** …I was hesitant, I would not talk. With this method, I have confidence in myself within the group and I saw I acquired much knowledge.
Willingness to Discussion	S1 S2 S3 S4 S5 S6	**S1:** …as a result of my research on a topic, while I was speaking my opinion another friend's defense of the opposite was making me attack. I can argue for hours to find common ground on the subject. **S4:** … helped me enjoy the lessons. I saw that I was generating new ideas in the discussion. It made me very happy to do research and to discuss a topic with my friends.
Be interested	S1 S2 S3	**S1:** It increased my interest in a lesson that I find boring. **S2:** I think all lessons and even all subjects can be taught with this method. In this way, our interest and desire to study increases. **S3:** …I saw that I could enjoy even a boring lesson.
Recommending for other Courses	S1 S2 S3 S4 S5 S6	**S2:** I think all lessons and even all subjects can be taught with this method. In this way, our interest and desire to study increases. **S3:** I think it can be used in other subjects. It seems more appropriate to use in verbal lessons. Retention of knowledge is increasing where there is discussion. **S4:** It should be used especially in verbal lessons... thanks to this method, we can learn something from the lessons we spent slumbering.

DISCUSSION and CONCLUSION

CEAT post-test results showed that there is a statistically significant difference between the mean scores of the experimental and control groups (t (64) = 7,449; p <.05). This difference is possibly due to argumentation method that enabled them to be very active, that allowed them to express themselves easily, that enabled them to learn by questioning information, and that made discussion environment for them fun. The data obtained from the interviews with the students in the experimental group also support this result. In the interviews, students stated that the method facilitated their learning, increased their interest in the lesson and, provide their knowledge to be retentive, accordingly increased their success. Similarly, the findings obtained from many studies investigating the effect of this method on different subjects and concepts support this result (Akkaş, 2017; Aktaş, 2017; Aslan, 2018; Balcı, 2015; Chen & She, 2012; Demircioğlu & Uçar, 2015; Yalçınkaya, 2018).

ASTC post-test scores revealed a statistically significant difference in favor of the experimental group (U = 368.500; p < .05). It is reported that students resist the change of attitude and that longer-term practices are required to change the attitude towards the course (Gençoğlan, 2017; Kaya, 2018; Uluçınar Sağır, 2008). However, for this study, a positive effect on the students' attitudes was obtained, possibly due to: the content of this study was related to daily life, the treatment was carried out in a relatively long period of nine weeks, and the course is made more attractive by being applied different activities. This result obtained in the presented research is in accordance with the researches in the literature which states that discussion activities are effective in improving students' attitudes towards the course (Akkuş et al., 2007; Balcı, 2015; Çınar, 2013; Günel et al., 2010; Işıker, 2017; Kaya, Doğan & Kılıç, 2005; Özer, 2009; Yalçın Çelik, 2010).

The fact that there is a statistically significant difference between the groups' mean scores in the SPST post-test (t (64) = 2.763; p <.05) can be interpreted in terms of that argumentation requires students to be active, develops a sense of responsibility in their

own learning, increases retention of knowledge and contributes to the development of basic skills of scientific thinking. The results of this study are in accordance with the findings of some studies in the literature, in which the positive effect of the argumentation method on students' scientific process skills was reported (Aslan, 2018; Ceylan, 2010; Cin, 2013; Demircioğlu, 2011; Ulu, 2011; Şekerci, 2013; Demirel, 2017).

There was a statistically significant difference between the groups' NKST post-test mean scores (t (64) = 6.371; p <.05). This result can be interpreted as an indicator of an increase in their self-confidence in scientific thinking by gaining experiences so that students who participate in scientific argumentation discussions have the chance to see many aspects of science in this process. When the mean scores of the experimental and control group students regarding the sub-dimensions of NKST are examined, it can be said that the students in the experimental group developed more accurate understandings of amoral, creative, developmental, parsimonious, testable, and unified characteristics of the scientific knowledge compared to the students in the control group. Studies have shown that the argumentation helps students learn scientific content (Bell & Linn, 2000; Zohar & Nemet, 2002), develop high-level reasoning, critical thinking and decision-making skills (Yeşiloğlu, 2007), understand how scientific knowledge is structured and evaluated (Dawson & Venville, 2009; Jiménez-Aleixandre & Erduran, 2008) and improve their social skills (Kuhn & Udell, 2003). There are similar studies in the literature regarding that the scientific argumentation-based learning method positively affects students' understanding of the nature of scientific knowledge (Altun, 2010; Boran, 2014; Kaya, 2005; Özer, 2009; Tekeli, 2009; Tümay, 2008; Tümay & Köseoğlu, 2010; Uluçınar Sağır, 2008).

There is a statistically significant difference (z = -4.882 p <.05) between the pre-test and post-test scores of the AS. This difference is in favor of the positive ranks, namely the AS posttest score. During the treatment in the classroom, it was tried to create a democratic environment in which students can express their thoughts and opinions clearly. The fact that the development of the sense of belonging of the students within the group, their struggle to understand the knowledge in a social structure, the increase in their desire of the students who are not interested in the course to participate in the lesson activities, and the positive change that the students showed in the discussions, especially in the last weeks, can be regarded as some of possible factors which increased their willingness to discussion. The students' statements from the interviews support this notion. The mean scores of the experimental and control group students regarding the AS sub-dimensions show that the students tried to avoid participating in the classroom discussion process before the treatment. However, the increase in the mean score after the application shows that the level of avoidance of students from participating in the discussion process has decreased and therefore they can express their opinions more easily. As a result, it can be said that there is a significant and positive effect on students' inclination to participate in the discussion. The result is similar to the results of some studies in the literature (Kaya, 2005; Şekerci, 2013; Demircioğlu et al., 2015; Uluçınar Sağır, 2008; Tekeli, 2009, Erdoğan, 2010; Yalçın-Çelik, 2010; Çınar, 2013).

When the written discussion activities of the experimental group students were examined, it was observed that students reached third level in all activities and only two students reached level 5 in the 4, 5, 7, 10 and 12th activities. In addition, it is seen that the percentage of students in terms of the items they use is the highest in Level 2. It can be stated that the reason for this is that students used expressions containing claims, data and warrants more frequently in activities, but they could not use expressions containing rebuttals. In fact, it is not considered possible for students to use refutation in every subject. Because the students reached a consensus in most of the activities (related to current issues), they could not use the expressions containing rebuttal. On the other hand, the fact that more groups reached the upper levels (level 4 and 5) in group discussions due to the use of refutational statements indicates that students can use scientific language better at in-group discussion and create better quality arguments in joint decision-making. In addition, as a result of the students' detailed feedback during group work, developing many alternatives and more solutions for problem solving can make the process more effective. It can be said that factors such as students' influencing each other in this process, generating more rational ideas with associations, changing perspectives towards each other, and multi-faceted thinking on the subject may affect this result. In studies by Aktaş (2017), Demircioğlu (2011), Osborne et al. (2004a), Şekerci (2013), Yalçın- Çelik (2010) and Yalçınkaya (2018), it is reported that students' argumentation levels are mostly Level 2. The results obtained in this study are in line with the findings of the literature in this respect.

Based on the results of this study, some suggestions for future research and applications are presented below;

• The effect of the argumentation method on the learning process can be compared with other teaching methods (such as demonstration and problem solving) in addition to the method in the existing program.

• A guideline determining the roles of students and teachers in argumentation activities can be prepared and used. These guidelines will contribute to the effective and efficient use of time in the argumentation-based learning process.

• In the studies to be done, the effects of argumentation-based learning method on different variables such as the permanence of students 'success, students' argumentative attitude, self-efficacy perception in chemistry course, argument quality, creative and critical thinking skills can be examined.

• In the studies to be carried out on the argumentation-based learning method, topics related to daily life that will attract the attention of the students and increase their curiosity can be applied as preparatory activities.

• In order to increase the quality of the arguments, teachers should direct and encourage students to scientific thinking and active participation in the classroom.

• In argumentation-based learning method applications, it can be aimed to increase the effectiveness of the method used by including more than one different type of activities.

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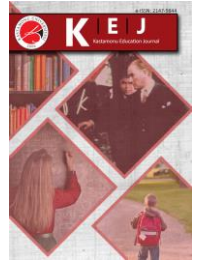
Examination of Inquiry Learning Skills toward Geometry in terms of Various Variables

Geometriye Yönelik Sorgulayıcı Öğrenme Becerilerinin Çeşitli Değişkenler Bağlamında İncelenmesi[1]

Diler KEDİKLİ[2], Yasemin KATRANCI[3]

Abstract

Purpose: Questioning, discovering, generalizing, verifying, and disproving are fundamental aspects of geometry teaching. As seen, the inquiry is at the geometry's core. According to this, inquiry learning toward geometry is a student-centered learning process that allows the student to construct geometric information and to create permanent learning by actively using inquiring skills such as hypothesizing, proving, and disproving in the geometry learning process. To see this process in detail, the purpose of this study is to examine middle-schoolers' levels of inquiry learning skills toward geometry, as well as their relationship to various variables.

Design/Methodology/Approach: In the survey model, 312 middle school students participated in the study. Data were collected using the Inquiry Learning Skills Scale for Geometry and Demographic Information Form.

Findings: It has been determined that middle-schoolers have a high level of inquiry learning skills toward geometry. As a result, inquiry learning skills toward geometry were found to significantly differ by gender, father's educational status, year-end achievement score, asking questions, using materials in the lesson, and associating geometry with daily life. However, there was no significant difference between these skills and the grade level and mother's education status.

Highlights: By using concrete abstract materials or models related to daily life in lessons, teachers can attract students' interest, arouse curiosity in students, and encourage students to use and develop their inquiry learning skills. In addition to educational activities at school, parents can contribute to the development of certain skills such as observation and questioning by creating opportunities for their children to participate in scientific activities at home or in their social environment and exposing them to different stimuli.

Öz

Çalışmanın Amacı: Geometri öğretiminin temel unsurları arasında; sorgulama, keşfetme, genelleme, doğrulama ve aksini ispatlama yer almaktadır. Görüldüğü gibi sorgulama geometrinin özündedir. Bu öze göre geometriye yönelik sorgulayıcı öğrenme, öğrencinin geometri öğrenme sürecinde hipotez kurma, ispatlama ve aksini ispatlama gibi sorgulama becerilerini aktif bir şekilde kullanarak geometrik bilgileri zihinde yapılandırmasına ve kalıcı öğrenmeler oluşturmasına olanak sağlayan öğrenci merkezli bir öğrenme sürecidir. Bu süreci detaylı olarak görebilmek adına bu çalışmada, ortaokul öğrencilerinin geometriye yönelik sorgulayıcı öğrenme beceri düzeylerinin belirlenmesi ve bu becerilerin çeşitli değişkenler açısından incelenmesi amaçlanmıştır.

Materyal ve Yöntem: Çalışma genel tarama modelinde 312 ortaokul öğrencisi ile yürütülmüştür. Veriler, Geometriye Yönelik Sorgulayıcı Öğrenme Becerileri Ölçeği ve Demografik Bilgi Formu ile toplanmıştır.

*Bulgular: S*onuçta; ortaokul öğrencilerinin geometriye yönelik yüksek düzeyde sorgulayıcı öğrenme becerilerine sahip oldukları belirlenmiştir. Geometriye yönelik sorgulayıcı öğrenme becerileri ile cinsiyet, baba eğitim durumu, yılsonu başarı puanı, soru sorma, materyal kullanımı ve günlük yaşamla ilişkilendirme arasında anlamlı bir farkın olduğu sonucu elde edilirken bu beceriler ile sınıf seviyesi ve anne eğitim durumu arasında anlamlı bir fark yoktur.

Önemli Vurgular: Öğretmenler derslerde somut-soyut materyaller ya da günlük yaşamla ilgili modeller kullanarak öğrencilerin ilgilerini çekebilir, öğrencide merak uyandırabilir ve bu sayede öğrencileri sorgulayıcı öğrenme becerilerini kullanmaya ve geliştirmeye teşvik edebilir. Okuldaki eğitim-öğretim faaliyetlerinin yanı sıra ebeveynler evde ya da sosyal çevrelerinde çocuklarının bilimsel aktivitelere katılmaları için fırsatlar yaratıp onları farklı uyaranlara maruz bırakmak yoluyla gözlem yapma ve soru sorma gibi birtakım becerilerinin gelişimine katkıda bulunabilir.

INTRODUCTION

Geometry explicitly or implicitly includes a seeing process, which includes several stages that start with physical-neural skills and continue with higher cognitive skills (such as conceptual thinking, reasoning, deduction, and inference) (Gal & Linchevski, 2010). In the curriculum published by the Ministry of National Education (MoNE) for the mathematics course for teaching these few stages, it is emphasized that students are active participants in the mathematics learning process (MoNE, 2018a). The reason for this is that geometry is excluded from mathematics courses in schools in our country and is taught as a separate course. Similarly, it is urgently recommended that the traditional geometry teaching model be changed to one that is more beneficial for teachers and students. Specifically, it is recommended to provide opportunities to explore geometry to enable students to understand the subject in depth and in connection with other areas of mathematics (Mensah-Wonkyi & Adu, 2016). In the geometry learning process, it should be emphasized that students are directed to produce hypotheses, conduct experiments, and obtain results to answer the hypothesis (Salim & Tiawa, 2015). Moreover, questioning, discovering, generalizing, verifying, and proving the contrary are essential elements in the study and teaching of Euclidean geometry (Soldano et al., 2019). As it can be seen, since questioning is at the core of geometry, inquiry learning should be focused on in geometry teaching. Studies in the literature emphasize the effect of inquiry learning on learning mathematics and geometry (Erbaş & Yenmez, 2011; Ferguson, 2010; Kandil & Işıksal-Bostan, 2019; Katrancı & Şengül, 2020; Novák & Nováková, 2014). Mensah-Wonkyi and Adu (2016), on the other hand, emphasized the importance of the inquiry learning strategy for students, stating that students who learn by questioning are more successful than those who memorize. Inquiry prompts students to think and gets them used to asking themselves questions. Thus, arousing interest and curiosity in students reveals the importance of inquiry in learning and teaching (Tanışlı, 2013). From this point of view, it is valuable to consider inquiry learning not only as a teaching strategy but also as a learning strategy. Thus, it is important to investigate students' inquiry learning skills levels and under which variables these skills differ. Salim and Tiawa (2015) state that the structured inquiry model supports the active and creative participation of students in the processes of researching, examining, and developing geometry concepts and principles. Thus, it is stated that it encourages students to develop intellectual skills in problem-solving. Hardianti et al. (2017) emphasized that the process-oriented guided inquiry model is one of the learning models that can improve geometric thinking skills. With this encouragement and emphasis, inquiry learning toward geometry needs to be addressed in detail. In the curriculum and assessment standards report for school mathematics by the National Council of Teachers Mathematics (NCTM), it is stated that geometry education at the 5th-8th grade level connects the processes that start informally in the preschool period to the formal processes at the 9th-12th grade level (NCTM, 1989). From this point of view, geometry education in middle school, which acts as a bridge between pre-school and high school education, contains a very critical period for students. In this context, it was considered important to examine the inquiry learning skills of middle-schoolers toward geometry. With this importance and necessity, this study focuses on inquiry learning about geometry in the context of various variables.

Inquiry Learning Toward Geometry (ILTG)

Inquiry is a way of thinking and approaching new knowledge (Gillon & Stotter, 2011). In this way, inquiry learning is a student-centered learning and teaching method (Gençtürk & Türkmen, 2007) in which students are introduced to mathematical and scientific inquiry methods (Maaß & Artigue, 2013). It is considered an integral aspect of problem-solving (Laxman, 2013). Inquiry learning skills enable students to ask questions and form hypotheses for solutions, design experimental setups to realize their hypotheses, perform data collection recording steps, analyze the data obtained because of this process, and construct knowledge themselves (Balım et al., 2008). Through inquiry skills, students are encouraged to recognize problems, make assumptions, test assumptions, develop proofs or solutions, and explain their ideas in the context of mathematics (Kogan & Laursen, 2014). Inquiry learning toward geometry can be defined as a student-centered learning process that enables students to construct geometric knowledge in their minds and create permanent learning by actively using inquiry skills such as hypothesizing, proving, and disproving in the geometry learning process (Kedikli, 2022). Within the framework of all these definitions, inquiry learning for geometry is an active learning process in which students construct geometric knowledge in their minds by questioning geometric knowledge and using various inquiry skills such as hypothesizing and proving. It is thought that analyzing these skills in the context of various variables will help us understand them better.

Inquiry Learning Toward Geometry and Various Variables

It is usual for inquiry learning skills to be affected positively or negatively by various variables and to affect lifelong learning (İnel-Ekici, 2017). Considering the importance of inquiry learning in mathematics and therefore geometry education and the importance of inquiry skills in this process, it is important to determine the inquiry learning skills toward geometry and to determine to what extent they are affected by which variables. Nehring et al. (2015) stated that different personal characteristics of students may contribute to a higher manifestation of scientific inquiry skills. These variables can be considered as some demographic characteristics of individuals, such as gender and parental education status. In fact, some studies show that gender has become a factor affecting students' learning outcomes in mathematics due to the biological differences between male and female brains (Erawati, 2020). This situation in mathematics is also valid for geometry at the middle school level. This is because geometry topics at this level are within the scope of the mathematics course. In addition, it is usual to think that the individual's experience of cognitive processes will increase as his/her age progresses and the grade level changes

accordingly. Eccles (2005), on the other hand, argues that there is a link between the educational level of the parents and the achievement of the children indirectly through the effect of family income, where the family can live and the occupation of the parents as possible consequences of this. As stated before, geometry is within the scope of middle school mathematics courses. In this context, the cognitive and affective processes that students have about geometry can be predicted through mathematics achievement. It is possible to say that geometry includes inquiry learning skills by its nature. Soldano et al. (2019) also mentioned that inquiry, discovery, generalization, verification, and refutation are the basic elements of Euclidean geometry. In this light, it is possible to examine the relationship between students' mathematics achievement and their inquiry learning skills toward geometry. On the other hand, inquiry is about asking questions and being curious, and the ability to ask questions is the basis of inquiry learning (Delcourt & McKinnon, 2011). Inquiry learning is considered by Perry and Richardson (2001) as searching and analyzing information by asking questions and transforming the collected data into meaningful information. In this context, it can be assumed that it would not be possible to separate students' asking questions in the lesson from inquiry learning skills. On the other hand, the results of the studies show that the use of materials in mathematics lessons enables the acquisition of skills such as learning by exploring and experimenting as well as geometry achievement, self-efficacy, and attitude (Baki & Özpınar, 2007; Demir, 2019; Okuyucu & Erdoğan, 2021; Yaman & Şahin, 2014). Enriching mathematics lessons with various materials (concrete materials, dynamic software, etc.) and associating them with situations from daily life positively contribute to geometry achievement (Adelabu et al., 2019; Alkhateeb & Al-Duwairi, 2019; Chan & Leung, 2014; Doğan & İçel, 2011; Ganesan & Eu, 2020; Güven, 2012; Zengin et al., 2012). It is usual to think that learning environments supported in this way can motivate a sense of curiosity in students and thus create a tendency to question. In this direction, it is important to investigate students' inquiry learning skills toward geometry in the context of differentiation according to the use of materials in lessons and associating geometry with daily life. The following studies are available in the relevant literature.

Literature Review

Studies examining middle-schoolers, prospective teachers, and teachers' levels of inquiry skills, as well as the factors that influence these skills, can be found in the literature (Abalı-Öztürk et al., 2017; Al-Afifi & Ambusaidi, 2014; Aldan-Karademir et al., 2019; Alkış-Küçükaydın, 2020; Balbağ & Aynur, 2020; Bedir, 2017; Elmalı & Yıldız, 2017; Evren, 2012; Gümüşdağ & Aydoğan, 2020; Işık, 2011; İnel-Ekici, 2017; Okumuş & Yetkil, 2020; Öner, 2019; Şahin et al., 2017; Vekli, 2021; Yavuz et al., 2018; Yılmaz & Karamustafaoğlu, 2015). In their study, Al-Afifi and Ambusaidi (2014) examined the relationship between the levels of inquiry and logical thinking skills of 182 tenth-grade students studying in Oman and the gender-related differences among students. The data of the study were collected using the Inquiry Skills Test. The results show that tenth-grade students have very low levels of both inquiry skills. In addition, it was found that there was a significant difference in favor of girls in activity and experiment design skills and in favor of boys in interpretation skills. Gençtürk and Türkmen (2007) stated that the achievement of the students who were educated with the inquiry method was higher than that of the students who were educated with the traditional method, and these students were more likely to participate in science lessons. This study aimed to investigate the inquiry learning skill levels of middle-schoolers toward geometry and to examine these skills according to various variables (gender, grade-level, mother's (MES) and father's (FES) education status, year-end mathematics achievement score (MAS), asking questions in lessons, and using materials in mathematics lessons). The sub-problems sought to be answered in line with the aim of the study are as follows:

1. What is the level of middle-schoolers' inquiry-learning skills toward geometry?
2. Do middle-schoolers' inquiry learning skills toward geometry differ in terms of various variables (gender, grade level, parental education levels, year-end mathematics achievement score, asking questions in lessons, and using materials)?

METHOD/MATERIALS

Survey research is the description of situations, events, or variables in nature without any external intervention (Tuncer, 2020). In this type of research, the researcher collects data to determine certain characteristics (attitudes, ideas, etc.) of a universe. In this context, the survey research describes, defines, and reveals what is what and generalizations are made for the universe (Hocaoğlu & Akkaş-Baysal, 2019). This study was conducted using the survey model in line with its purpose.

Participants

Convenient sampling, a type of purposive sampling, was used to determine the group that would be included in the study. In this sampling, the researcher takes the sampling elements that he/she can easily reach (Özen & Gül, 2007). The participants consisted of middle-schoolers studying in three different public schools in the province where one of the researchers was working. 26.28% (N=82), 25.96% (N=81), 25.00% (N=78), and 22.75% (N=71) of the students were studying in the fifth, sixth, seventh, and eighth grades, respectively. In addition, 49.35% (N=154) of the students were female and 50.64% (N=158) were male. Therefore, 312 middle-schoolers participated in the study.

Data Collection Tools and Obtaining Data

Data for this research were collected using the Inquiry Learning Skills Scale for Geometry (ILSSG) and the Demographic Information Form (DIF). The DIF includes questions about students' gender, grade level, parental education status, year-end

mathematics achievement scores, their questioning in mathematics lessons, the effect of using materials in mathematics lessons, and associating geometry with daily life on their questioning (yes/no). The data collected through this form constitute the independent variables in determining middle-schoolers' inquiry learning skills toward geometry.

The ILSSG developed by Kedikli and Katrancı (2022) is organized in a five-point Likert type and includes 12 items. The scale consists of two factors: positive perceptions toward inquiry (PTI+) and negative perceptions toward inquiry (PTI-). Cronbach's alpha (CA) coefficients for the factors and the whole scale are 0.785, 0.635, and 0.818, respectively. In cases where a scale developed in a previous study is used, repeating the confirmatory factor analysis (CFA) is recommended (Orçan, 2018). In this context, CFA was repeated in this study, and CA coefficients were calculated. When the findings of the CFA were analyzed, the X^2/df ratio (1.80≤2.50), NFI value (0.92≥0.90), NNFI value (0.95≥0.95), and CFI value (0.96≥0.95) is interpreted as excellent fit (Kline, 2005; Sümer, 2000; Thompson, 2004). The RMSEA value (0.05≤0.07), RMR value (0.07<0.08) and SRMR value (0.05<0.08) indicate good fit (Brown, 2006; Steiger, 2007). Based on the CFA findings, it was proved that the scale showed good/excellent fit, and the factors of the scale were confirmed for this study. CA coefficients of the scale were calculated as 0.726, 0.631, and 0.756 for the factors and the whole scale, respectively. In this context, the scale was proven to be highly valid and reliable (Yıldız & Uzunsakal, 2018), and it was decided that it was appropriate to use it for this study.

The data of this research were obtained in the 2020-2021 academic year, between the first and third weeks of March, using ILSSG and DIF during a class hour (30') deemed appropriate for pandemic conditions. In this framework, data were collected from 442 middle-schoolers studying in three different public middle schools. After the data were collected, 130 scales that were left unanswered, incompletely filled, or randomly marked were not included in the study in order not to negatively affect the validity and reliability of the data.

Data Analysis

The IBM SPSS Statistics 20 package program was used in the data analysis process, and the significance level was set as 0.05. The mean scores of the students from The ILSSG were evaluated as 1.00-1.80 very weak, 1.81-2.60 weak, 2.61-3.40 medium, 3.41-4.20 high, and 4.21-5.00 very high according to the range they were in. The normality of the data was examined with the Kolmogorov-Smirnov test because the dataset was more than 50 (p=0.004<.05) and it was decided to continue the study with nonparametric tests. In this context, the Mann Whitney-U (MW-U) test was conducted to investigate the difference between the measurement results of two unrelated groups, including gender, the effect of asking questions in mathematics lessons, the use of materials in mathematics lessons, and the effect of associating geometry with daily life on asking questions (Kilmen, 2015). In the analyses performed for the variables of grade level, parental education status, and year-end mathematics achievement score, the Kruskal Wallis-H (KW-H) test was used to determine whether there was a significant difference between the measurement results of more than two unrelated groups. In case of a difference in the tests, effect sizes were calculated. In the interpretation of the calculated effect sizes, r=0.1 was considered as low, r=0.3 as medium and r=0.5 as large (Cohen, 1988; quoted from Kilmen, 2015).

FINDINGS

The data obtained because of the analyses conducted to determine the level of inquiry learning skills of middle-schoolers toward geometry are shown in Table 1.

Table 1. ILSTG levels

	N	X̄	df	Min.	Max.
PTI+	312	3.74	0.6	1.67	5.00
PTI-	312	3.68	0.7	1.60	5.00
ILSSG	312	3.69	0.6	1.83	5.00

The mean score of middle-schoolers' inquiry learning skills toward geometry is 3.69, as shown in Table 1. It is noted that the mean PTI+ factor score is 3.74, whereas the mean PTI- factor score is 3.68. Table 2 shows the MW-U test findings regarding the gender differential of middle-schoolers' inquiry learning skills toward geometry.

Table 2. ILSTG and gender

	Gender	N	Mean Rank	Total Rank	U	Z	p
PTI+	F	154	170.59	26271.50	9995.500	-2.735	.006
	M	158	142.76	22556.50			
PTI-	F	154	183.89	28319.50	7947.500	-5.314	.000
	M	158	129.80	20508.50			
ILSSG	F	154	181.27	27915.50	8351.500	-4.793	.000
	M	158	132.36	20912.50			

According to Table 2, inquiry learning skills toward geometry, both in the factors and in the whole scale, differ significantly according to gender. The mean ranks of female students are higher both in the whole scale and in the factors. When the effect size of this difference was analyzed, it was seen that gender had a moderate effect on inquiry learning skills toward geometry

(p<.05; r=0.27<0.30). In Table 3, the results of the KW-H test are shown in relation to the differentiation of middle schoolers' inquiry learning skills toward geometry by grade level.

Table 3. ILSTG and grade level

	Grade Level	N	Mean Rank	df	X²	p
PTI+	5	82	189.26	3	22.104	.000
	6	81	164.37			
	7	78	142.53			
	8	71	125.04			
PTI-	5	82	174.35	3	6.685	.083
	6	81	162.23			
	7	78	142.23			
	8	71	145.02			
ILSSG	5	82	185.52	3	16.910	.001
	6	81	164.11			
	7	78	140.92			
	8	71	131.42			

According to Table 3, the PTI+ factor and the whole scale varied significantly according to the grade level of middle schoolers. Rank averages revealed that fifth grade students had the highest scores in both factors and the whole scale. When the effect size of the difference in the overall scale was examined, it was determined that the grade level variable affected the inquiry learning skills toward geometry at a moderate level (p<.05; r=0.22<0.30). The KW-H test was used to test whether middle-schoolers' inquiry learning skills toward geometry differed in terms of their MES. The findings are presented in Table 4.

Table 4. ILSTG and MES

	MES	N	Mean Rank	df	X²	p
PTI+	Illiterate	14	161.57	4	4.095	.393
	Primary School (PS)	108	157.25			
	Middle School (MS)	120	147.42			
	High School (HS)	59	175.11			
	University	11	142.00			
PTI-	Illiterate	14	185.68	4	9.936	.042
	PS	108	160.62			
	MS	120	138.35			
	HS	59	173.14			
	University	11	187.68			
ILSSG	Illiterate	14	184.29	4	7.308	.121
	PS	108	156.90			
	MS	120	142.59			
	HS	59	177.20			
	University	11	157.86			

Table 4 shows that middle-schoolers' positive perceptions toward inquiry and their inquiry learning skills toward geometry do not differ in terms of their MES. However, there is a difference in the PTI- factor according to the MES. The effect of this difference was found to be quite low (p<.05; r=0.004<0.10). The findings regarding the examination of middle-schoolers' inquiry learning skills toward geometry in the context of FES are shown in Table 5.

Table 5. ILSTG and FES

	FES	N	Mean Rank	df	X²	p
PTI+	Illiterate	3	115.50	4	13.663	.008
	PS	64	154.93			
	MS	109	134.40			
	HS	103	174.36			
	University	33	180.52			
PTI-	Illiterate	3	191.33	4	10.980	.027
	PS	64	149.69			
	MS	109	144.89			
	HS	103	157.53			
	University	33	201.67			
ILSSG	Illiterate	3	163.50	4	13.231	.010
	PS	64	154.96			
	MS	109	135.65			
	HS	103	167.06			
	University	33	194.76			

According to Table 5, it is seen that middle-schoolers' inquiry learning skills toward geometry differ in both factors and the whole scale according to their father's education status. According to the mean ranks, the students with the highest mean ranks in both factors and in the whole scale are the children of university graduate fathers. The effect of the difference obtained was determined to be at a low level (p<.05; r=0.13<0.30). The test findings obtained according to the year-end mathematics achievement score of middle-schoolers' inquiry learning skills toward geometry are given in Table 6.

Table 6. ILSTG and MAS

	MAS	N	Mean Rank	df	X²	p
PTI+	55-69	73	129.55			
	70-84	90	135.46	2	23.888	.000
	85-100	149	182.41			
PTI-	55-69	73	126.62			
	70-84	90	141.85	2	20.633	.000
	85-100	149	179.99			
ILSSG	55-69	73	123.79			
	70-84	90	133.67	2	31.695	.000
	85-100	149	186.31			

According to Table 6, middle-schoolers' inquiry learning skills toward geometry differ significantly on the whole scale and in both factors. According to the rank averages, the group with the highest score was the students whose year-end mathematics achievement score was between 85 and 100. The effect of this difference was found to be significant (p=<.05; r=0.308<0.50). The findings obtained according to the inquiry learning skills of middle-schoolers toward geometry in terms of asking questions in lessons are presented in Table 7.

Table 7. ILSTG and asking questions during lessons

	Asking questions	N	Mean Rank	Total Rank	U	Z	p
PTI+	Yes	209	166.20	34736.50	8735.500	-2.717	.007
	No	103	136.81	14091.50			
PTI-	Yes	209	165.42	34572.00	8900.000	-2.496	.013
	No	103	138.41	14256.00			
ILSSG	Yes	209	168.20	35153.50	8318.500	-3.266	.001
	No	103	132.76	13674.50			

When Table 7 is analyzed, it is seen that according to the answers given by middle-schoolers, their positive-negative perceptions toward inquiry and their inquiry learning skills toward geometry differed significantly in the context of asking questions in the lessons. The effect of this difference was found to be at a low level (p<.05; r=0.18<0.30). In addition, the mean ranks of the students who stated that they asked questions were higher. The findings related to the differentiation level of middle-schoolers' inquiry learning skills toward geometry according to whether their teachers use materials in mathematics lessons are shown in Table 8.

Table 8. ILSTG and the use of materials in mathematics lessons

	Use of Materials	N	Mean Rank	Total Rank	U	Z	p
PTI+	Yes	103	180.20	18560.50	8322.500	-3.270	.001
	No	209	144.82	30267.50			
PTI-	Yes	103	177.67	18299.50	8583.500	-2.920	.004
	No	209	146.07	30528.50			
ILSSG	Yes	103	182.89	18837.50	8045.500	-3.631	.000
	No	209	143.50	29990.50			

When Table 8 is analyzed, it was found that the positive-negative perceptions of the middle-schoolers toward inquiry and their inquiry learning skills toward geometry differed significantly according to their teachers' use of materials in the lessons. The effect of the difference obtained for the overall scale was found to be at a moderate level (p<.05; r=0.20<0.30). According to the rank averages, the scores of the students who stated that they asked more questions when materials were used in the lessons were higher. The findings related to the determination of whether the inquiry learning skills of middle-schoolers toward geometry differ according to the association of geometry with daily life are shown in Table 9.

Table 9. ILSTG and associating geometry with daily life

	Association	N	Mean Rank	Total Rank	U	Z	p
PTI+	Yes	148	183.08	27095.50	8202.500	-4.963	.000
	No	164	132.52	21732.50			
PTI-	Yes	148	173.70	25707.00	9591.000	-3.210	.001
	No	164	140.98	23121.00			
ILSSG	Yes	148	182.99	27082.00	8216.000	-4.932	.000
	No	164	132.60	21746.00			

According to Table 9, the answers of middle-schoolers show that their positive-negative perceptions of inquiry and their inquiry learning skills of geometry differ significantly according to whether geometry is associated with daily life in the lessons. On the other hand, when the rank averages are analyzed, the scores of the students who stated that they asked more questions when geometry was associated with daily life in the lessons were higher. Associating lessons with daily life has a moderate effect ($p<.05$ $r=0.27<0.30$) on inquiry learning skills toward geometry.

RESULT and DISCUSSION

Because of the analyses, middle-schoolers' inquiry learning skills toward geometry were found to be at a high level. When the literature was examined, no results were encountered regarding the inquiry learning skill levels of middle-schoolers toward geometry. However, Aldan-Karademir et al. (2019) found that the inquiry skills of prospective teachers studying in various programs were above the medium level. Tanışlı (2013) examined the inquiry skills of prospective elementary mathematics teachers and pointed out that they were not at a sufficient level. In the literature, the results of studies with prospective teachers show that inquiry skills are good/high level and positive (Abalı-Öztürk et al., 2017; Balbağ & Aynur, 2020; Bedir, 2017; Şahin et al., 2017; Yavuz et al., 2018; Yılmaz & Karamustafaoğlu, 2015). Katrancı and Şengül (2020) concluded that middle-schoolers' inquiry learning skills toward mathematics were high. It is a remarkable result that inquiry skills and inquiry learning skills were evaluated as moderate/good/high/sufficient in studies in the literature although the samples of these vary. In this context, it can be interpreted that the relevant results of this study support the literature. In addition, in most studies, inquiry skills were examined in the context of prospective teachers and in the field of science. However, it is important to consider inquiry learning not only as a teaching strategy in the field of science but also as a geometry learning strategy. In addition, it is obvious that there is a lack of exemplary studies in the literature on geometry. In this context, in terms of discussing the results and contributing to the literature and considering the possibility that today's students are the teacher candidates of the future, it is thought that it is important to diversify the studies and to take measures in line with the results. On the other hand, although students' inquiry learning skills toward geometry were found to be high in this study, the results of our country's large-scale international exams, PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study), as well as the High School Transition System (LGS) exam in mathematics are not very encouraging (MoNE, 2015; 2019; 2020). This may be because the results regarding inquiry learning skills for geometry were obtained from students' own perceptions.

It was found that middle-schoolers' inquiry learning skills toward geometry differed significantly in favor of female students. When the related literature is examined, it is encountered with studies in which results are obtained that gender variable has no effect on inquiry learning skills (Abalı-Öztürk et al., 2017; Evren, 2012; Öner, 2019; Şahin et al., 2017; Yılmaz & Karamustafaoğlu, 2015). In addition to these studies, there are studies in which inquiry/inquiry learning skills differ according to gender. The results of these studies also vary. In some related studies, it was concluded that the significant difference was in favor of girls (Balbağ & Aynur, 2020; Çakmak et al., 2016; Gümüşdağ & Aydoğan, 2020; Işık, 2011; İnel-Ekici, 2017; Katrancı & Şengül, 2020; Vekli, 2021). However, although there are some studies, results in favor of men have also been obtained in some studies. For example, Nehring et al. (2015) reported that boys performed better than girls in the inquiry. In a significant part of the studies conducted with prospective teachers in the literature, it is noteworthy that the inquiry skills of female prospective teachers are higher than those of male prospective teachers. This result was also found in studies conducted with middle school students. This shows that the related results of this study are supported by the literature. In addition, this result coincides with the results of studies examining the relationship between gender and different variables in geometry (Armstrong, 1981; Özcan, 2020). Gümüşdağ and Aydoğan (2020) stated that because of the more active participation of female students in the learning process, they can work in harmony with each other, communicate well with their teachers, and they think that this situation leads to their perception of inquiry skills more than male students. In addition, it can be thought that female students are more interested and curious about the lessons; their attitudes differ from those of male students; therefore, their perceptions of inquiry learning skills are higher than those of male students. It was observed that as the grade level increased, middle-schoolers' positive perceptions toward inquiry and their inquiry learning skills toward geometry decreased. When the related literature is examined, it is noticed that there are studies that do not overlap with the results of this study and that the results that inquiry/inquiry learning skills do not differ significantly based on class variable (Elmalı & Yıldız, 2017; Öner, 2019; Yılmaz & Karamustafaoğlu, 2015). However, on the contrary, it can be said that the number of studies containing the results that these skills differ significantly depending on the grade level is higher (Aldan-Karademir et al., 2019; Balbağ & Aynur, 2020; Bedir, 2017; Işık, 2011; İnel-Ekici, 2017; Okumuş & Yetkil, 2020; Şahin et al., 2017). It can be said that the results of the studies conducted with middle-schoolers (Işık, 2011; Katrancı & Şengül, 2020; Okumuş & Yetkil, 2020) are in parallel with the result of this study regarding the decrease in inquiry learning skills as the grade level increases. Doğan et al. (2020) stated in their study that the development of understanding toward scientific inquiry starts in primary school years. In this direction, it can be said that the fact that there is no difference according to grade level shows that the education given to students in middle schools does not contribute to their inquiry learning skills. Vekli (2021) listed three factors that may have caused this result. The first is the complexity of the subjects, which depends on the grade level and the difficulty of students in questioning abstract concepts. Second, due to the complexity of the subjects, inquiry-based activities are less included in the learning process. Third, it is summarized as students spending time on multiple-choice test-type questions rather than on inquiry-based activities such as experiments and research. At this point, it can be said that the students' sense of curiosity diminished as they got older during

middle school education. Various interpretations can be made, such as that this feeling is not supported by teachers or that the system blunts the tendency toward inquiry in students. To investigate the reasons underlying this situation and to take the necessary measures, more comprehensive studies, especially qualitative and quantitative studies, can be conducted in a mixed design. It can be conducted with students selected from different grade levels, and the variables that cause this result can be analyzed to contribute to the literature.

There was a difference in the PTI- factor of middle-schoolers between students whose mothers graduated from middle school and high school, with the difference favoring students whose mothers' education status was high school. In addition, a significant difference was found in the whole scale and factors according to the father's education status. In the literature, it is seen that Aldan-Karademir (2013) found no significant difference in the inquiry skills of prospective teachers in terms of the mother's education status. According to the father's education status, there was no difference in the sub-dimensions of acquiring knowledge and controlling knowledge, but there was a difference in the sub-dimension of self-confidence. It is a result obtained in the studies in the literature that inquiry skills do not differ in terms of parents' education status (Balbağ & Aynur, 2020; Çakmak et al., 2016). On the other hand, results have also shown that these skills change according to the educational level of the parents (İnel-Ekici, 2017; Vekli, 2021). The results of this study coincide with those of the studies in which differences were obtained. It is usual for students' attitudes, achievement, self-efficacy, and similar situations to differ according to their parents' educational level. In the studies, it is seen that a father's educational level causes a statistically significant difference (Kaba et al., 2016; Kaba & Özdişci, 2018). This may be because parents with a higher level of education approach their children more consciously or support their tendency to ask questions/inquiry in daily life. In this context, it is important for parents to be interested in their children's educational activities regardless of their educational level.

It is among the results reached in the literature that inquiry skills vary according to academic achievement (Çakmak et al., 2016; İnel-Ekici, 2017; Katrancı & Şengül, 2020; Vekli, 2021). In this context, the results of the studies are parallel to the relevant result of this study. Nehring et al. (2015) stated that cognitive variables play an important role in predicting inquiry skills. Furthermore, research in the literature has revealed a positive relationship between inquiry learning and academic achievement (Abdi, 2014; Korkman & Metin, 2021; Uzezi & Zainab, 2017). Based on the results of the studies, it can be said that inquiry learning increases student achievement. In this context, the ability of students who gain inquiry learning skills in the inquiry learning process to use these skills effectively may have enabled them to learn better and increase their success. Katrancı and Şengül (2020) also considered this situation of students with high academic achievement as a natural consequence of the fact that their levels of conceptual learning and making connections between concepts are superior to other students in the context of problem-solving and evaluating the results. In addition, Almeida (2012) mentioned that students' low levels of inquiry and explanation are associated with low achievement.

It was observed that the inquiry learning skills of middle-schoolers differed significantly according to their level of questioning. It was noticed that the mean scores of the students who stated that they asked questions in the lessons were higher. Students' ability to ask inquiring questions to their teachers will enable them to be active learners and increase their academic success. Questions are seen as the essence of inquiry-based learning and are considered to be at the center of the general learning process (Becker, 2000). In this context, it can be accepted that students who express that they ask more questions have high inquiry learning skills. It can be thought that students' endeavor to obtain information by asking questions when they are confused or curious about learning improves their inquiry learning skills. Kazeni et al. (2018) emphasized that low performance in questions related to inquiry skills indicates that students lack high-level thinking skills. In this context, it can be said that this statement can explain the high level of inquiry learning skills of students who stated that they asked questions. Kong (2015) suggests that students should be exposed to inquiry-based assessment questions more frequently to experience the process of scientific inquiry more naturally. On the other hand, Kazeni et al. (2018) stated that the use of ineffective teaching and learning methods may partially explain the low performance in questions related to inquiry skills. In parallel, Van Zee et al. (2001) found that students asked more questions in a classroom environment where inquiry-based activities were included. From this perspective, it is predicted that exposing students to inquiry-based activities or questions in the lessons will be useful in developing inquiry learning skills.

Middle-schoolers' asking questions differed significantly according to the use of materials in the lessons. İnan (2006) stated that mathematics teaching with traditional methods is aimed at helping students find answers to questions with a single predetermined correct answer. In addition, it is claimed that a narrow and closed environment is presented while investigating the solutions to the questions. On the other hand, it is stated that instructional materials provide students with open and enquiring environments and thus provide the opportunity to work freely. In this case, it can be considered that the lessons supported by the materials attracted the attention of the students who were bored with the monotonous lesson environment and that the students were exposed to different stimuli in these environments. In addition, it can be thought that they can be more flexible; in some cases, they can try to make sense of the material and thus ask more questions. For this reason, it can be said that students use inquiry learning skills more frequently in lessons where materials are used. Tang et al. (2019) stated that inquiry-based teaching strategies require students to actively use experimental materials and associate new knowledge with their daily lives outside school. It is assumed that students' inquiry skills can be increased by using materials in lessons.

The findings show that middle-schoolers' inquiry learning skills toward geometry differ significantly depending on whether geometry is associated with daily life in the courses. It is possible to say that associating geometry, which consists of abstract

concepts, with daily life arouses a sense of connection, desire to understand, and curiosity in students, and this situation creates the urge to ask questions in students. MoNE (2018b) also states that the most important power that encourages individuals to learn is the sense of curiosity. As the variety of associations with daily life increases during the lesson, it can be thought that the situations that the student needs to construct and associate in his/her mind will increase, and in parallel, inquiry situations may develop. In this context, it can be accepted that making associations is important for the development of inquiry learning skills.

FUTURE DIRECTIONS

In addition to collecting data with ILSSG, interviews (such as activity-based interviews, semi-structured interviews, etc.) can be conducted with students to examine their inquiry learning skills toward geometry. The records of the relevant interviews can be analyzed, and evaluations can be made in the context of content analysis.

To explain the relationship between gender variables and inquiry learning skills, qualitative analyses can be carried out by conducting studies designed with appropriate methods where qualitative data can be obtained.

To determine the reasons for the negative change in inquiry learning skills depending on the change in grade level and to determine the variables that cause students to regress in terms of inquiry learning skills, the curriculum, mathematics textbooks, and even the problem situations and instructions in the textbooks can be examined with an appropriate method such as content analysis, and a report on the current situation can be presented.

The study can be repeated at different grade levels and with different samples, and by conducting studies enriched with qualitative methods as well as quantitative approaches, the results related to inquiry learning skills can be diversified and contributed to the literature to discuss the results and bring new views to the field.

LIMITATIONS AND RECOMMENDATIONS

In this study, in which students' inquiry learning skills toward geometry were examined, the results were reached by interpreting the quantitative data obtained from students' perceptions. This situation can be considered a limitation of the study. In addition, the study was limited to 442 students who participated in the study. Studies can be conducted with larger samples.

Recommendations for teachers considering the relevant results of the study

By using concrete-abstract materials or models related to daily life in lessons, teachers can attract students' interest, arouse curiosity in students, and thus encourage students to use and develop their inquiry learning skills.

Teachers can encourage other students to ask questions through their attitudes toward students who frequently ask questions in lessons. In addition, it can be thought that the teacher's knowledge of the technique of asking questions in the lessons can be useful in setting an example for the students. In some cases, students can be motivated to think of creative questions by directing them to ask questions to the class in the role of the teacher.

Recommendations for parents

In addition to educational activities at school, parents can contribute to the development of certain skills such as observation and questioning by creating opportunities for their children to participate in scientific activities at home or in their social environment and exposing them to different stimuli.

In addition, parents can make students question the geometric shapes, objects, and concepts they encounter to acquire a basic level of inquiry skills for learning geometry. For example, awareness can be aroused with concepts from daily life such as which geometric object a refrigerator is similar to, which geometric shape can be associated with the shape of a pizza, why the square paper is given that name, or what distinguishes a matchbox from a tennis ball.

Declaration of Conflicting Interests

There are no conflicts of interest.

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We hereby declare that the study has not unethical issues and that research and publication ethics have been carefully observed.

Researchers' Contribution Rate

All authors contributed equally to this article.

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| Research Article / Araştırma Makalesi|

Relatıons Between Error Management Culture, Work Engagement And Organizational Creativity

Hata Yönetimi Kültürü, İşe Cezbolma ve Örgütsel Yaratıcılık Arasındaki İlişkiler[1]

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Abstract

Purpose: The purpose of this research is to determine the effects of error management culture and work engagement behaviors on organizational creativity.

Design/Methodology/Approach: In this study, the relational screening model was used since it was aimed to determine the relationship, relational change, effect and their degrees between at least two variables. In the 2018-2019 academic year, 747 teachers working in primary and secondary schools in five education regions in the city center of Elaziğ constitute the sample of the research. Relational screening model was used. The "Error Management Culture" scale was developed by the researcher. In the research, structural equation analysis was used to measure the effects of error management culture and work engagement behaviors on organizational creativity, and correlation analysis was used to measure the relationship between these concepts. In this research, a mediation analysis was conducted considering that the error management culture has a mediating role in the effect of work engagement behaviors on organizational creativity.

Findings: In the research, it has been determined that the error management culture and the behaviors of work engagement have a significant relationship with organizational creativity. Error management culture and work engagement predict organizational creativity positively, significantly and weakly. In the mediation analysis, it was concluded that the error management culture partially mediate the effect of work engagement behaviors on organizational creativity.

Highlights: In schools, practices that support teachers' engagement to work should be included. In addition, in-service trainings and informative trainings on managing errors should be given to administrators and teachers.

Öz

Çalışmanın amacı: Bu araştırmanın amacı, hata yönetimi kültürü ve işe cezbolma davranışlarının örgütsel yaratıcılık üzerindeki etkilerini belirlemektir.

Materyal ve Yöntem: Bu çalışmada en az iki değişken arasındaki ilişkinin, ilişkisel değişimin, etkinin ve bunların derecelerinin belirlenmesi amaçlandığından ilişkisel tarama modeli kullanılmıştır. 2018-2019 eğitim- öğretim yılında, Elaziğ il merkezindeki beş eğitim bölgesindeki ilk ve orta dereceli okullarda görev yapan 747 öğretmen araştırmanın örneklemini oluşturmaktadır. İlişkisel tarama modeli kullanılmıştır. "Hata Yönetim Kültürü" ölçeği araştırmacı tarafından geliştirilmiştir. Araştırmada hata yönetimi kültürü ve işe bağlılık davranışlarının örgütsel yaratıcılık üzerindeki etkilerini ölçmek için yapısal eşitlik analizi ve bu kavramlar arasındaki ilişkiyi ölçmek için korelasyon analizi kullanılmıştır. Bu araştırmada, işe cezbolma davranışlarının örgütsel yaratıcılığa etkisinde hata yönetimi kültürünün aracılık rolü olduğu düşünülerek bir aracılık analizi yapılmıştır.

Bulgular: Araştırmada, hata yönetimi kültürü ve işe cezbolma davranışlarının örgütsel yaratıcılık ile anlamlı bir ilişkisi olduğu tespit edilmiştir. Hata yönetimi kültürü ve işe cezbolma, örgütsel yaratıcılığı olumlu, önemli ve zayıf bir şekilde yordamaktadır. Aracılık analizinde, hata yönetimi kültürünün işe cezbolma davranışlarının örgütsel yaratıcılık üzerindeki etkisine kısmen aracılık ettiği sonucuna varılmıştır.

Önemli Vurgular: Okullarda öğretmenlerin işe cezbolmalarını destekleyen uygulamalara yer verilmelidir. Ayrıca yöneticilere ve öğretmenlere hizmet içi eğitimler kullanılarak, hataları yönetme konusunda bilgilendirici eğitimler verilmelidir.

INTRODUCTION

Having a say in the changing world, creating new products and being able to compete will be possible with the production of knowledge. The production and sustainability of knowledge will be ensured by educating the members of the organization by using previously unused ways and enriched trainings. Education affects individuals in particular and the whole society in general. If the education and training process is carried out in a healthy way, the society will be affected positively. If this process cannot be carried out properly, it will be negatively affected (Ertürk, 1992). The most important actors of this important process are teachers. Because teachers are the direct implementers of the ultimate goals of education (Köse, 2015, p.10). Behaviors of teachers and school administrators in the school environment primarily affect themselves, then other stakeholders of the school such as students and parents, etc. As a result of this interaction, a culture will be formed in the school. The resulting culture will be learned and shared by the stakeholders of school and transferred from generation to generation. In this transfer, culture and individual will affect each other, while culture will affect the life of the person, the individual will also affect the culture (Şişman, 2002, p.1-2). Considering the mentioned effect of culture, the fact that the managers follow employees' work proportionally and without exaggeration and praise the successful ones will reduce the negative emotion that will occur in the employees at any time. The fact that the employees can share their troubles easily and that the given job is at a level that the employee can do will increase the desire and excitement of the employees towards their work (Küçüksayraç, 2013, p.28). In addition, continuous support of change and development, detection of mistakes and tolerance in a proportionate way will help in correcting mistakes. Because as long as human actions exist, there will be mistakes. People need to accept this so that the concept of error will be better understood (Gronewold & Donle, p.2011). Error is defined as wrong, mistake, crime, sin and fault made unintentionally (TDK Current Turkish Dictionary, 2020). Error management, focuses on the causes of the error by taking the necessary steps and changing the rules in order to prevent the errors from happening again and to minimize the undesirable situations that occur as a result of the error (Helmreich, 1998).

Management of errors in organizations is an element of organizational culture. Error management culture is the form of communication and information network that the members of the organization will reveal while performing the transactions and they use about the error. It refers to all the practices and official procedures related to how the error is detected, what tools and methods are used to solve it, and how they deal with these errors (Van Dyck et al., 2005). According to the researcher, the error management culture expresses the emotional and behavioral process experienced by the members of the organization in the time period between the moment the error occurs and the moment it results. This process includes all activities related to ways of responding to the error, sharing of errors, responsibility for errors and response to the error. The competencies that employees have in managing errors are also part of the process. In institutions with a high error management culture, learning from mistakes is provided, and the way to learn from mistakes is as follows (Guchait et al., 2015): Creating awareness about mistakes, making employees feel responsible for mistakes, analyzing mistakes in accordance with the system, sharing experiences against mistakes, sharing the situations that cause mistakes, high level of information sharing of employees, supporting the ability to talk about mistakes.

All practices related to error management will lead to the formation of a cultural process within the organization over time. It is thought that this process will be shaped by organizational phases in error management. According to Goodman et al. (2011) the first stage is before the error occurs, the second stage is what happens during the occurrence of the error, and the final stage is the stage after the error occurs. Rybowiak et al. (1999, p.532) divided the error management culture, which has three different phases, into dimensions according to its content, duration and management style as follows. *Dealing with Errors:* Having the knowledge and skills to solve the errors as quickly as possible. *Learning from mistakes*: It is to gain some future gains from mistakes. *Taking the Risk in Failure*: It means being flexible against mistakes. *Error Pressure*: It refers to thinking about the troubles and fears that mistakes can bring to him. *Awareness that Errors Can Occur:* Accepting that mistakes are unavoidable and relevant to the job. *Closing Errors*: It means ignoring and hiding errors. *Communicating about Errors*: It means that employees can talk and discuss about mistakes. *Thinking about Mistakes*: It refers to generating ideas for the mistakes that occur within the organization.

It can be said that one of the ways to be successful in the management of mistakes is to have high energy of employees towards their work. The high level of work-oriented energy brings to mind the concept of work engagement. Goffman defined work engagement as a person's energizing work, embracing the role one has, being selected for the designated role, and a visibly active interest, commitment, or spontaneous participation in the behavior that that role imposes on the person, interest and effort (Goffman, 1959). Making one of the largest studies on the subject, Schaufeli et al. (2002, p.74) stated that work engagement consists of three sub-dimensions: vigor, dedication, and absorption. He explained these dimensions as follows (Turgut, 2013, p.2): *Vigor:* Willingness to go to work, having work-related energy. *Dedication:* Thinking that the work you do is meaningful and serves a purpose. *Absorption:* Not forgetting everything while working, not understanding how time passes, not getting caught up in the work being done.

There are a number of factors that affect work engagement, which are considered in three dimensions: *Individual Factors*: The individual knows himself well, makes good use of the time given, gives importance to personal development, has sufficient knowledge about his job, is committed to his institution, has motivating factors, establishes an emotional bond with the other, adopts the goals of the organization by not seeing their own goals higher than the organization's goal (Çakıl, 2011). *Organizational Factors*: Factors such as establishing a fair reward system within the organization, ensuring that people are equally distributed

and controlled, supporting employees by providing opportunities, providing feedback to employees about their work, ensuring the health and safety of the workplace, and supporting the employee of the organization are organizational factors that affect work engagement. (Wollard & Shuck, 2011). Work engagement, whose dimensions are given above, creates a motivated state of well-being that provides positive job-related satisfaction (Schaufeli & Bakker, 2004). According to Bal (2009), the energy of the person increases and the idea of quitting his job decreases during the period of increased work engagement. In addition, it has been determined that there is a very strong connection between the engaged employee and the employee's commitment to their organization, the excitement experienced during work, the search for innovation and difference (Haid and Sims 2009; cited in Bostancı and Ekiyor, 2015, p.40).

Definitions that will be created by strengthening the relationship between the organization and thinking differently and seeking innovation explain organizational creativity. In order to understand organizational creativity, first of all, it is necessary to know what creativity is. In the simplest sense, creativity means discovery, invention and innovation. Creativity makes you feel that it is the most important condition of innovation by revealing the thought that was not thought, previously thought and not applied (Yalazan, 2006). Organizational creativity is "the development of new and useful ideas about products, services and processes by individuals or groups within an organization" (Martins and Terblanche, 2003). New ideas come only from the hands of creative people. For this reason, creativity is primarily individual, for this reason, providing and maintaining organizational creativity will be possible if the organization creates a work environment where employees can reveal their creativity and makes some organizational arrangements for creativity (Çekmecelioğlu, 2002). It is important to remember that change is inevitable. The organization's existence in this change will only be possible with creative and innovative employees and the culture they create, and they will gain superiority by providing creativity (Yüceler, 2009). Balay (2010) examines organizational creativity in three dimensions as individual, managerial and social: *Individual creativity*: It is the characteristics that reveal the creativity of the individual. (Yıldırım, 2007, p.112) *Managerial Creativity*: It is defined as enabling the manager of the organization to express the creativity features of the employees. (Chang and Chiang, 2007). *Social Creativity*: It is the relationship between the support of the social environment and the creativity level of the person (Balay, 2010).

Organizational creativity, which is handled in three different dimensions, includes different processes such as the emergence of ideas, development of ideas and implementation (Yıldırım, 2007). Because respecting new ideas, valuing individuals, being open to discussions, and providing freedom creates an atmosphere of creativity in the educational environment (Sungur, 1997). Increasing freedom and providing error-oriented communication (Carmeli ve Gittell, 2009) contribute to the establishment of trust between the teacher and the administration (Helmreich, 1998) and the formation of a culture of error management. Establishing a trial-and-error environment by encouraging the teacher, giving confidence, ensuring that he overcomes his fears (Kahn, 1990), distribution of work equally, and supporting the teacher by providing opportunities (Wollard ve Shuck, 2011) ensure that teachers are attracted to work. As can be seen, strong communication in schools, a healthy and safe work environment, respect for ideas, encouraging and freedom are common determinants of error management, engagement and organizational creativity. In the light of the aforementioned information, it is possible to say that there may be a connection between engagement, organizational creativity and error management culture.

For this reason, it is a matter of curiosity how teachers' energies towards their work change as a result of the mistakes they experience in schools and how these two situations affect their creativity behaviors in schools. From this point of view, teachers' perceptions and roles are of great importance in the formation of the targeted error management culture, ensuring that the employees are attracted to the work, and organizational creativity comes to the fore. In this study, it has been considered as a problem whether the culture related to the management of mistakes in schools and the teachers' work engagement behaviors predict organizational creativity, and whether the error management culture has a determining feature in the relationship between work engagement and organizational creativity.

When the literature is examined, it is seen that there is not enough number and variety of research on the concepts of work engagement, error management culture and organizational creativity. In the literature review for this study, no studies were found that used the concepts of error management culture, work engagement and organizational creativity together and examined the relationship between them. In fact, it has been determined that error management culture from these three concepts has not been examined in educational environments. However, it is thought that the essence of creativity will be innovation, and innovation will be provided by a culture that is open to innovation as a structure and can manage mistakes. This situation reveals the fact that it is necessary to examine the relationship between organizational creativity and error management culture. From this point of view, examining the relationship between error management culture, work engagement and organizational creativity, presenting relevant findings and developing suggestions will contribute to the literature with the topicality of the research topic, its diversity and the diversity of the sample in the research.

Purpose of the Research

The general purpose of this study is to determine the relationship between error management culture and work engagement behaviors with organizational creativity. Sub-objectives have been created for this general purpose;

1. Is there a significant relationship between error management culture, work engagement and organizational creativity?
2. Are error management culture and work engagement a significant predictor of organizational creativity?

The general purpose of the research and the hypothesis for the first research question are as follows: **H₁:** Error management culture and work engagement are significant predictors of organizational creativity.

METHOD

In this study, the relational screening model was used since it was aimed to determine the relationship, relational change, effect and their degrees between at least two variables (Creswell, 2012).

Universe and sample

Since it is a method that best meets the purpose of the research, stratified sampling method, one of the random sampling methods, was used. (Miles and Huberman, 1994). The population of the research consists of a total of 2691 teachers, 1233 of whom work in primary schools and 1458 in secondary schools, located in five educational regions with differences in terms of various variables (social, economic, cultural, etc.) in the city center of Elazig. The sample size was calculated according to +-0.03 sampling error and 747 was found using the formula (Sümbüloğlu & Sümbüloğlu, 2007). Of the 747 teachers who participated in the research, 394 (53%) were male and 353 (47%) were female. 103 (14%) of the teachers participating in the research are 1-5 years, 119 (16%) are 6-10 years, 112 (15%) are 11-15 years, 131 (17%) are 16-20 years and 103 (38%) of them have 21 years or more seniority; 443 (60%) were classroom teachers and 304 (40%) were branch teachers. It is seen that 499 (67%) graduated from the faculty of education, 194 (26%) from the faculty of science and literature, and 54 teachers (7%) graduated from other educational institutions.

Data Collection Instruments

Three different scales were used to collect data in line with the general purpose and sub-purposes of the research.

Work Engagement Scale

A frequently used scale in research, "Work Engagement" scale, which is called the "Utrecht Work Engagement Scale (UWES)" and developed by Schaufeli et al. (2002), was used in this study. The scale consists of 3 dimensions and 17 items. The translation of the scale into Turkish, validity and reliability studies were carried out by Turgut (2013). In the validity test, the power to explain the concept of work engagement was found to be 62.21%, and each statement was placed under the predicted factor with a weight above 0.50.

Confirmatory factor analysis was applied to test the validity of the Work Engagement Scale. Since the confirmatory factor analysis results were within the acceptable range (X2/sd: 4,321, GFI: .935, AGFI: .908, CFI=.953, NFI=.940, IFI=.953, SRMR=.044, RMSEA=.058) , the validity of the scale was ensured (Kline, 2011; Baumgartner & Homburg, 1996; Bentler, 1980; Schermelleh-Engel & Moosbrugger, 2003; Brown, 2006; Tabachnick & Fidell, 2007). The factor loads obtained as a result of the confirmatory factor analysis of the scale were found to be between 0.57 and 0.83 for the vigor sub-dimension, between 0.60 and 0.81 for the devotion sub-dimension, and between 0.60 and 0.78 for the absorption sub-dimension. In this study, the Cronbach Alpha internal consistency coefficients of vigor, dedication and absorption were calculated as 0.851, 0.854 and 0.865, respectively. The Cronbach's alpha coefficient for all items of the Work Engagement Scale was found to be 0.934, and it was seen that the reliability of the scale based on internal consistency was high (Tavşancıl, 2014).

Organizational Creativity Scale

The "Organizational Creativity Scale" developed by Balay (2010) was used in the research. The scale consists of 3 dimensions and 39 items. When the factor loads were examined, it was seen that they varied between .47 and .88. In addition, 20.3%, 19.7% and 18% are the variance rates explained by each factor, respectively. Three factors explain 58% of the total variance. Alpha coefficients were calculated as .92 for the first factor, .93 for the second factor, and .95 for the third factor, respectively.

CFA analysis was conducted to test the validity of the organizational creativity scale. Since the confirmatory factor analysis results (X2/sd: 3.378, CFI=.906, NFI=.901, GFI=.916, AGFI: .857 IFI: .904, SRMR=.042, RMSEA=.062) were within the acceptable range, it can be said that the scale has validity (Kline, 2011; Baumgartner & Homburg, 1996; Bentler, 1980; Schermelleh-Engel & Moosbrugger, 2003; Brown, 2006; Tabachnick & Fidell, 2007). The factor loads obtained as a result of the confirmatory factor analysis of the scale were found to be between .55 and .75 in the dimension of individual creativity, between .47 and .87 in the dimension of managerial creativity and between .51 and .88 in the dimension of social creativity. In this study, the Cronbach Alpha internal consistency coefficients belonging to the sub-dimensions of individual creativity, managerial creativity and social creativity were calculated as .936, .931 and .927, respectively. Cronbach's alpha coefficient for all items of the organizational creativity scale was found to be .960, and it was concluded that the scale was reliable.

Error Management Culture Scale

Various stages have been passed to develop the error management culture scale. It is possible to list these stages as follows:

1. The Lawshe (1975) technique was used to ensure the content validity of the "Error Management Culture" scale developed by the researcher. First of all, the opinions of twelve experts were taken. *In the second step*, a literature review was conducted to identify the possible items of the scale (Edmondson, 2004; Goodman et al., 2011; Keith & Freze, 2011; Van Dyck et al., 2005) and a pool of 41 items was developed. *In the third step*, expert opinions were obtained about the items in the scale. *In the next step*, content validity rate (CVR) was calculated for each item by evaluating the expert opinion, and 10 items were removed from the draft version of the scale as they were below the statistical criteria (Veneziano & Hooper, 1997). *In the fifth step*, the total content

validity index (CVI) for the remaining items was calculated as 0.74. The content validity of the scale, consisting of 31 five-point Likert-type items ranging from strongly disagree to strongly agree, was completed.

2. There are different sampling approaches for validity and reliability analyzes in the literature related to scale development studies. There are studies suggesting that the number of samples should start from 4 times the number of items to 10 times or be in this range (Büyüköztürk, 2010; Kurnaz & Yiğit, 2010; Tavşancıl, 2014; Widaman et al., 2009). In this study, in the light of the above information, 312 different teachers were reached for exploratory factor analysis and 324 different teachers for confirmatory factor analysis.

3. For the Error Management culture scale, firstly, exploratory factor analysis was performed. The lowest item factor load of .56 in the final version of the scale indicates that the items have the desired factor load. In addition, KMO and Bartlett tests were also carried out. It was revealed that the obtained KMO value (0.848) and Bartlett's test of Sphericity result (2098.483, p=0.000: p<.01) were suitable (Büyüköztürk, 2010). After all these analyzes were made, it was seen that the scale consisted of 4 dimensions and 16 items. According to the results obtained, the Sharing of Error dimension consists of five items with factor loadings ranging between .563 and .773 and explains 30.05% of the total variance. The Error Competence dimension consists of five items with factor loadings ranging from .577 to .811 and explains 50.93% of the total variance. Error Avoidance dimension consists of three items with factor loadings varying between .742 and .809 and explains 58.40% of the total variance. Response to Error dimension, on the other hand, consists of three items with factor loadings ranging between .677 and .861 and explains 64.69% of the total variance.

Confirmatory Factor Analysis was applied to test the Error Management Culture Scale. After the model created, it was determined that the Chi-Square/sd value (193.917/97=1.999) showed a perfect fit (Kline,2011). Other values obtained from CFA (CFI=.945, NFI=.905, IFI: .946 AGFI: .912, GFI=.927, SRMR=.051, RMSEA=.058) are proof that the scale is in acceptable fit (Baumgartner & Homburg, 1996; Bentler, 1980; Schermelleh-Engel & Moosbrugger, 2003; Brown, 2006; Tabachnick & Fidell, 2007). In the "Error Competence" dimension, it was decided to make a correlation between the 4th and 5th items together with the expert opinion, and the model took its final shape. According to the CFA results obtained, the factor loads of the items belonging to the Error Sharing dimension were .760, .750, .679, .565 and .543, respectively; the factor loads of the items belonging to the Error Competence dimension were .823 and .709, .706, .657, .567, respectively; the factor loads of the items belonging to the Error Avoidance dimension were found to be .763, .723, .709, respectively, and the factor loads of the items belonging to the Response to Error dimension were found to be .843, .778 and .634, respectively.

4. When the Cronbach Alpha Reliability Coefficients for the Error Management Culture Scale are examined, the reliability coefficient for the Error Sharing sub-dimension is .814, the reliability coefficient for the Error Competence sub-dimension is .838, the reliability coefficient for the Error Avoidance sub-dimension is .796, and the reliability coefficient for the Error Response sub-dimension is .784. and the total item reliability coefficient of the Error Management Culture Scale was found to be .846. When the results obtained are examined, it is seen that the Error Management Culture Scale is reliable. It was concluded that the Error Management Culture Scale, which was created as a result of all the data obtained, is a valid and reliable scale.

Data Analysis

SPSS 21 and AMOS 18 were used to analyze the data. Structural equation analysis (Byrne, 2013) was used because there was a need for a statistical technique that simultaneously tested two or more relationships that allowed the relationship between more than one variable to be permanent or separated. In addition, correlation analysis was used to examine the relationship between two or more variables without interfering with these variables in any way (Büyüköztürk, et al., 2012, p.226).

Normality test was applied primarily in the study. In addition, the structural equation model has outliers, normality, multicollinearity problem and sample size prerequisites: Stage 1: Outliers in the data set (based on the absolute values of -3 and 3 according to z scores) were examined and 15 data determined to be outliers were removed. Then outliers were eliminated. Stage 2: The normality of the data was examined. In this study, Skewness and Kurtosis values were examined to look at the normality values. Since the Skewness and Kurtosis values were between ±2 values, it was determined that the data showed normal distribution (George & Mallery, 2016). Stage 3: The problem of multicollinearity is examined. The fact that the correlation between the independent variables in the model is high (greater than 0.80) is an indicator of the multicollinearity problem (İslamoğlu, 2011). The correlation matrix between work engagement and error management culture was examined. The values for the data obtained are given in Table 1.

Table 1. Correlation matrix showing the relationship between error management culture and work engagement

Variables	A	A1	A2	A3	B	B1	B2	B3	B4
A. Work Engagement	1								
A1.Vigor	.911**	1							
A2.Devotion	.895**	.733**	1						
A3. Absorption	.902**	.716**	.721**	1					
B. Error Management Culture	.371**	.350**	.321**	.331**	1				
B1. Error Sharing	.389**	.364**	.344**	.343**	.738**				
B2. Error Competence	.388**	.361**	.331**	.357**	.742**	.685**	1		
B3. Error Avoidance	.124**	.123**	.113**	.099**	.644**	.129**	.155**	1	
B4. Response to Error	.093*	.091*	.071	.088*	.645**	.129**	.133**	.616**	1

Correlation coefficients between independent variables were found to be the lowest .071 and the highest .389. In this study, it was observed that there was no multicollinearity problem between the variables. In Stage 4: It was examined whether the sample size was sufficient or not. Considering the information in the literature, it can be said that the sample of this research, which has 71 items, is large enough, consisting of 747 data (Bayram, 2013; Kline,2011).

RESULTS

Findings and Comments on the First Sub-Aim of the Research

Correlation analysis was conducted for the question, which is the second sub-objective of the research, "According to teachers' opinions, is there a significant relationship between error management culture and work engagement behaviors and organizational creativity?". The correlation matrix showing the relationship between error management culture and its sub-dimensions and organizational creativity and sub-dimensions is given in Table 2.

Table 2. Correlation matrix showing the relationship between error management culture and organizational creativity

Variables	A	A1	A2	A3	A4	B	B1	B2	B3
A. Error Management Culture	1								
A1. Error Sharing	.738**	1							
A2. Error Competence	.742**	.685**	1						
A3. Error Avoidance	.644**	.129**	.155**	1					
A4. Response to Error	.645**	.129**	.133**	.616**	1				
B. Organizational Creativity	.452**	.527**	.481**	.076*	.114**	1			
B1. İndividual Creativity	.324**	.386**	.351**	.049	.071	.844**	1		
B2. Managerial Creativity	.406**	.479**	.430**	.063	.103**	.876**	.574**	1	
B3. Social Creativity	.440**	.497**	.462**	.088*	.124**	.833**	.515**	.680**	1

There is a positive, moderate statistically significant relationship between error management culture and organizational creativity (r:0.452, p<0.01). There was a positive, highly significant relationship between error management culture and error sharing (r:0.738, p<0.01) and error competencies (r:0.742, p<0.01), which are sub-dimensions of error management culture. There is a positive, moderately statistically significant relationship between error management culture and error avoidance (r:0.644, p<0.01) and response to error (r:0.645, p<0.01). There is a weak and positive correlation between the error management culture and the sub-dimensions of organizational creativity behaviors of individual creativity (r:0.324, p<0.01), managerial creativity (r:0.406, p<0.01) and social creativity (r:0.440, p<0.01).

While there is a moderately significant positive correlation between error sharing and error competence (r:0.685, p<0.01) sub-dimensions of error management culture, there is a statistically significant correlation between error avoidance (r:0.129, p<0.01) and error response (r:0.129, p <0.01) in the positive direction but at a very weak level. In addition, a positive and moderate relationship is observed between sharing of error and organizational creativity (r:0.527, p<0.01), while a weak positive relationship is observed between individual creativity (r:0.386, p<0.01) sub-dimension of organizational creativity, and managerial creativity (p<0.01). A positive and close to moderate relationship is observed between managerial creativity (r:0.479, p<0.01) and social creativity (r:0.497, p<0.01).

There is a very weak, positive and significant relationship between the competence of the error management culture sub-dimension, error avoidance (r:0.155, p<0.01) and response to error (r:0.133, p<0.01). In addition, there is a positive and close to moderate correlation between error competence and organizational creativity (r:0.481, p<0.01), which are sub-dimensions of

organizational creativity, managerial creativity (r:0.430, p<0.01) and social creativity (r:0.462, p<0.01). There is a weak and positive correlation between error competence and individual creativity (r:0.351, p<0.01).

There is a positive and moderately significant relationship between error avoidance, which is a sub-dimension of error management culture, and response to error (r:0.616, p<0.01). In addition, although there is a positive relationship between organizational creativity (r:0.076, p<0.05) and social creativity, which is a sub-dimension of organizational creativity (r:0.088, p<0.05), there is a very weak relationship. There was no statistically significant relationship between error avoidance and individual creativity and managerial creativity.

While there is a very weak positive relationship between the sub-dimension of error management culture and organizational creativity (r:0.114, p<0.01), managerial creativity (r:0.103, p<0.01) and social creativity (r:0.124, p<0.01), which are the sub-dimensions of organizational creativity, there was no statistically significant relationship with individual creativity.

There is a positive and highly significant relationship between organizational creativity and individual creativity (r:0.844, p<0.01), managerial creativity (r:0.876, p<0.01) and social creativity (r:0.833, p<0.01), which are the sub-dimensions of organizational creativity. In addition, there is a moderate positive relationship between individual creativity and managerial creativity (r:0.574, p<0.01) and social creativity (r:0.515, p<0.01), and a moderate relationship between managerial creativity and social creativity (r:0.680, p<0.01).

According to teachers' opinions, correlation analysis was conducted to reveal the relationship between work engagement and organizational creativity. The correlation matrix showing the relationship between work engagement and its sub-dimensions and organizational creativity and sub-dimensions is given in Table 3.

Table 3. Correlation matrix showing the relationship between work engagement and organizational creativity

Variables	A	A1	A2	A3	B	B1	B2	B3
A. Work Engagement	1							
A1.Vigor	.911**	1						
A2.Devotion	.895**	.733**	1					
A3. Absorption	.902**	.716**	.721**	1				
B. Organizational Creativity	.466**	.424**	.412**	.424**	1			
B1. İndividual Creativity	.514**	.478**	.424**	.486**	.844**	1		
B2. Managerial Creativity	.350**	.302**	.339**	.310**	.876**	.574**	1	
B3. Social Creativity	.295**	.275**	.268**	.257**	.833**	.515**	.680**	1

There is a statistically significant relationship between the scale of work engagement and the scale of organizational creativity in the positive direction and close to the middle level (r:0.466, p<0.01). There is a positive and very highly significant relationship between work engagement and vigor (r:0.911, p<0.01), dedication (r:0.895, p<0.01) and absorption (r:0.902, p<0.01), which are the sub-dimensions of work engagement. There is a positive and moderate relationship between work engagement and individual creativity(r:0.514, p<0.01), which are the sub-dimensions of organizational creativity, and a weak and positive relationship between managerial creativity (r:0.350, p<0.01) and social creativity (r:0.295, p<0.01).

There is a positive and highly significant relationship between the vigor dimension of work engagement and the dimensions of dedication (r:0.733, p<0.01) and absorption (r:0.716, p<0.01). In addition, there is a positive and close to moderate relationship between the vigor dimension of work engagement and the organizational creativity scale (r:0.424, p<0.01) and the individual creativity dimensions of the organizational creativity scale (r:0.478, p<0.01) . A positive and weak relationship was observed between the vigor dimension of work engagement and the managerial (r:0.302, p<0.01) and social creativity (r:0.275, p<0.01) which are the sub-dimensions of organizational creativity.

There was a high and positive significant relationship between the commitment sub-dimension of work engagement and absorption (r:0.721, p<0.01) .In addition, there is a weak and positive relationship between the commitment sub-dimension of work engagement (r:0.412, p<0.01) and the organizational creativity scale and the individual creativity (r:0.424, p<0.01), which are the sub-dimensions of organizational creativity. There is a positive and weak relationship between the commitment sub-dimension of work engagement and the managerial (r:0.339, p<0.01) and social creativity (r:0.268, p<0.01), which are the sub-dimensions of organizational creativity.

There is a moderate and positive significant relationship between absorption sub-dimension of work engagement and organizational creativity scale (r:0.424, p<0.01) and individual creativity (r:0.486, p<0.01), which are the sub-dimension of organizational creativity. There is a positive and weak relationship between the absorption sub-dimension of work engagement and the managerial (r:0.310, p<0.01) and social creativity (r:0.257, p<0.01), which are the sub-dimensions of organizational creativity.

Findings and Comments on the Second Sub-Aim of the Study

In this section, findings and comments regarding the second sub-purpose of the study are given. In the first stage, a structural equation model was created in line with the first hypothesis stated below. Figure 1 gives information about the model.

H$_1$: Error management culture and work engagement are significant predictors of organizational creativity.
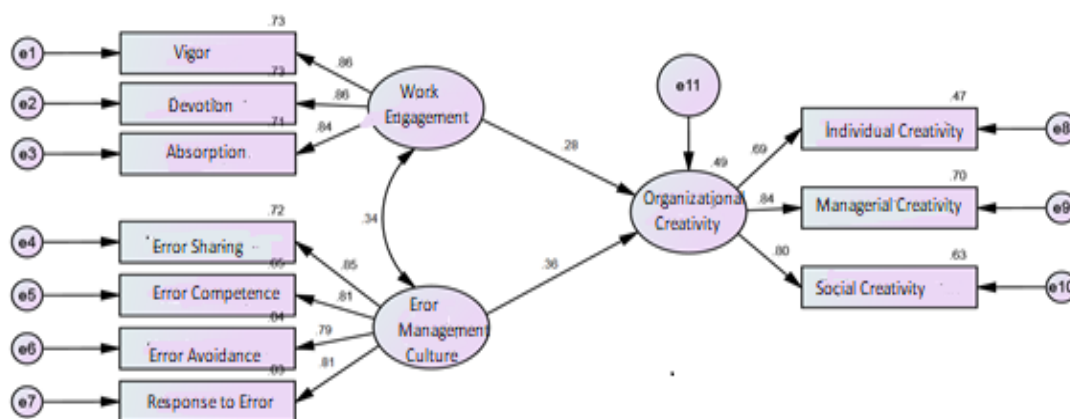

Figure 1. The structural equation model between the scales of error management culture, attractiveness, and organizational creativity

In the light of the information above, the fit of each scale used in the research to the model was tested by performing confirmatory factor analysis tests, it was observed that the index values of the measurement models of each scale had acceptable fit values, and detailed information about the fit indices was given in the method section of the research. In accordance with the structural model created, the model was tested in order to reveal the predictors of work engagement and error management culture on organizational creativity. The fit index values obtained as a result of testing the structural model are given in Table 4.

Table 4. Structural equation model fit index values

Notation	Perfect fit values	Recommended value	Calculated value	Result
X^2/sd	$0 \leq$ X^2/sd ≤ 3	$3 \leq$ X^2/sd ≤ 5	4.740	Recommended fit
GFI	$.95 \leq$ GFI ≤ 1.00	$.90 \leq$ GFI ≤ 95	.963	Perfect fit
AGFI	$.90 \leq$ AGFI ≤ 1.00	$.85 \leq$ AGFI $\leq .90$	.934	Perfect fit
CFI	$.97 \leq$ CFI ≤ 1.00	$.95 \leq$ CFI $\leq .97$	.967	Recommended fit
NFI	$.95 \leq$ NFI ≤ 1.00	$.90 \leq$ NFI $\leq .95$	.958	Perfect fit
IFI	$.95 \leq$ IFI ≤ 1.00	$.90 \leq$ IFI $\leq .95$	.968	Perfect fit
RMSEA	$.00 \leq$ RMSEA $\leq .05$	$.05 \leq$ RMSEA $\leq .08$	.071	Recommended fit
SRMR	$.00 \leq$ SRMR $\leq .05$	$.05 \leq$ SRMR $\leq .10$	.045	Perfect fit

For the structural equation model, the structural model created after the measurement models was tested. The t values of the structural model and the fit index values of the model were examined for the statistical significance of each path that emerged in the path analysis. When Table 37 is examined for the fit index values of the structural model (χ2/sd: 4.740, GFI: .963, AGFI: .934, CFI: .967, NFI: .958, IFI: .968 ve RMSEA: . 071), it is observed that the fit index values of the structural model are mostly at the level of perfect fit, and some index values are at an acceptable level. The model created for the structural equation is given in Figure 2.

CMIN=146.932; DF=31; p=.000;CMIN/DF=4.740; GFI=.963; CFI;=.967; RMSEA=.071

Figure 2. Structural equation model diagram created between scales and test results

When the results of the diagram regarding the structural model were examined, it was observed that the path coefficient between work engagement and organizational creativity was 0.284, and the path coefficient between error management culture and organizational creativity was 0.361. It was observed that all path coefficients related to the structural model were statistically significant. In addition, it is observed that work engagement explains 0.080 variance in organizational creativity and error management culture explains 0.13 variance in organizational creativity. Standardized regression values, t values and explanatory variances for the dimensions of the structural model are given in Table 5.

Table 5. Structural equation model standardized regression coefficients, t-values and explained variances

	β	S.E.	t	Explained Variances	P
İndividual Creativity	1				
Managerial Creativity	.841	.077	18.662	.707	<0.001
Social Creativity	.804	.071	18.237	.646	<0.001
Absorption	1				
Devotion	.857	.041	26.839	.734	<0.001
Vigor	.864	.041	26.794	.746	<0.001
Error Competence	1				
Error Sharing	.848	.061	19.015	.719	<0.001
Error Avoidance	.791	.072	14.102	.516	<0.001
Response to Error	.813	.079	18.684	.660	<0.001

In addition to the fit index values, t values were also examined for the statistical significance of the structural model for each path that emerges in the path analysis. Accordingly, it was determined that the t values of the model created were between 14.102 and 26,839 and all the paths created in the model were statistically significant at the .001 level. All of the regression coefficients related to the structural model created to examine the relationships between work engagement and error management culture and organizational creativity scales were found to be statistically significant. The standardized regression coefficients of the observed variables of the constructed structural model were observed between .791 and .864. It was observed that the variances explained by the observed variables belonged to the vigor sub-dimension with the highest .746 and the individual creativity sub-dimension with the lowest .516. Standardized regression values, t values and explanatory variances for the overall scales of the structural model are given in Table 6.

Table 6. Structural equation model path coefficients table

Structural Equation Model			β_1	S.E.	*t*	Explained Variances	P
Organizational Creativity	<---	Work Engagement	.284*	0.032	5.237	.080	<0.001
Organizational Creativity	<---	Error Management	.361*	0.042	10.244	.130	<0.001

Work engagement and error management culture predicted organizational creativity in a statistically significant way. There is a weak positive correlation between work engagement and organizational creativity (β1:0.284, p<0.001), and there is a weak positive correlation (β1:0.361, p<0.001) between the error management culture scale and the organizational creativity scale. Considering all the findings regarding the structural model, it is observed that the regression coefficient between work engagement and organizational creativity was .284, and the regression coefficient between error management culture and organizational creativity was .361. Accordingly, it was determined that work engagement and error management culture scales predicted organizational creativity positively and weakly. Thus, hypothesis 1 was accepted. In addition, work engagement explains 8% of organizational creativity, and error management culture explains 13% of organizational creativity.

CONCLUSION AND DISCUSSION

Results and Discussion on the First Sub-Objective

It was concluded that there is a positive, significant and close to moderate level relationship between error management culture and organizational creativity (r:0.452, p<0.01). When the relationship between the error management culture and the sub-dimensions of organizational creativity is examined, the highest level of relationship is between the error management culture and the social creativity sub-dimension of organizational creativity (r:0.440, p<0.01) and the weakest relationship was found between the error management culture and the individual creativity (r:0.324, p<0.01) sub-dimension of organizational creativity. According to the relevant results, as the culture for error management in schools increases, the behaviors of teachers to take risks, being curious about new experiences and experiences, developing themselves by constantly learning, and producing original products also increase. When the literature is examined, reasons such as not being able to balance pressure and discipline, being exposed to excessive pressure or, on the contrary, not having discipline (Yıldırım, 1998), fear of being ridiculed (Temizkalp, 2010), striving to be perfect and the desire to do serious work (Amabile, 1997) hinders organizational creativity. In fact, the same reasons also affect the management of errors. Because Helmreich (2004) emphasized that in order to be successful in creating a culture of error management, it is necessary to establish trust between the employee and the management, and to create an understanding policy against mistakes. Employees who are exposed to excessive pressure cannot use different ways in order not to make mistakes, and cannot share their mistakes for fear of being mocked. As it is seen, the result of the research that the existence of the created error management culture will increase the existence of organizational creativity is supported by the literature. Behaviors that affect the culture of error management also affect organizational creativity.

When the relationship between work engagement and organizational creativity was examined, it was found that there was a positive, significant and close to moderate relationship (r=0.466, p<0.01). Between work engagement and organizational creativity sub-dimensions, the highest level of relationship was between work engagement and organizational creativity's individual creativity sub-dimension (r:0.560, p<0.01) and the weakest relationship was found between work engagement and social creativity (r:0.295, p<0.01) sub-dimension of organizational creativity. According to the related results, as the energy and enthusiasm of the teachers towards their work, the ideas that their work is meaningful, and their focusing behaviors by integrating themselves with their work increase, they see different points of relationship between events and phenomena, act flexible towards new ideas, transform competitiveness and opportunities into concrete benefits. Individual creativity behaviors increase as well. It can be said that as work engagement increases, creativity behaviors of school management and other teachers also increase. In another study conducted between 2008 and 2009, it was concluded that there is a serious relationship between work engagement and the organizational performance and productivity of those who seek excitement, innovation and difference during work (Haid and Sims 2009, cited in Bostancı and Ekiyor 2015, p. 40). In another study, a significant relationship was found between work engagement and managerial creativity (Durgut & Günay, 2014). The components of work engagement are participation, compromise, passion, willingness, ability to concentrate, effort, energy and focus (Schaufeli, 2012, p.3). The first step of creativity is absorption and willingness on the subject (Yıldırım, 1998). For this reason, the knowledge of the literature that the creativity of the person increases as the energy towards his work increases supports the result of the research.

Results and Discussion Regarding the Second Sub-Objective

When the structural equation analysis results, which were conducted to reveal the extent to which error management culture and work engagement predict organizational creativity, the theoretical model was first tested, and almost all of the index values (χ2/sd: 4.740, GFI:.963, AGFI:.934, CFI: .967, NFI: .958, IFI: .968: RMSEA:.071) showed excellent fit. According to the regression coefficients (between .791 and .864), the relationships between the scales and sub-dimensions in the model were found to be positively significant. In the model created to examine the predictive effect of error management culture and work engagement on organizational creativity, it was seen that there was a weak positive relationship between error management culture and organizational creativity (β_1:0.361, p<0.001), and a weak positive relationship between work engagement and organizational creativity (β_1:0.284, p<0.001). Error management culture explains 13% of organizational creativity, and work engagement explains 8% of organizational creativity. According to the related result, it can be said that organizational creativity in schools will undergo a more positive change as the culture formed for the management of mistakes such as discussing and sharing mistakes, taking responsibility for mistakes by intervening in a timely manner, not being afraid of the reactions to be given, seeing mistakes as a learning tool rather than a punishment tool. In addition, it can be said that teachers' exhibiting behaviors of being attracted to work such as reflecting their energies on their work, thinking that their work serves the purpose, and concentrating on their work in a way that does not understand how the time passes, will make a positive contribution to organizational creativity in the schools where they work.

SUGGESTIONS

1. It has been concluded that error management culture and work engagement are significant predictors of organizational creativity. In schools, practices that support teachers' engagement to work should be included. In addition, in-service trainings and informative trainings on managing errors should be given to administrators and teachers.

2. Decisions taken in MoNE can sometimes negatively affect teachers' work engagement and creativity. Before making a decision, the Ministry of National Education can get the opinions of teachers through education portals such as EBA (Education Informatics Network), MEBBİS (Ministry of National Education Information Systems) etc.

3. In this study, the effects of error management culture and work engagement on organizational creativity were examined. It can also be examined which variables have not been studied in the field of education and which variables are effective on the error management culture.

4. The research was carried out with teachers working in official primary and secondary schools. Similar studies can be applied at different education levels (high school and university) and private schools. This study, carried out in the city center, can also be applied in rural areas, which are thought to differ in every aspect.

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Statements of publication ethics

We hereby declare that the study has no unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

It was decided that this study complied with the ethical rules of Education and Humanities due to the meeting dated 21.10.2019 by Firat University Ethics Committee from the Social and Humanities

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