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FROM THE EDITOR

Dear Colleagues,

It is our privilege to present the latest issue of our scientific journal, which brings together innovative research and impactful studies from various domains. The diverse topics reflect the commitment of our contributors to address key challenges and opportunities in education, technology, and human development. This issue features eight meticulously reviewed articles, each contributing to advancing our understanding in their respective fields.

This issue highlights three overarching themes:

The Intersection of Education and Technology: With the rapid integration of technology into educational systems, the articles in this issue explore its implications on learning and teaching. For example, *"The Relationship Between Teachers' Digital Literacy Levels and Research Literacy Skills"* (submitted on June 29, 2024, and accepted on December 20, 2024) investigates how educators' proficiency with digital tools aligns with their ability to conduct and utilize research. Similarly, *"Exploring EFL Students' AI Literacy in Academic Writing: Insights into Familiarity, Knowledge, and Ethical Perceptions"* (submitted August 26, 2024, and accepted December 18, 2024) delves into how AI is reshaping the landscape of English as a Foreign Language (EFL) learning.

Mathematical Skills and Their Development: Mathematical education remains a cornerstone of intellectual growth. Articles like *"Effectiveness of Early Intervention Programs in Developing Early Mathematical Skills: A Meta-Analysis"* (submitted April 1, 2024, and accepted October 29, 2024) and *"Investigation of Middle School Students' Opinions and Self-Efficacy Beliefs on Mathematical Connection with Using Modelling Tasks"* (submitted March 28, 2024, and accepted December 14, 2024) underscore the importance of early and sustained interventions to nurture mathematical proficiency.

Psychosocial Impacts of Modern Challenges: The societal implications of contemporary phenomena are examined through articles like *"Digital Game Addiction and Peer Interaction: The Role of Parents' Education Levels"* (submitted July 22, 2024, and accepted November 15, 2024), which explores the complex interplay between gaming behavior and social dynamics.

The journey from submission to publication is a testament to the dedication of our reviewers and editorial board. The average duration from submission to acceptance spans approximately eight months, ensuring each article undergoes thorough evaluation and refinement. For instance, *"Scale of Time Traps Teachers Fall into: A Validity and Reliability Study"* (submitted August 19, 2024, and accepted January 25, 2025) exemplifies our commitment to robust methodological scrutiny.

In this issue, we are also proud to feature innovative scale development studies, such as *"Data Literacy at School: A Scale Development Study"* (submitted April 23, 2024, and accepted January 25, 2025). These works pave the way for new metrics and methodologies that can be adapted globally.

We extend our gratitude to the authors for their contributions, the reviewers for their invaluable feedback, and our readers for their continued support. As we navigate the evolving landscape of research, we remain steadfast in our mission to disseminate knowledge that inspires, informs, and impacts society.

Kindest regards,

Fatih GÜNGÖR, PhD
Afyon Kocatepe University
Faculty of Education

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Adaptation and Validation of Short Form of the Foreign Language Enjoyment Scale (S-FLES) into Turkish*

Yabancı Dil Keyfi Ölçeği Kısa Formunun (K-YDKÖ) Türkçe'ye Uyarlanması ve Doğrulanması

Hilal GÜNEŞ** **Hacer Hande UYSAL*****

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ABSTRACT: With the increasing interest in Positive Psychology within the realm of L2 learning, the role of positive emotions, particularly Foreign Language Enjoyment (FLE) has garnered attention in Second Language Acquisition research (Dewaele & MacIntyre, 2014). Despite the growing interest in FLE in Turkey, the widely used Foreign Language Enjoyment Scale (FLES) has been employed without thoroughly validating its psychometric properties in the Turkish context. This study addresses this gap by psychometrically validating and adapting the Turkish version of the Short Form of the Foreign Language Enjoyment Scale (S-FLES) developed by Botes et al. (2021). The translated version was administered to 390 university-level Turkish EFL (English as a Foreign Language) students in Turkey. Results from Confirmatory Factor Analysis indicated acceptable levels of goodness of fit for the 3-factor and 9-item model, confirming the structural validity of the Turkish S-FLES. The results also demonstrated that the scale has discriminant validity and high internal consistency. With its robust psychometric properties, the validated S-FLES in Turkish can be a valuable resource for educational researchers, offering a standardized scale for investigating the factors influencing FLE in the Turkish context.

Keywords: Foreign Language Enjoyment, FLES, validating S-FLES, adapting S-FLES into Turkish.

ÖZ: İkinci dil öğrenimi alanında Pozitif Psikolojiye olan ilginin artmasıyla birlikte, olumlu duyguların, özellikle de Yabancı Dil Keyfinin (YDK) rolü İkinci Dil Edinimi araştırmalarında dikkat çekmiştir (Dewaele & MacIntyre, 2014). Türkiye'de YDK'ye artan ilgiye rağmen, yaygın olarak kullanılan Yabancı Dil Keyfi Ölçeği (YDKÖ), Türkiye bağlamında psikometrik özellikleri tam olarak doğrulanmadan kullanılmıştır. Bu çalışma, Botes vd. (2021) tarafından geliştirilen Yabancı Dil Keyfi Ölçeği Kısa Formunun (K-YDKÖ) Türkçe versiyonunun psikometrik açıdan geçerlilik ve uyarlamasını yaparak bu boşluğu doldurmayı amaçlamaktadır. Ölçeğin Türkçeye çevrilmiş versiyonu, Türkiye'deki üniversite düzeyinde yabancı dil olarak İngilizce öğrenen 390 öğrenciye uygulanmıştır. Doğrulayıcı Faktör Analizinden elde edilen sonuçlar, 3 faktörlü ve 9 maddeli model için kabul edilebilir düzeyde uyum iyiliği göstermiş ve K-YDKÖ'nün yapısal geçerliliğini doğrulamıştır. Sonuçlar ayrıca ölçeğin ayırt edici geçerliliğe ve yüksek iç tutarlılığa sahip olduğunu göstermiştir. Sağlam psikometrik özellikleri ile Türkçe geçerliliği yapılmış olan K-YDKÖ, eğitim araştırmacıları için değerli bir kaynak olabilir ve Türkiye bağlamında YDK'yi etkileyen faktörleri araştırmak için standartlaştırılmış bir ölçek sunabilir.

Anahtar kelimeler: Yabancı Dil Keyfi, YDKÖ, S-FLES'in doğrulanması, S-FLES'in Türkçe uyarlaması.

* This study is part of the first author's PhD thesis, conducted under the supervision of the second author at the Institute of Educational Sciences, Hacettepe University.

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With the growing interest in positive psychology, the broadening power of positive emotions has been recognized in language learning. Among positive emotions, Foreign Language Enjoyment (FLE) has become one of the cornerstones of Second Language Acquisition (SLA) research in recent years (Dewaele et al., 2019a; Li, 2020; Wei et al., 2019). FLE has been formulated to encompass Frederickson's (2001) theory of positive emotions, known as the broadening-and-building theory (Botes et al., 2021; Dewaele & MacIntyre, 2014). It has been characterized as an expansive, positive emotion language learners feel when their psychological needs are fulfilled during demanding language learning endeavors (Dewaele & MacIntyre, 2014).

The rising popularity of FLE in the SLA field has generated a necessity for a measure of FLE (Botes et al., 2021). In response to this demand, Dewaele and MacIntyre (2014) developed a 21-item FLE scale (FLES) by adapting Ryan et al.'s (1990) 7-item Interest/Enjoyment sub-scale to the FL environment. Since then, the FLES has been utilized, modified, and adapted into different languages and cultures in various contexts, including China (Jin & Zhang, 2018; Li et al., 2018), Japan (Saito et al., 2018); Korea (Gordon, 2022), Poland (Mierzwa, 2018), Spain (Acosta-Manzano & Barrios, 2022); Saudi Arabia (Alenezi, 2020; Dewaele & Alfawzan, 2018), Iran (Nemati et al., 2020; Shirvan & Taherian, 2021), and Turkey (Özer & Altay, 2021; Proietti Ergün & Ersöz Demirdağ, 2022).

So far, most of the studies have used the FLES along with additional scales to assess the interaction of various psychological variables such as anxiety, motivation, willingness to communicate, and so on (e.g., Chen et al., 2021). This practice has resulted in fairly lengthy questionnaires. Studies have shown that longer questionnaires are associated with reduced response rates and an increased risk of non-response bias (Galesic & Bosnjak, 2009; Schoeni et al., 2013). Considering this drawback, the need arose to create a shorter version of the FLES (Botes et al., 2021). Although there have been some attempts to shorten FLES (Dewaele & MacIntyre, 2019; Dewaele et al., 2018) they were only based on expert knowledge rather than the psychometric properties of the scale. Therefore, Botes et al. (2021) developed a more psychometrically sound, valid, and reliable measurement of S-FLES informed by best-practice psychometric guidelines and theoretical considerations.

Similar to many other countries, Turkey has shown a growing interest in FLE, particularly in the past decade. Numerous studies have employed the FLES or S-FLES in the Turkish context. Nevertheless, these studies have merely translated the scale into Turkish without exploring the psychometric properties (Özer & Altay, 2021; Proietti Ergün & Ersöz Demirdağ, 2022; Uzun, 2017). As a result, the validity of the scale concerning the Turkish language and culture remains uncertain. Recognizing this gap, translating the S-FLES into Turkish, verifying its structural properties, and subsequently presenting the tool to Turkish researchers and practitioners would contribute to more valid and reliable research results. In light of this, the present study aims to adapt and psychometrically validate S-FLES for the Turkish language and culture. To this end, the following research questions will be sought throughout the study:

1. *How valid is the Turkish version of S-FLES?*
2. *How reliable is the Turkish version of S-FLES?*

Literature Review

Foreign Language Enjoyment Scale in the World

In their pioneering study, Dewaele and MacIntyre (2014) developed 21-item Foreign Language Enjoyment Scale (FLES) to measure the construct of FLE. They collected data from 1742 foreign language learners from different countries and various educational levels. The majority of the participants were Europeans, followed by Asians. The FLES reflected a variety of facets of enjoyment in the foreign language classroom, such as creativity, interest, fun, and a positive environment. It consisted of positively phrased items such as *"I enjoy my FL class," "There is a positive environment in my FL class," "The teacher is encouraging," and "The peers are nice."* The degree of agreement with the statements collected by the items was expressed on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). It exhibited an acceptable Cronbach's alpha reliability (α=.86). Also, its discriminant validity was assessed through its correlation with its negative counterpart, Foreign Language Classroom Anxiety Scale (FLCAS) developed by Horwitz et al. (1986), and it yielded a moderate negative correlation (r=−.36, p<.001).

In a follow-up study with the same dataset, Dewaele and MacIntyre (2016) conducted Exploratory Factor Analysis (EFA) to identify major dimensions of 21-item FLES, which resulted in two separate dimensions as "*Private-FLE"* and "*Social-FLE."* Accordingly, Private-FLE was associated with personal reactions to language learning, reflecting relatively internal thoughts or feelings. This dimension included items such as *"I don't get bored,"* and *"I've learnt interesting things."* Social- FLE was concerned with the aspects of the social environment or the presence of others; including items of *"We form a tight group," and "We laugh a lot."*

Today, the FLES stands out as the most widely used tool for assessing FLE. It has been adapted into numerous languages and cultures so far. Among them, Jin and Zhang (2018) aimed to explore underlying dimensions and the psychometric properties of the Chinese version of the 21-item FLES. Participants were recruited from 320 senior high school EFL students in China. As a result of the internal reliability analysis, one item was deleted from the scale since it has a low corrected item-total correlation. The remaining 20-item scale resulted in Cronbach's alpha value of α=.91. Additionally, test-retest reliability (α=.79, p<.001) was obtained over a 14-day interval with 35 Chinese EFL participants. Afterward, EFA with Principal Component Analysis (PCA) was conducted, which resulted in 16 items and three factors, named *"Enjoyment of Teacher Support,""Enjoyment of English Learning,"* and *"Enjoyment of Student Support."*

In the Chinese context, Li et al. (2018) also aimed to validate the Chinese version of the FLES. Participants were recruited from two samples of 1718 and 360 EFL Chinese high school students. For the construct validity, both Exploratory and Confirmatory Factor Analysis (CFA) were performed. As a result, the new scale consisted of three factors and 11 items. The factors were named as *"FLE Private," "FLE Teacher,"* and *"FLE Atmosphere."* The results showed that the Chinese version of the FLES has convergent and discriminant validity. The scale also had high reliability, with Cronbach's alpha value of α=.82, and a split-half reliability value of .87.

Apart from the Chinese context, the FLES was adapted to the Spanish context. Acosta-Manzano and Barrios (2022) conducted the cultural adaptation and the

validation of the FLES into Spanish. Participants were 184 EFL learners from a language school in Spain. To assess construct validity, they conducted EFA and CFA. After the factor analyses, it was observed that the one-factor 20-item FLES satisfactorily fits the data of the Spanish EFL learners. The study has also found evidence of convergent and divergent validity for this scale. Likewise, the internal consistency value was very high (α=.91).

In an attempt to shorten the 21-item FLES, Dewaele et al. (2018) extracted 10 items from the FLES that reflect the dimensions of *Social and Private FLE* (Dewaele & MacIntyre, 2016). This scale was then applied to 189 British high school students to assess their foreign language enjoyment level. This scale's reliability was obtained as .88. However, the 10-item FLES primarily relied on expert knowledge and did not undergo any additional validation studies. This 10-item FLES has also been used in various studies and contexts. For instance, in their study, Dewaele and Alfawzan (2018) applied it in two different contexts: British secondary school foreign language learners in London, and Saudi EFL undergraduate students in Saudi Arabia. Likewise, Dewaele et al., (2019b) used it with 210 EFL learners from different educational levels in Spain.

Some researchers translated 10-item FLES in their studies. Among them, Alenezi (2020) translated it into Arabic language for his study with 163 University EFL learners in Saudi Arabia. To inspect construct validity, he conducted a pilot study and compared the corrected correlation coefficients of the items and the factors of both instruments. He calculated the internal consistency coefficient as α=.81. Apart from this study, Gordon (2022) translated it into Korean language in his research. Participants were EFL learners studying at a university in Korea. However, he did not conduct any validity or reliability analysis for the Korean version of the scale.

As evidenced in the literature, there is a lack of psychometric evidence for the validity and reliability of the S-FLES. Considering this apparent deficiency, Botes et al. (2021) developed the S-FLES based on current best-practice psychometric guidelines and methods (Marsh et al., 2005), along with theoretical considerations. To achieve this, they utilized the original dataset collected by Dewaele and MacIntyre (2014). The participants consisted of 1603 adults learning various foreign languages in formal classroom settings. Initially, they randomly split the complete dataset into two parts: sample 1 (n=822) and sample 2 (n=781). In the first step, using sample 1, they conducted exploratory factor analysis (EFA) with the 21-item FLES and selected items for the short version. In the second step, using sample 2, they conducted confirmatory factor analysis (CFA) along with reliability and validity analyses.

In step 1, after applying PCA with an oblique (promax) rotation and the ACO algorithm, it was observed that the items loaded onto three distinct factors: *teacher appreciation*, *personal enjoyment*, and *social enjoyment* in the FL classroom. Later, items were chosen for each factor based on the factor loadings, design intent, and theoretical underpinnings. Accordingly, three items for each factor were retained in the S-FLES, which was also confirmed through the ACO algorithm. *In step 2*, CFA of the 9-item S-FLES with the three factors was tested with sample 2. Overall, the suggested model provided a good fit to the data, with the RMSEA=.059, CFI=.978, and TLI=.967 (Kline, 2005).

Convergent validity was evaluated by determining the correlation between the long version (FLES) and the short version (S-FLES). The correlation was very high, r=.90, p<.001, showing almost identical rank orders for the two versions, proving convergent validity. Moreover, discriminant validity was assessed by measuring the correlation between S-FLES and the shortened version of the Foreign Language Classroom Anxiety Scale (S-FLCAS), originally developed by Horwitz et al. (1986). The discriminant validity of the FLES has often been examined through a comparison with FLCAS because FLE is considered a positive emotion that exhibits negative relations with FLCA (Botes et al., 2021). There was a small negative correlation between the S-FLES and the FLCAS, r=−.241, p<.001, indicating discriminant validity.

In terms of reliability, the internal consistency of the overall scale was measured with Cronbach's alpha and McDonald's omega, which was high for the overall scale (α=.81, ω=.82). In addition, each subscale also exhibited high internal consistency: teacher appreciation, α=.91, ω=.91; personal enjoyment, α=.71, ω=.70; social enjoyment, α=.79, ω=.79. As a result, the psychometric properties of 9-item and three factors S-FLES has been determined and confirmed that it has high reliability and validity. Overall, the scale is based on a strong theoretical foundation and demonstrated robust psychometric qualities.

Foreign Language Enjoyment Scale in the Turkish context

Studies on FLE in Turkey have increased, especially in recent years. However, the FLES has been applied in various forms and versions in the Turkish context. Most studies examining students' FLE used the 21-item FLES. Among them, Uzun (2017) investigated the English language enjoyment of 166 undergraduate students who were taking English as a compulsory course in Turkey. For this study, the researcher translated the scale into Turkish using the translation-back-translation method. However, no thorough psychometric analysis was conducted; only internal consistency was indicated as α=.90. Similarly, Özer and Altay (2021) translated the 21-item FLES for 233 fifth-grade students studying in secondary school in Turkey. They also used the translation-back-translation technique but did not conduct any validity analysis, only reporting the internal consistency as α=.84.

In some studies, the 21-item FLES was used without translating it. For example, Durmuş (2022) explored pre-service English language teachers' enjoyment of online speaking skills courses, applying the English version of the scale to 722 participants from 33 universities in Turkey. In another study, Kaplan (2022) investigated Turkish university students' English language enjoyment using the English version of the scale. His participants were 150 tertiary EFL learners enrolled in a preparatory program in Turkey. Kaplan reported a Cronbach's alpha of α=.76.

Recent studies in Turkey have preferred shorter versions of the FLES. For instance, Yeşilçınar and Erdemir (2023) examined the sources of FLE among Turkish learners. They collected data from 305 EFL students studying at preparatory schools across various state universities, using a 10-item version of the FLES. Their analysis measured two FLE dimensions: *Social* and *Private.* The scale was administered in English, and no validity or reliability analyses were conducted.

Apart from the Turkish EFL context, a study was conducted with Kazakh students learning Turkish as a foreign language. For this study, Dewaele et al. (2022) translated the 10-item FLES into Turkish. The participants included 592 secondary school and undergraduate students in Turkey. First, they replaced the term "foreign language" with "Turkish language" before translating it into Turkish. Two Turkish native-speaking English language teachers then reviewed the translation. The Cronbach's alpha coefficient for the Turkish version of the scale was α=.93.

In a different study, Proietti Ergün and Ersöz Demirdağ (2022) examined the Italian and French language enjoyment of Turkish university students. To measure foreign language enjoyment, they used the 9-item S-FLES developed by Botes et al. (2021). The researchers translated the S-FLES into Turkish but did not conduct any validity analysis, only calculating Cronbach's alpha internal consistency coefficient for the overall scale (α=.85).

Given that the original and adapted versions of FLE scales may not be suitable for students with low proficiency levels, Aydın et al. (2023) developed a new Foreign Language Learning Enjoyment Scale (FLLES) in Turkish. They collected data from EFL learners across various proficiency levels and educational backgrounds. As a result of construct validity analyses, using EFA with Sample 1 and CFA with Sample 2, they developed a 12-item, one-factor FLLES. The FLLES demonstrated high criterion validity, showing a moderate correlation with the FLES (Dewaele & MacIntyre, 2014). Additionally, the scale showed good test-retest reliability over a 10-day interval (α=.85, p<.001) and high internal consistency, with a Cronbach's alpha of α=.95.

Based on the studies in the Turkish context that we have reviewed, it is evident that the FLES has been utilized in various ways. Earlier studies tended to use the 21-item FLES, while more recent research favors shorter versions. Regardless of version length, different Turkish translations have been used in separate studies. This inconsistency among translations makes it challenging to evaluate and compare the results of FLES studies in Turkey. Additionally, none of the studies that translated the scale conducted a validity analysis for the Turkish version. As Li et al. (2018) noted, it is essential to confirm the validity of a translated scale in a new context. Therefore, using a standardized scale with a single, validated, and reliable translation would allow for more robust results in the Turkish context.

While we acknowledge the contribution of the FLLES, developed by Aydın et al. (2023), to the FLE literature in the Turkish context, we believe that the validated Turkish S-FLES also offers valuable insights from different perspectives. First, the FLLES features a single-factor structure, with most items focused on the personal/private enjoyment of foreign language learning. As a result, the FLLES may be particularly suited to studies examining self-driven foreign language learning. In contrast, the Turkish S-FLES, with its multidimensional structure, provides a broader scope, allowing researchers to explore the distinct roles of foreign language teachers, peers, and the social environment in fostering foreign language enjoyment. By utilizing the Turkish S-FLES, researchers can independently examine levels of social enjoyment and teacher appreciation alongside personal enjoyment. This enables a more detailed assessment of how these three factors, individually or collectively, influence other psychological constructs or foreign language achievement.

Method

This study aims to adapt and validate the short version of the Foreign Language Enjoyment Scale (S-FLES) for Turkish participants. To achieve this objective, the scale was first translated into Turkish, and then sequential validity and reliability analyses were conducted.

Participants

The participants were recruited through a convenience sampling method. This participant selection method was chosen primarily for its practicality and effectiveness in accessing a large and diverse group of EFL learners across different universities. This method helpful in reaching participants who were readily available and willing to participate in the study.

The participants consisted of 390 students who learn English as a foreign language (EFL) at the preparatory school of a state university in Ankara. The mean age of the participants was 19.85 years, with an age range of 18 to 27 (*SD*=2.11). Among the participants, 212 were female (54.4%), 168 were male (43.1%), and 10 did not indicate their gender (2.6%). Participants included 14 (3.6%) beginners, 28 (7.2%) elementary, 314 (80.5%) intermediate, 6 (1.5%) upper-intermediate, and 28 (7.2%) advanced level students according to CEFR standards.

Data Collection Tools

The online survey included a demographic information part, a Turkish translation of S-FLES, and an 8-item Short Form Foreign Language Classroom Anxiety Scale (S-FLCAS), which was adapted into Turkish by Karabulut (2023). S-FLCAS was used to measure the discriminant validity of the Turkish version of S-FLES.

S-FLCAS is a shortened version of the 33-item FLCAS which was originally developed by Horwitz et al. (1986). MacIntyre (1992) developed the short version of the scale by minimizing the number of items based on corrected item-total correlations. Botes et al. (2022) performed thorough validity and reliability analyses of S-FLCAS, reporting the Cronbach's alpha coefficient as α=.89. The adaptation of the S-FLCAS into Turkish and its validity and reliability analyses was conducted by Karabulut (2023). As a result of the EFA and CFA, the Turkish version of S-FLCAS was found to be valid and reliable (Karabulut, 2023). The Cronbach's alpha value for the Turkish S-FLCAS was reported to be α=.89. The online version of the survey was created and disseminated using Google Forms.

Ethical Procedures

For this study, Ethics Committee Approval was obtained from Hacettepe University Institute of Educational Sciences (Approval No. 35853172-101.02.02, dated 10.03.2020). Participants were informed of the study's objective through the accompanying text in the survey. They were explicitly notified that their participation was voluntary and the responses would be treated anonymously.

Translation and Cultural Adaptation of the S-FLES

The S-FLES was translated and adapted into Turkish by the researchers. Both translation and back-translation techniques were conducted to ensure that there was no

semantic loss between English and Turkish versions of the scale (Brislin, 1980). First of all, the phrase "foreign language" was replaced with "English", as suggested by the scale developers (Dewaele & MacIntyre, 2014).

Afterward, the researchers conducted two separate translations of the S-FLES into Turkish. Both researchers are experienced ELT professionals who are bilingual in Turkish and English, and have a deep understanding of both languages and their cultural nuances. During translation, various linguistic and cultural factors were taken into account. Rather than a word-for-word translation, a semantic approach was preferred to convey the intended meaning of the items in a culturally appropriate way. For example, in item 7, instead of the literal translation "Sıkı bir grup oluşturuyoruz," the phrase "İngilizce dersinde iyi bir grubuz" was used to make it more appropriate for the Turkish context. Since some English concepts or idiomatic expressions do not have direct equivalents in Turkish, adjustments were made to ensure a meaningful translation. In item 9, for instance, idiomatic expressions that do not exist in Turkish were transformed. Rather than translating the literal meanings as "yaygın efsaneler" and "süregelen espriler," these were adapted into the more commonly understood forms "herkesin anladığı espriler" and "ortak paylaşımlar."

Additionally, the agglutinative nature of Turkish language was considered during the adaptation process. In item 4, for example, the phrase "İngilizce dersinde → keyif alıyorum" was ungrammatical. Thus, the phrase "İngilizce dersinde" was added at the beginning of all items, rather than just the scale, to ensure grammaticality. Consequently, item 4 was adapted as "İngilizce dersinden keyif alıyorum." Likewise, in item 6, "İngilizce dersinde → Başarılarımla gurur duyuyorum" was adapted as "İngilizce dersindeki başarılarımla gurur duyuyorum."

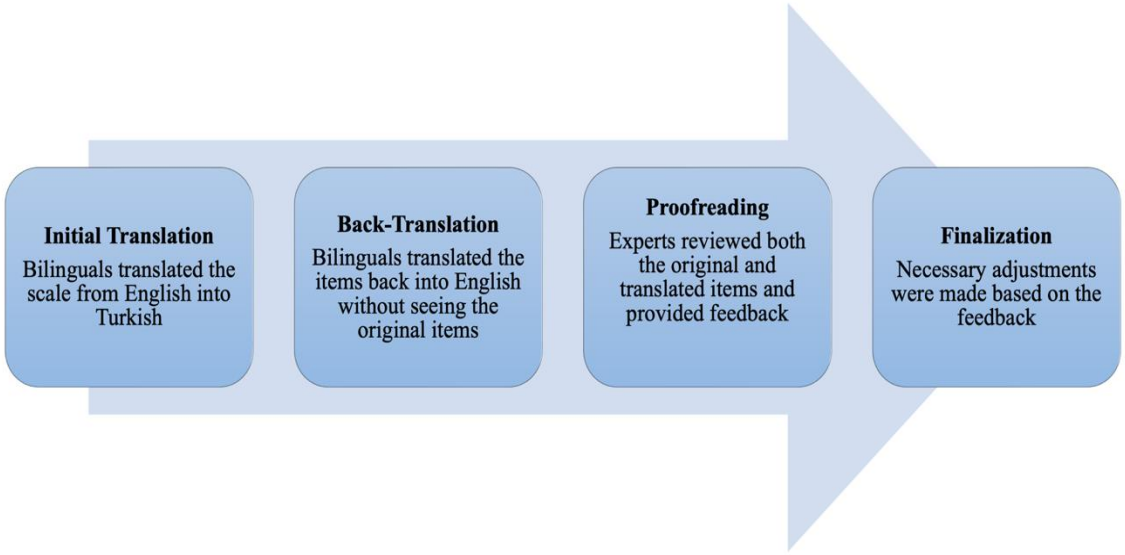
In the second phase, the translators came together and negotiated the differences in translation, and produced one draft, paying special attention that translation is not just literal but also contextually appropriate. This draft was then back-translated into English by two different ELT professionals, who were also bilingual in Turkish and English. The back-translation was performed without reference to the original English scale (Geisinger, 1994). This process helped ensure that the meaning of the original text was preserved in the Turkish version (Brislin, 1980). The two back-translators also collaborated, comparing their translations and merging them into a final draft.

Lastly, the original items of the scale and their Turkish translations were reviewed by two faculty members from the Turkish Education Department and the Psychological Counseling and Guidance Department. They were asked to evaluate how well the Turkish version matched the original in terms of grammar, meaning, and content. Based on the expert opinions, minor adjustments were made to the Turkish items. These adjustments involved replacing certain words or phrases with more culturally appropriate synonyms. For instance, in item 5, the word "şeyler" (things) was considered too vague and replaced with "bilgiler" (information). Additionally, "interesting" was changed to "ilgi çekici" instead of the initial translation "ilginç," as the former was more suitable in this context. In item 2, "friendly" was translated as "sıcakkanlı" rather than the initial "arkadaş canlısı," as the former better fit the context.

After these changes, it was determined that the Turkish version of the S-FLES accurately reflected the original content. The Turkish S-FLES preserved the original scale's number of factors, items in each factor, item order, and the rating scale.

Figure 1

The Adaptation Process



Before the scale was administered to the participants, the opinions of 10 EFL students and 5 EFL instructors from the Preparatory School, and 5 faculty members from the ELT Department were obtained regarding the content, clarity, design, and layout of the scale. They did not report any problems with the design and layout; and stated that all items in the scale were clear and understandable (see Appendix A for the Turkish version of S-FLES).

Results

Preliminary Analysis of Factor Structure and Psychometric Properties of the S-FLES

This study aims to confirm the previously proven structure by Botes et al. (2021). As we "have specific expectations regarding the underlying structure" (Loewen & Gonulal, 2015, p. 184), we used Confirmatory Factor Analysis (CFA) for this adaptation and validation study. Before conducting CFA and Reliability analyses, the data were primarily evaluated in terms of sample size, missing values, outliers, and normality (Tabachnick & Fidell, 2013). Accordingly, while no missing values were found, it was observed that the data has a normal distribution (See Appendix B for the test of normality results of the Turkish version of the S-FLES).

Confirmatory Factor Analysis of S-FLES

In order to determine whether the 3-factor and 9-item structure fits well with the sample data, CFA was performed by using AMOS 23.0 package program. As proposed by Botes et al. (2021), a higher-order FLE factor with three lower-order factors (teacher appreciation, personal enjoyment, and social enjoyment) was tested as a measurement model.

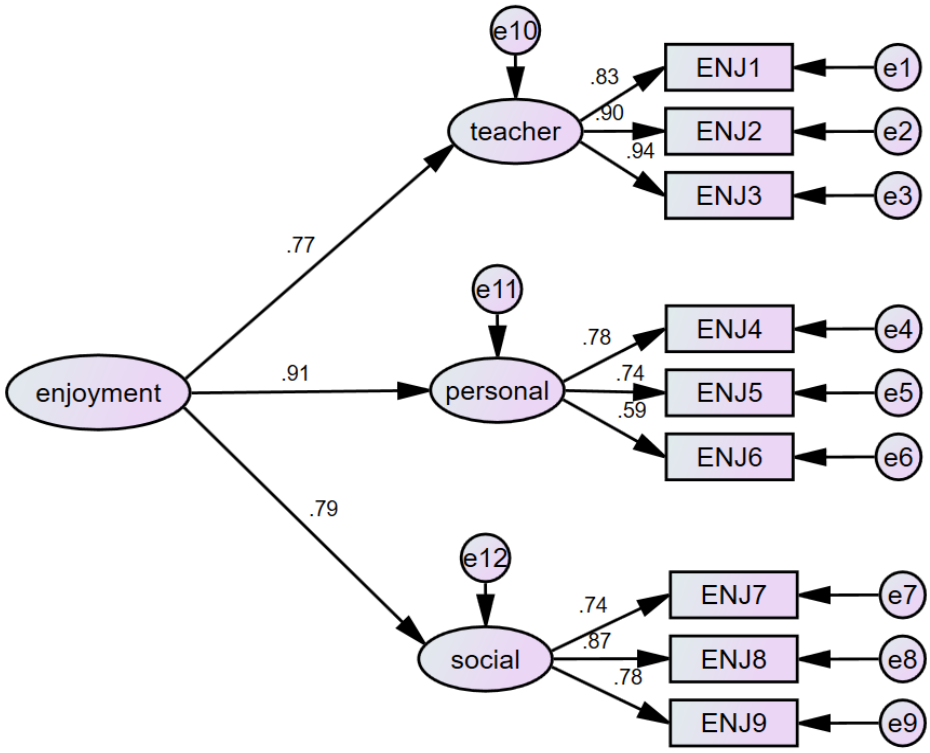
Because the data met the assumption of sample size, univariate and multivariate normality, the Maximum Likelihood (ML) estimation method and standard error

handling were employed in the analysis. ML estimation was deemed appropriate for its efficiency in providing unbiased and consistent parameter estimates (Byrne, 2010; Kline, 2005).

As a result of the analysis, a value of χ^2=61.908 (*df*=24, *p*<.001) was obtained regarding the structure of the three-factor scale consisting of 9 items. The chi-square value is generally expected to be insignificant; however, it is highly sensitive to sample size and can often become significant in larger samples (Tabachnick & Fidell, 2013). As an alternative, it is recommended to calculate the chi-square value by dividing it by the degrees of freedom (Hoe, 2008). In this study, this value was found to be (χ^2/df= 2.58). A value of 5 or less indicates that the model has an acceptable goodness of fit (Şimşek, 2007; Tabachnick & Fidell, 2007). In addition, other measures of Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Tucker-Lewis Index (TLI), Comperative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA) fit indexes were calculated. Generally, GFI, AGFI, TLI and CFI being .90 and above; RMSEA below .08; and RMR below .08 indicate goodness of fit (Dimitrov, 2012; Tabachnick & Fidell, 2007). In this study, the values obtained were calculated as GFI=.97, AGFI=.94, TLI=.97, CFI=.98, RMR=.032, and RMSEA=.064, which shows that 3-factor S-FLES consisting of 9 items fits perfectly well with the sample to which it was applied. The corresponding path diagram is presented in Figure 2.

Figure 2

Path Diagram and Factor Loadings of Turkish S-FLES



As can be seen in Figure 2, the factor loadings of the 3-factor model of the Turkish S-FLES ranged between .59 and .94. Since the factor loadings are above the recommended cut-off point (.32), they are considered statistically significant

(Tabachnick & Fidell, 2007). The Turkish S-FLES preserved the original scale's higher-order factor model including factor names, item numbers, item order, and the rating scale.

The Discriminant Validity of S-FLES

With the aim of exploring discriminant validity, the correlation between the Turkish version of S-FLES and S-FLCAS, which was validated and adapted into Turkish by Karabulut (2023), was measured.

S-FLCAS is a shortened version of the 33-item FLCAS which was originally developed by Horwitz et al. (1986). It has been one of the most extensively used tools for the measurement of L2 learning anxiety. The discriminant validity of the FLES is often examined through a comparison with FLCAS because FLE is considered a positive emotion that demonstrates a negative association with FLCA. So far, there has been a small-to-moderate negative association with FLE and FLCA (Dewaele & MacIntyre, 2014). Therefore, a small-to-moderate negative correlation between S-FLCAS and the translated S-FLES will provide evidence regarding the discriminant validity, which is also suggested by Botes et al. (2021). Accordingly, the Pearson correlation coefficient was calculated as (r=−.32, p<.01), which indicates a somewhat moderate negative relationship between S-FLES and S-FLCAS, providing evidence for the discriminant validity of the new scale.

Reliability Analyses of S-FLES

So as to evaluate the internal consistency of three factors of the Turkish S-FLES, namely, *Teacher Appreciation, Personal Enjoyment,* and *Social Enjoyment,* Cronbach's alpha coefficient was calculated. The findings are illustrated in Table 1.

Table 1

Internal Consistency Results of Three Factors

	Cronbach's alpha values of the current study	Cronbach's alpha values in Botes et al.'s (2021) study	Number of items
Teacher Appreciation	.91	.91	3
Personal Enjoyment	.75	.71	3
Social Enjoyment	.84	.79	3

As shown in Table 1, the Cronbach's alpha value for the factor *"Teacher Appreciation"* was calculated as α=.91, *"Personal Enjoyment"* as α=.75, and "*Social Enjoyment"* as α=.84, indicating high internal consistency, with all values above the recommended threshold of α=.70 (Büyüköztürk, 2009).

To determine the reliability of the overall scale, first, Stratified alpha coefficient was calculated manually by the researchers using the following formula:

$$\alpha_s = 1 - \frac{\sum_{i=1}^{k} \sigma_i^2 (1 - \alpha_i)}{\sigma_x^2}$$

σ_i^2 = variance of i component

α_i = reliability of i component

σ_x^2 = variance of total score

The Stratified alpha value for the whole scale was found to be α=.92, which shows that the S-FLES has a high reliability.

Apart from this, McDonald's omega was also calculated for the construct reliability of the overall S-FLES by using the JASP statistical program. It was calculated as ω=.89, indicating a high construct reliability.

Conclusion and Recommendations

In Turkey, where attention to FLE has significantly increased, numerous studies have utilized the FLES without adequately validating or thoroughly examining the psychometric properties of the translated scale. Utilizing a scale with a strong theoretical foundation and robust psychometric qualities is crucial for obtaining valid and reliable research results. Therefore, this study aimed to contribute to SLA field by psychometrically validating and adapting the Short-Form Foreign Language Enjoyment Scale (S-FLES) to the Turkish language and culture.

When translating and validating the S-FLES into Turkish, several important linguistic and cultural aspects were considered. Rather than employing a word-for-word translation, we opted for a semantic translation to convey the intended meanings of the items in a culturally appropriate manner (Hambleton, 2005). Given that some English concepts or idiomatic expressions lack direct equivalents in Turkish, meaningful adjustments were made. Attention was also directed towards the agglutinative structure of the Turkish language, which necessitated careful consideration in the translation process. Additionally, the adaptation involved a meticulous translation and back-translation process conducted by bilingual researchers, focusing on cultural nuances. This rigorous procedure ensured conceptual equivalence and helped identify potential loss or distortion of meaning in the translation (Brislin, 1980). These considerations of linguistic features and cultural values guaranteed that the Turkish version of the S-FLES is both culturally relevant and semantically equivalent to the original scale.

Prior to administering the scale to participants, feedback was solicited regarding the content, clarity, design, and layout of the instrument from 10 English language learners, 5 English language instructors from the Preparatory School, and 5 faculty members from the ELT Department at a state university. They did not report any problems with the design and layout and indicated that the items in the scale were clear and understandable. Therefore, we confidently assert that the Turkish version of the S-FLES adequately reflects the original content while being easily comprehensible to Turkish-speaking EFL learners. The Turkish version maintained the original higher-order structure, including the factors, number of items, order of the items, and the rating scale.

In order to determine whether the 3-factor and 9-item structure fits well with the sample data, CFA was performed. As a result, the following values were obtained: $\chi 2/df$=2.58, GFI=.97, AGFI=.94, TLI=.97, CFI=.98, RMR=.032, RMSEA=.064, which shows that 3-factor and 9-item structure fits perfectly well with the sample to which it was applied. The CFA results were also consistent with the values (RMSEA=.059, CFI=.978, and TLI=.967) obtained by Botes et al. (2021). In addition to construct validity, discriminant validity was assessed by measuring the correlation between the current S-FLES and S-FLCAS. The results indicated a somewhat moderate negative relationship (r=−.32, p<.01), providing evidence for the discriminant validity of the current scale. This result is also similar to Botes et al.'s (2021) discriminant validity results (r=−.241, p<.001).

Apart from validity analyses, reliability analyses of the newly translated S-FLES were calculated. The Stratified alpha value for the whole scale was found to be α=.92, which shows that the S-FLES has a strong reliability. Apart from this, McDonald's omega was calculated as ω=.89, indicating a high construct reliability. When comparing the results, it can be seen that the reliability values of the current scale are a bit higher than the original scale (α=.81, ω=.82). Lastly, for the factors of Teacher Appreciation, Personal Enjoyment, and Social Enjoyment, Cronbach's alpha value was calculated as α=.91, α=.75, and α=.84 respectively. This indicates that apart from the overall scale, each factor also has high reliability. These values also closely align with the results reported by Botes et al. (2021) who found them as α=.91, α=.71, and α=.79 respectively. Considering the results, it can be deduced that there is consistency and coherence regarding the factor structure and reliability of the Turkish S-FLES.

The Turkish version of the S-FLES aims to assess the perceived level of FLE in language classrooms. It consists of 9 items and 3 factors: Teacher Appreciation (3 items), Personal Enjoyment (3 items), and Social Enjoyment (3 items). The *Teacher Appreciation* factor refers to the degree to which learners feel that their psychological needs are addressed by the language teacher. The items are related to the language teacher's role in fostering a positive atmosphere in the language classroom, including statements like "The teacher is encouraging" (İngilizce öğretmeni destekleyicidir). The *Personal Enjoyment* factor is related to the learner's personal enjoyment in the process of language learning, including statements like "I enjoy it" (İngilizce dersinden keyif alıyorum). The *Social Enjoyment* factor is related to the enjoyment of social interactions in the language classroom, including statements like "We laugh a lot" (İngilizce dersinde çok güleriz).

When applying the scale, the term "İngilizce" (English) should be adjusted based on the specific foreign language context, such as German or French. It can also be applied to learners of Turkish as a foreign language by simply substituting the word "English" with "Turkish". Like the original one, the Turkish S-FLES is based on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). All items are phrased positively. A higher score in a specific factor indicates a higher level of FLE in that factor. Additionally, a higher score on the overall scale suggests that students have a higher level of FLE. Since the Turkish S-FLES preserves the original scale's higher-order factor model – including factor names, item count, item order, and rating scale – the results can be compared to those of the original S-FLES.

The psychometric properties of the Turkish S-FLES can be considered acceptable, indicating that the scale is valid and reliable to use with Turkish EFL students studying at the university. In terms of getting more robust inferential statistical findings, basing the quantitative results on a well-validated and reliable scale is crucial. Therefore, the availability of a psychometrically validated version of the S-FLES provides educators with a valid and reliable tool to assess the levels of FLE among Turkish EFL students. Furthermore, the validated S-FLES in Turkish can be a valuable resource for educational researchers, offering a standardized tool for investigating the factors influencing FLE in the Turkish context. Research findings based on the scale can contribute to the broader field of Positive Psychology in language education, aiding in the development of evidence-based teaching practices that prioritize students' emotional experiences and well-being in language learning settings.

The reduced number of items in the Turkish S-FLES offers practical advantages for both study participants and researchers. Participants can benefit from a more efficient and less time-consuming assessment process, as they are required to respond to fewer items. This not only reduces the burden on participants but also reduces the likelihood of randomly marking answers. For researchers, the reduced items can be both time and cost-saving in terms of data collection and analysis. With fewer items to administer, researchers can minimize the resources, both financial and temporal. This efficiency is particularly important in large-scale studies where there are time and budget constraints. In essence, the abbreviated version of Turkish S-FLES is a more practical and advantageous tool for both researchers and participants.

The multidimensional structure of the S-FLES sheds light on the complexity of FLE, particularly highlighting that it not only focuses on the individual but also peers and the teacher. It emphasizes the important role of social dynamics and teacher appreciation as essential components of the enjoyment students experience in foreign language classrooms (Botes et al., 2021). Therefore, the Turkish S-FLES will be instrumental in understanding the distinct roles of personal, social, and teacher enjoyment with its multidimensional structure. This scale will also allow researchers to explore the interrelationships among these key factors and their predictive effects on foreign language achievement or other psychological variables.

One of the pedagogical implications of this study is that gaining insight into the factors influencing learners' personal, social, and teacher enjoyment can assist Turkish EFL teachers in creating efficient classroom interventions that promote FLE. They can foster FLE by promoting social interaction through group activities like discussions and games, which build stronger peer relationships. They can also enhance teacher appreciation by creating a supportive and encouraging environment, offering constructive feedback, and celebrating student success. Additionally, integrating culturally relevant content and varying instructional methods can boost personal enjoyment, making lessons more engaging and relatable.

In their study, Botes et al. (2021) emphasize the importance of expanding research on FLE, particularly through cross-validation studies of the S-FLES. They suggest that such studies should include translated versions of the S-FLES to ensure the scale's suitability across various foreign language learning contexts. They also note that any future use of the S-FLES will contribute to a deeper understanding of the scale's validity and reliability. Accordingly, our study serves as a cross-validation effort,

further contributing to the ongoing scholarly discourse surrounding the structure of FLE.

The adaptation and validity study of the S- FLES involved data collection from Turkish university students aged 18 to 27, enabling the scale's application to assess FLE of adolescent and adult learners within foreign language classroom settings. However, it is important to note that the scale should not be used with children unless further validation studies are conducted. Future research should prioritize evaluating the validity and reliability of the Turkish S-FLES for primary and secondary school children to broaden its applicability.

Limitations

Due to time constraints, measurement invariance testing was not conducted to evaluate the equivalence of the newly validated Turkish scale with the original S-FLES. Therefore, direct comparisons between the two versions should be interpreted with caution. Moreover, invariance across key demographic factors such as age, gender, and educational background was not tested. Without testing for invariance across these groups, it is unclear whether the Turkish scale functions equivalently across different subgroups. Future research should address this by conducting measurement invariance testing between the English and Turkish versions, as well as across demographic subgroups, to ensure the validity and reliability of cross-group comparisons.

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Statement of Responsibility

All the authors have sufficiently contributed to the study and agreed with the results and conclusions.

Conflicts of Interest

The authors declare no conflict of interest.

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APPENDIX A

Original S-FLES (Botes et al., 2021)		**Turkish version of the S-FLES**	
In the foreign language class:			
1	The teacher is encouraging	**1**	İngilizce öğretmeni cesaretlendiricidir.
2	The teacher is friendly	**2**	İngilizce öğretmeni sıcakkanlıdır.
3	The teacher is supportive	**3**	İngilizce öğretmeni destekleyicidir.
4	I enjoy it	**4**	İngilizce dersinden keyif alıyorum.
5	I've learned interesting things	**5**	İngilizce dersinde ilgi çekici bilgiler öğreniyorum.
6	I am proud of my accomplishments	**6**	İngilizce dersindeki başarılarımla gurur duyuyorum.
7	We form a tight group	**7**	İngilizce dersinde iyi bir grubuz.
8	We laugh a lot	**8**	İngilizce dersinde çok güleriz.
9	We have common 'legends,' such as running jokes	**9**	İngilizce dersinde herkesin anladığı espriler gibi ortak paylaşımlarımız var.

Teacher appreciation subscale = Items 1, 2, 3

Personal enjoyment subscale = Items 4, 5, 6

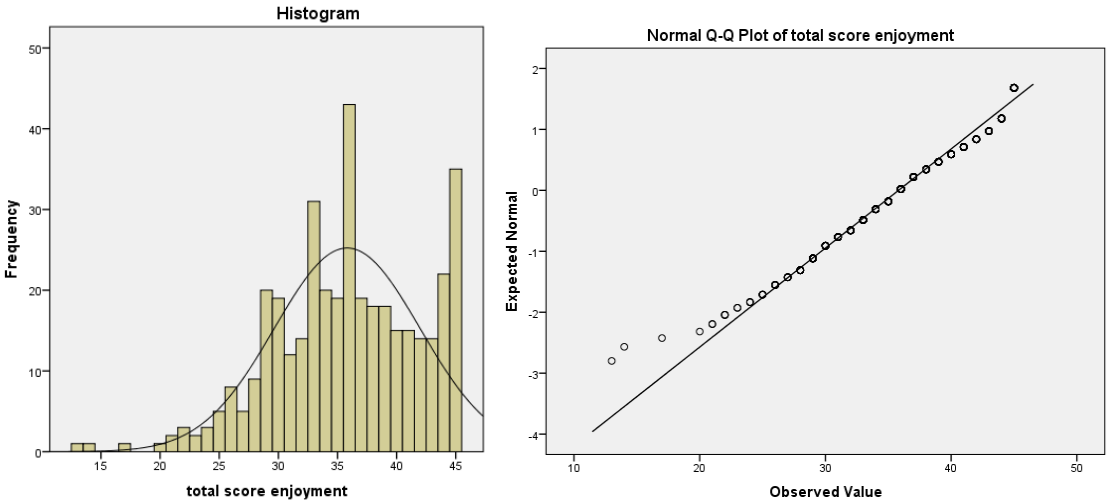
Social enjoyment subscale = Items 7, 8, 9

APPENDIX B

1. Test of Normality Results for the Turkish Version of S-FLES

	Statistic	Std. Error
Mean	35.82	.312
5% Trimmed Mean	36.08	
Median	36	
Minimum	13	
Maximum	45	
Std. Deviation	6.151	
Skewness	-.440	.124
Kurtosis	.104	.247

2. Histogram and Normal Q-Q Plots



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Investigation of Middle School Students' Opinions and Self-Efficacy Beliefs on Mathematical Connection with Using Modelling Tasks*

Ortaokul Öğrencilerinin Modelleme Etkinlikleri Yoluyla Matematiksel İlişkilendirme Süreçlerine Yönelik Öz-Yeterlik İnançları ile Görüşlerinin İncelenmesi

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ABSTRACT: The purpose of this study is to determine the opinions and self-efficacy beliefs of middle school students towards mathematical connections before and after the process in a learning environment prepared in the context of connections with different disciplines and including modeling tasks. An embedded experimental mixed method design was used in the research. The study was conducted with a sum of sixty-one students in the seventh-grade experimental and control groups for fifteen weeks, including the pre-test¬, post-test, and application process. As a data collection tool, mathematical modelling tasks, mathematical connection self-efficacy scale, and pre-post opinion forms for mathematical connection were applied. It was observed that there is no statistically meaningful difference between the pre-test and post-test scores of the groups in terms of mathematical connection self-efficacy. However, after the process, it was specified that connecting mathematics with other disciplines assisted the development of students' opinions on mathematics and different courses.

Keywords: Mathematical connection, mathematical modelling, middle school students, self-efficacy.

ÖZ: Bu çalışmanın amacı ortaokul öğrencilerinin diğer disiplinlerle ilişkilendirme bağlamında hazırlanan modelleme etkinlikleriyle tasarlanmış bir öğrenme ortamında matematiksel ilişkilendirmeye yönelik öz-yeterlik inançları ile görüşlerini ortaya çıkarmaktır. Araştırmada iç içe deneysel karma yöntem tasarımı kullanılmıştır. Araştırma yedinci sınıf deney ve kontrol grubundaki toplam 61 öğrenciyle ön test, son test ve uygulama süreci dahil olmak üzere on beş hafta boyunca yürütülmüştür. Veri toplama aracı olarak matematiksel modelleme etkinlikleri, matematiksel ilişkilendirme öz-yeterlik ölçeği ile matematiksel ilişkilendirmeye yönelik ön ve son görüş formları uygulanmıştır. Grupların matematiksel ilişkilendirme öz-yeterliği açısından ön test ve son test puanları arasında istatistiksel olarak anlamlı bir fark olmadığı görülmüştür. Ancak süreç sonrasında matematiğin diğer disiplinlerle ilişkilendirilmesinin öğrencilerin matematiğe ve farklı derslere ilişkin görüşlerinin gelişimine katkı sağladığı belirlenmiştir.

Anahtar kelimeler: Matematiksel ilişkilendirme, matematiksel modelleme, ortaokul öğrencileri, öz-yeterlik.

*This study forms a part of the corresponding author's master' thesis. In addition, this study was presented at the 6th International Symposium of Turkish Computer and Mathematics Education 28-30 October 2023, in Ankara, Türkiye.

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In addition to the aims of the general education process, it is known that the main aim of mathematics education is to acquire mathematical thinking skills, and that mathematical thinking requires mathematical connections (Baki, 2018). Making connections plays a meaningful role in generalizing and abstracting some mathematical concepts (García-García & Dolores-Flores, 2021a), as well as being an important task for both teachers and students in classrooms (Mousley, 2004) where it is aimed to develop a mathematical understanding. The more mathematical connections a student makes in cognitive processes, the better his mathematical understanding can be considered (Chigeza, 2013; García-García & Dolores-Flores, 2021b). Since the connection is one situation that encourages the individual to think when encountered, procedures related to connection processes are needed in mathematical thinking processes (Narlı, 2016). Similarly, it is mentioned that mathematical connection helps students to remember and use many ideas and that mathematics learning can be strengthened with connection (Bossé, 2003).

It is aimed that students develop mathematical connection skills (Leikin & Levav-Waynberg, 2007; Özgen, 2013a, 2016), which are believed to be as important as communication, problem-solving, reasoning skills, and modelling, during the education process (Ministry of National Education [MoNE], 2013). Similarly, there is an emphasis on connection in curricula or process standards in our country and in different countries (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2015; Curriculum Planning and Development Division [CPDD], 2012; MoNE, 2013, 2017; National Council of Teachers of Mathematics [NCTM], 2000; National Curriculum Board, 2009; Ontario Ministry of Education [OME], 2002). For example, in Spain, one of the European countries, it is encouraged to connect mathematics content with students' preparation for the future; in Ireland, problem-solving skills with concrete examples in mathematics, and in Estonia, middle school teachers are encouraged to connect geometry and symmetry with architecture and visual arts (Eurydice/EACEA/European Commission, 2012).

Mathematical connections can be defined as a process involving a wide range of mental activities such as making links between mathematical concepts and operations, learning fields (algebra, geometry, numbers, etc.) and different representations (verbal, algebraic, tables, figures, equations, graphs, concrete models, symbols, real life situations, etc.) with other disciplines and daily life (Kılıç, 2020). There are various classifications on mathematical connection in the literature. In his study, Eli (2009) handled connection under five different headings: procedural, characteristic/property, algebraic/geometric, derivational, and 2-D/3-D connection. In the study conducted by Leikin and Levav-Waynberg (2007), connections were categorized under three headings: (i) connections about the similarities and differences of the same concept, (ii) connections about different mathematical concepts and operations, and (iii) connections between different branches of mathematics. Rodríguez-Nieto et al. (2022), in their study, consider mathematical connections in terms instruction-oriented, different representations, procedural, implication or if–then, part-whole, meaning, feature, reversibility, and metaphorical types. Özgen (2013a) discusses mathematical connection under three headings: making connections with daily life, making connections with different disciplines, and making connections within mathematics itself.

In the literature, there are various studies examining participants' opinions, skills, and self-efficacy towards mathematical connections. Özgen (2013a) concluded in his study that students' knowledge, opinions, and experiences about connecting mathematics within itself, connecting it with different disciplines and connecting it with daily life should be improved. In the five-year project study that Shulman and Armitage (2005) conducted with teachers, the participants stated that when they made connections, they felt more empowered in terms of mathematics, and the teaching processes improved. Students can experience mathematics as a meaning-making task in which they form ideas, make connections, and engage in problem-solving tasks. When supported by appropriate environmental conditions, mathematics will become a meaning-making activity where students can develop metacognitive competencies and productive beliefs (Schoenfeld, 2022). As can be seen, the findings in the literature on mathematical connections reveal the contribution of mathematical connections to mathematics and its importance for mathematics learning and teaching. Because there is a close relationship between the learning and teaching process and self-efficacy (DiGregorio & Liston, 2018) and the importance of mathematical connections, it is thought that students' self-efficacy in mathematical connections should be investigated. In fact, Yavuz-Mumcu and Aktaş (2018) found a positive and significant relationship between mathematical connections skills and self-efficacy beliefs in their study.

In general, an individual's judgment of himself or herself regarding the capacity to organize the tasks necessary to perform a given performance and to successfully perform that task is called self-efficacy (Bandura, 1986). It is known that people who do not back down easily when faced with difficulties, who are persistent and patient, have high self-efficacy and make serious efforts to achieve a task (Schwarzer & Fuchs, 1995). For this reason, it has been emphasized in many studies that the self-efficacy perception is one of the notable features that should be emphasized in education (Aşkar & Umay, 2001; Hodges & Stackpole-Hodges, 2018).

It is thought that students' mathematical connection self-efficacy should be investigated because there is a close relationship between learning- teaching processes and self-efficacy (DiGregorio & Liston, 2018) and connection skills include the integrity of mathematics and its relationship with daily life and other disciplines. Mathematical connections should be taught to students throughout the mathematics education process and the development of students' self-efficacy in making connections, the importance of which has been emphasized by various studies, should be targeted. (García-García & Dolores-Flores, 2021a; Mousley, 2004). Therefore, it can be thought that students with high self-efficacy beliefs regarding making connections will also have changes in their beliefs about the connection of mathematics with daily life and other disciplines.

Mathematical modeling, which refers to the ability to solve real-world problems through mathematics (Kaiser, 2020), helps in connecting daily life with mathematics (Doruk & Umay, 2011) and serves as an effective tool for establishing relationships with other disciplines (Gürbüz et al., 2018). Mathematical modeling-based instructional processes interventions support the idea that disciplines such as science, engineering, and mathematics have a high potential to facilitate retention by improving students' self-efficacy (Czocher et al., 2019). Today, as mathematical thinking is needed to solve real problems, the products that need to be produced for a problem often require much

more than short answers to routine math problems (Sriraman & Lesh, 2006). Therefore, the general idea accepted by today's mathematics educators is that individuals should be trained to produce solutions through mathematical modeling to problems that have the potential to be addressed mathematically in daily life, industry, and many other sectors. (Ural, 2018).

It is known that mathematical modelling is a powerful tool to help students who are faced with a world shaped by increasingly complex, dynamic, and powerful information systems, to better adapt to daily life and to develop high-level mathematical ideas and problem-solving processes (English, 2004). Sriraman and Lesh (2006) state that mathematical modelling education should start at an early age and emphasize that mathematical modelling encourages understanding and development of mathematical concepts in daily life, improves critical thinking and mathematical literacy. Similarly, English (2007) and Maaß (2005) state that integrating mathematical modelling into primary school curriculum should not be postponed to middle school and beyond. As a matter of fact, mathematical modelling, which is included in curricula and standards for mathematics teaching in different countries and whose necessity is emphasized (CPDD, 2012; NCTM, 2000), has also started to be incorporated in curricula at different education levels in our country (MoNE, 2017, 2018a). Mathematical modelling has started to be instructed as a compulsory course in Primary Education Mathematics Teaching and Middle Education Mathematics Teaching Undergraduate Programs, updated by the Council of Higher Education (CoHE, 2018). Similarly, in the Middle School Mathematics Applications Curriculum (MoNE, 2018b), it is clearly stated, along with the instructions, that mathematics application lessons will be taught according to the modelling approach.

There are approaches that consider mathematical modelling as skills that should be taught as a result of mathematics teaching (Blomhøj, 2007; Blum & Borromeo-Ferri, 2009; Lingefjärd, 2006; Maaß, 2006), as well as approaches that consider mathematical modelling as a tool for mathematics teaching (Lesh & Doerr, 2003). According to both perspectives, the activities prepared should include real life situations and interdisciplinary relationships (Blum & Borromeo-Ferri, 2009; English, 2006). These activities, which offer social interaction to students and make them experience a real problem-solving process, are called modelling activities (Lesh & Doerr, 2003). Model-Eliciting Tasks are defined as problem-solving tasks in which students constitute models and explain these models using mathematical thinking skills, test them and make necessary corrections to enable students to benefit from mathematical modelling in multifaceted real-life problems (Eric, 2008). Borromeo-Ferri (2018) states that there is a strong consensus that mathematical modelling can be defined as a task that involves switching back and forth between reality and mathematics, which is a fundamental feature of mathematical modelling.

Many studies emphasize the importance of mathematical modeling for interdisciplinary learning (Blomhøj, 2007; English, 2015; Kertil & Gürel, 2016; Sriraman & Dahl, 2009) and state that it is an ideal tool for interdisciplinary learning (English, 2007). However, when the studies on mathematical modeling are examined, it is seen that while there are many studies dealing with mathematical modeling in the context of connecting with daily life (Blum & Leiss, 2005; Borromeo-Ferri, 2006, 2010; Cai et al., 2014; Lesh et al., 2003), there is a limited number of studies dealing with

mathematical modeling in the context of connecting with different disciplines (Domínguez et al., 2015; English, 2007; Güder & Gürbüz, 2018).

Krawitz and Schukajlow (2018) state that in addition to mathematical content, mathematical modeling and other problem types do not have a significant effect on students' self-efficacy beliefs. However, considering that mathematical modeling is an effective tool in the context of connecting with different disciplines (English, 2007), it can be considered that self-efficacy beliefs and opinions towards mathematical connection processes through mathematical modeling can be examined. Based on these thoughts, the aim of this study is to determine the opinions and self-efficacy beliefs of middle school students towards mathematical connections before and after the process in a learning environment prepared in the context of connections with different disciplines and including modeling tasks. Therefore, in this research, the main research problem can be stated as "How are students' mathematical connection self-efficacy beliefs and opinions before and after the learning process designed with modelling tasks?" In addition, the research focuses on the following sub-problems.

- Is there a meaningful difference between the mathematical connection self-efficacy beliefs of the students in control and experimental groups after the application process designed with modelling tasks?
- What are the experimental group students' opinions on mathematical connection before and after the application process designed with modelling tasks?
- What are the experimental group students' opinions on the importance of connecting mathematics with other disciplines before and after the application process designed with modelling tasks?

Method

Research Design

This study is mixed research conducted to investigate middle school students' mathematical connection self-efficacy beliefs and opinions in a learning environment designed with modelling tasks prepared in the context of connecting with other disciplines. The research used an embedded experimental mixed method design (Creswell & Plano Clark, 2018, p. 98), in which a qualitative phase can be added to a quantitative study. In line with the aim of the study, qualitative data were used to support the dominant quantitative data, and this design was preferred to seek answers to the secondary problems in the study. In the quantitative part of the study, a quasi-experimental design with pre and post-test control group was implemented. While the experimental group was subjected to a special intervention during the course designed in the research, no experimental intervention was made to the control group. However, in this study, quantitative data were emphasized in accordance with the mixed design of the research. Quantitative and qualitative data were collected simultaneously in the research; qualitative data were blended with quantitative data and quantitative data were supported.

Participants

This study was conducted with seventh grade students training in a public school located in the center of one of the metropolitan cities of Türkiye. Before the research, it

was thought to work with eighth graders, but since the central exam anxiety of the eighth graders was high, it was decided to work with the seventh graders.

The study group was selected with easily accessible case sampling, one of the purposive sampling methods. Since it is not possible to randomly distribute the students to the control and experimental groups for the experimental process, the group matching design (Büyüköztürk et al., 2019) was used by the researcher on the existing groups. Among the groups in the school where the researcher worked, the two classes with the closest mathematics course grade point average were assigned as the control and experimental groups. Mathematics grades of the students in the control and experimental groups were obtained from the e-School system. It was observed that the number of students with a grade point average of 70 points and above was equal and fourteen in the experimental and control groups. Similarly, while the percentage of students with a grade point average of 55 and above was 62.9% in the control group, it was 55.9% in the experimental group. According to these values, it can be said that the control and experimental group students are similar with respect to mathematics achievement.

In addition to the sampling methods given, the embedded sample relation, one of the sampling designs used in mixed research, was used. In the embedded sample relationship, the participants chosen for one stage of the study constitute a particular part of the participants chosen for the study's other phase (Johnson & Christensen, 2014). According to the embedded sample relationship, the control and experimental groups consisting of a sum of sixty-one students were selected in the quantitative part of the study, while only the experimental group students consisting of thirty-four students were selected in the qualitative part of the study. Since the real names of the students were not wanted to be given in the study, the experimental group students were coded as "E1, E2, E3, E4 ..." and the control group students were coded as "C1, C2, C3, C4 ...".

Data Collection Tools

Mathematical Connection Self-Efficacy Scale

The Mathematical Connection Self-Efficacy Scale improved by Özgen and Bindak (2018) was used to specify students' self-efficacy perceptions towards mathematical connection. This scale was also used in different studies with middle school students (Kaya, 2020; Yılmaz, 2022). Although this mathematical connection self-efficacy scale is a five-point Likert-type scale, it consists of six negative, sixteen positive, twenty-two items, and five factors. In this context, the factors were named as (i) difficulty, (ii) using mathematics, (iii) connecting mathematics within itself, (iv) connecting with other disciplines, and (v) connecting with daily life. A reliability and validity analysis of the scale was performed, and it was determined that the scale was usable. The Cronbach alpha reliability coefficient of the scale is 0.85. In this study, the Mathematical Connection Self-Efficacy Scale was applied to the students in control and experimental groups twice, after and before the application process. The Cronbach's alpha reliability coefficient was determined as 0.76 and 0.83 before and after the application process respectively in this study.

Pre- and Post-Opinion Forms

Opinion forms containing structured questions were prepared to specify the opinions of the students on mathematical modelling, mathematical connection, and the relation of mathematics in other disciplines throughout the study process. "Pre-Opinion Form" for the pre-implementation and "Final Opinion Form" for the post-implementation were prepared. In these forms, there are three questions in the pre-opinion form and three in the final opinion form for the students to make explanations. The questions that appear in the opinion forms are listed below.

Questions for the pre-opinion form:

- Did your mathematics teachers relate to the topics or concepts you have learned in your other lessons? Explain with concrete examples.
- Did your teachers make connections between the subjects or concepts related to mathematics in your courses such as social studies, science, physical education, and visual arts? Please explain with concrete examples.
- In your opinion, what kind of benefits will it be for you to connect mathematics with your different courses? Please explain with justifications and give concrete examples.

Questions for the final opinion form:

- Has making a connection between your mathematics course and your courses such as social studies, science, physical education, and visual arts contributed to your interest in mathematics and your success in mathematics? If so, how did it contribute? Please explain.
- Did connecting the concepts related to your courses such as science, social studies, visual arts, and physical education with some basic concepts in your mathematics course contribute to your interest and success in these courses? If so, how did it contribute? Give reasons for your opinion. Give specific examples.
- What kind of difficulties or challenges do you think mathematics may have in its connection with other courses? Explain with justifications. Give concrete examples.

The aim of the questions in the pre-opinion form was to determine the students' level of knowledge about mathematical connections and, connection knowledge, to get their opinions about the benefits of this type of connections and to enable them to give examples. The final opinion form, which was used after the experimental process, assumed that the students had knowledge about mathematical connections and asked them to give their opinions and examples about the contributions of connecting mathematics with other disciplines, both to mathematics and to other disciplines, and the difficulties that might be encountered in this process. Expert advice was sought on the suitability of the questions on the opinion form for eliciting students' opinions, and the necessary arrangements were made. Then, to specify whether the questions were understandable or not, the opinions of the students who will not participate in the research were taken, necessary arrangements were made, and the forms were made ready to use in the research.

Mathematical Modelling Tasks

In this study, when developing mathematical modelling tasks, attention was paid to following the curriculum and acquisitions of mathematics and other disciplines, making interdisciplinary connections, developing modelling skills and creating different mathematical models for given problem situations. The tasks were designed considering the readiness level of the students and identifying outcomes appropriate to their level, including topics and concepts from previous semesters. In addition, topics were selected that were appropriate to the students' interests and that covered different disciplines, and connects were made to real-life contexts and interdisciplinary topics. Factors such as the applicability of the tasks in the classroom environment, the simplicity of the language and the suitability of the visuals were also considered. As in Kerpiç and Bozkurt's (2011) study, design, and implementation principles such as the roles of students and teachers, materials to be used, classroom organization, time management and evaluation were also considered.

In addition, while preparing the modelling tasks, the characteristics of the mathematical modelling tasks created by Tekin Dede and Bukova Güzel (2014, p. 98) within the framework of the literature and the principles of the modelling tasks stated by Lesh et al. (2003, p. 43) were examined. On the other hand, considering the basic components of modelling tasks (Chamberlin & Moon, 2005), the tasks were divided into stages such as "reading passage", "readiness questions", "problem situation", and "presentation of solutions". "Reading passage" is a reading page, like a newspaper article, whose purpose is to familiarize and prepare you for the context of the problem situation. "Readiness questions" are preparatory questions, that a student answers about a previous article. Their purpose is to familiarize and prepare for the context of the problem situation. The "problem situation" can be of various kinds, such as a diagram, a table, a map. It is the basic component of the modeling task. In the "presentation of solutions" section, a mathematically complex problem is solved, and the model is generalized to subsequent situations.

In addition, care was taken to connect modeling tasks to learning outcomes in mathematics and other disciplines (science, social studies, visual arts, physical education, sport, information technology). The tasks were designed to include mathematical concepts such as ratio-proportion, length measurement, equation, volume measurement, percentage, circle graph and whole numbers. Connections were made to the themes of natural resources, national economy, history, stripes and scale on maps in the social studies course, force, mixtures and speed in the science course, perspective in the visual arts course, healthy living in the physical education course, and data storage in the information technology course.

While designing the tasks, arrangements were made in keeping with the aim of the study, such as what to do during the two lesson hours, the role of the student and the teacher, the materials to be used, the classroom organization, the use of time, measurement, and evaluation. The Task Evaluation Form, which includes titles such as the appropriateness of the outcomes, language expression, tables/graphics and visuals, connection with different disciplines, mathematical modeling, and appropriateness to the outcomes of different disciplines, was prepared and evaluations were taken from five academicians and three graduate students who are experts in their fields and necessary arrangements were made. After the necessary arrangements were made in the

tasks, a pilot study was conducted with 8 students outside of class time. The task development process was completed by considering the feedback from the students.

Data Analysis

The quantitative data in this study are based solely on the data obtained with the mathematical connection self-efficacy scale. The obtained quantitative data were analyzed using the SPSS 22 program.

Since the group size was less than 50, the Shapiro-Wilk test was used to examine whether the data obtained showed a normal distribution. The Shapiro-Wilk coefficients of the post-test control and experimental groups were found to be less than 0.05, and the ratio of the skewness coefficient (S.C.) to the standard error (S.E.) was specified to be less than 1.96 by looking at the z statistics. The fact that the S.C.S.E. ratio is less than 1.96 can be interpreted as the distribution does not deviate excessively from the normal (Büyüköztürk, 2014). For this reason, t-test, one of the parametric tests, was used in the analysis of the data. First, descriptive statistics were used to determine whether there was a significant difference between the post-test self-efficacy scores of the control and experimental group students. The t-test was used for independent measurements to specify whether the difference was meaningful. For each control and experimental group, the t-test was used depending on measurements.

The qualitative data of the research were obtained by using the pre and post opinion forms from the data collection tools. Firstly, the opinions of academics who are experts in their field were sought before deciding whether the questions in the opinion form were suitable for eliciting students' opinions. A pilot study was then carried out with students who were not involved in the research to see if the questions were understandable, and their opinions were considered. The forms were finalized after necessary arrangements were made based on expert opinions and pilot study data.

Thematic analysis and content analysis methods, which are among the qualitative analysis methods, were used in the student opinions in the pre- and post-opinion forms. The student opinions analyzed by content analysis method were systematically organized, codes and categories were created, explanatory concepts and relationships were determined, and the data were interpreted accordingly. Thematic analysis was used in cases where the student responses in the opinion forms could not be conceptualized in accordance with the content analysis. Because thematic analysis is more superficial than content analysis, and direct quotations are included to reflect the opinions of individuals in a striking way (Çepni, 2012).

Implementation Process

Three weeks before the application process, the groups were applied a pre-opinion form, a mathematical connection self-efficacy scale, and three mathematical modelling problems as a pre-test. After the application process, which lasted for nine weeks and included modelling tasks with the experimental group, post-tests were implemented for the groups for three weeks. As a post-test, the final opinion form, mathematical connection self-efficacy scale, and three mathematical modelling problems were applied, and the process was completed.

In this study, quantitative data was collected from both groups, while qualitative data was only collected from the experimental group. This preference was based on the

aim to subject the experimental group to the intervention and to analyze in depth the effects of this process on the participants. As the control group did not receive the experimental intervention, it was predicted that collecting qualitative data from this group would not make a meaningful contribution to the research. Quantitative data was considered sufficient to compare the two groups. During this process, qualitative and quantitative data were picked up, and analyses were made in conformity with the research problems. Thus, meaningful findings on the subject were tried to be obtained.

This study lasted fifteen weeks in total and included three weeks of pre-test, nine weeks of implementation and three weeks of post-test phases. The pre-test and post-test modelling tasks consisted of the same modelling tasks. The first task connected the concepts of equality and equation in mathematics with the concepts of weight and mass in science; the second task connected the concepts of length measurement and ratio in mathematics with speed in science. The third task connected volume measurement in mathematics with natural resources in social studies. In the pre-test and post-test applications, students were asked to complete the modelling tasks individually in 40 minutes. The pre-opinion and post- opinion forms and the pre-test and post-test mathematical connection self-efficacy scale were applied individually to the students before and after the experimental process.

Throughout the experimental process, different mathematical modelling tasks were carried out each week, prepared in advance by the researcher and implemented over nine weeks. Each modelling task used in the experimental process was conducted in the preparation, implementation, and evaluation stages in accordance with the constructivist approach. The experimental group was heterogeneously divided into groups of three. Before each task, the students were prepared with homework, presentation and research tasks given in the previous weeks. In the preparation phase, the students gave presentations on the homework they had prepared in class and then the teacher showed appropriate videos, presentations or computer applications related to the task and asked preparatory questions about the problem situation. The roles of teacher and students were clearly defined before each task. This reduced the role of the teacher and created a collaborative learning environment in which students were more active. As part of the constructivist approach, the teacher minimized the role of narration and explanation and encouraged students to solve problems in a rich discussion environment. After the application, one or two groups were expected to present solutions to the class.

Finally, after each task, different perspectives were developed by discussing the students' proposed solutions and providing a constructive evaluation environment. This process helped students to better understand the connections between mathematics and other disciplines. An example of a task and a sample daily schedule suitable for the experimental process is given in Appendix 1.

Ethical Procedures

During the research, permission was obtained from the Dicle University Educational Sciences Ethics Committee with the decision number 90871155-044 dated 03/01/2018 and Directorate of National Education. While conducting this research, attention was paid to the "Higher Education Institutions Scientific Research and Publication Ethics Directive".

Findings

This section is discussed under two headings and focuses on the sub-problems of the research. Quantitative data are presented under the first heading and qualitative data are presented in the second heading.

Findings from the Analysis of the Student Mathematical Connection Self-Efficacy Scale

In Table 1 below, independent samples t-test results are given to reveal whether there is a meaningful difference between the self-efficacy scores for the mathematical connection skill of the students in the control and experimental groups.

Table 1

T-Test Results of Control and Experimental Group Students' Pre-test Self-Efficacy Scores for Mathematical Connection

Group	*N*	*M*	*S*	*Sd*	*t*	*p*
Experimental	34	54.26	13.68	59	-.609	.54
Control	27	56.55	15.65			

According to the t-test results of the pre-test self-efficacy scores for mathematical connection in Table 1, no significant difference could be found between the groups [$t(59)=-.609$, $p>.01$]. Although the mean self-efficacy scores for the mathematical connection of the control group students ($M=56.55$) were more significant than the experimental group students ($M=54.26$), the t-test results show that this difference is not meaningful. According to these values, it can be interpreted that there is no relationship between groups and self-efficacy scores for mathematical connection.

The results of the independent samples t-test conducted to examine whether the difference between the post-test mathematical connection self-efficacy mean scores of the experimental and control groups was statistically significant are presented in Table 2.

Table 2

T-Test Results of Control and Experimental Group Students' Post-test Self-Efficacy Scores for Mathematical Connection

Group	*N*	*M*	*S*	*Sd*	*t*	*p*
Experimental	34	55.55	9.49	59	-1.804	.07
Control	27	60.29	11.00			

According to the t-test results of the post-test self-efficacy scores for mathematical connection, there is no meaningful difference between the groups, [$t(59)=-1.804$, $p>.01$]. Although the mean self-efficacy scores for mathematical connection of the control group students ($M=60.29$) were higher than the experimental group students ($M=55.55$), the t-test results show that this difference is not meaningful.

According to these values, it can be interpreted that there is no relationship between the groups and the post-test self-efficacy scores for mathematical connection.

Table 3 shows the results of the t-test performed to specify whether there is a meaningful difference between the post-test and pre-test self-efficacy scores for the mathematical connection of the control group students.

Table 3

T-Test Results of Control Group Students' Pre-test and Post-test Self-Efficacy Scores for Mathematical Connection

Test	*N*	*M*	*S*	*sd*	*t*	*p*
Pre	27	56.55	15.65	26	-1.149	.26
Post	27	60.29	11.00			

According to the t-test results in Table 3, there was no meaningful difference between the pre-test and post-test self-efficacy scores for the mathematical connection of the control group students [$t(26)=-1.149$, $p>.01$]. There was an increase in the post-application mean score ($M=60.29$) compared to the pre-application mathematical connection self-efficacy mean score ($M=56.55$) of the students. However, this increase displays that the application process does not have a meaningful impact on the student's self-efficacy scores averages for mathematical connection. In Table 4, the t-test results are given to specify whether there is a meaningful difference between the post-test and pre-test self-efficacy scores for mathematical connection of the experimental group students.

Table 4

T-Test Results of Experimental Group Students' Post-test and Pre-test Self-Efficacy Scores for Mathematical Connection

Test	*N*	*M*	*S*	*sd*	*t*	*p*
Pre	34	54.26	13.68	33	-.548	.58
Post	34	55.55	9.49			

In Table 4, no significant difference could be detected between the post-test and pre-test self-efficacy scores for mathematical connection of the experimental group students [$t(33)=-.548$, $p>.01$]. There is an increase in the post-application mean score ($M=55.55$) compared to the pre-application self-efficacy mean score for mathematical connection of the students ($M=54.26$). This increase shows that there is no meaningful difference between the pre-test and post-test self-efficacy sum scores for mathematical connection of the experimental group students. To determine whether the t-test results and the experimental group students' opinions on mathematical connection show parallelism, opinions of the students in the pre-opinion and post-opinion forms were examined.

Findings From the Student Opinion Forms

The opinion forms were aimed at revealing if there was a difference in the experimental group students' opinions towards mathematical connection. In these forms, structured open-ended survey questions were used, and the answers given by the students were analyzed by using content analysis and thematic analysis methods with a qualitative approach.

In the pre-test opinion form, the open-ended question "Did your mathematics teachers relate to the topics or concepts you have learned in your other lessons? Explain with concrete examples" was analyzed thematically with a qualitative approach. In this question, which was answered by all students, twenty-five of the students stated that mathematics was connected with science lesson, four to social studies lesson, one to physical education lesson, one to music lesson, and one to visual arts lesson. Although two students stated that a connection was made, they did not give information about which course the connection was made with. Although many of the students mentioned that there was a connection between mathematics and a different discipline, they did not give any concrete examples. The number of students who gave concrete examples about the connection was limited. For example, the student E23 drew attention to the connection made with the science lesson with the statement, "Yes, my mathematics teacher had an example showing weight on an equal-armed scale on the subject of equations, and he related it to the weight subject in the science lesson". The E18 student, on the other hand, talked about the connection made with the social studies lesson with the statement, "Sometimes he touches on these subjects for our lesson, for example, he explained it with the title of maps, measurement and scales". Similarly, the student E17 mentioned the connection between physical education lessons and number patterns in mathematics lessons with the statement, "I think there is math, for example, and the body says two steps back in the body, it is related to mathematics". Analysis of students' responses revealed that although the majority of students stated that connections are made with other disciplines in mathematics class, the number of explanations supported by concrete examples was limited. This situation shows that students have the impression that connections are made, but they are unable to understand these connections in depth. In other words, students show a superficial awareness but lack in-depth knowledge or concretization. In this context, the need for teachers to make stronger and more explicit connections with other disciplines in mathematics education comes to the fore.

Similarly, the answers of students to the open-ended question, "Did your teachers make connections between to the subjects or concepts related to mathematics in your courses such as social studies, science, physical education, and visual arts? Please explain with concrete examples." in the pre-opinion form were subjected to thematic analysis, and the findings gained were submitted in Table 5 by creating codes and categories. As a result of the thematic analysis of the students' responses, the general concepts mentioned by the students in other disciplines were rephrased by the researcher by connecting them with the related mathematical subjects and concepts. The table shows the codes created by the researcher in this process.

Table 5

Students' Opinions in the Pre-Opinion Form on the Connecting of Other Courses' Topics or Concepts with Mathematics

Category	1st Degree Subcategories	2nd Degree Subcategories	Codes	*f*
Connection Subjects or Concepts of Other disciplines with Mathematics	Science	Velocity, equal-arm scale, volume, solid pressure	Ratio -proportionality, equations, volume measurement units	22
	Social sciences	Parallel and meridian data strip	Coordinate system, integers	2
	Physical education	Walking pattern	Measuring length, number patterns	2
	Music	Beats	Fractions	1

While twenty-seven of the students stated that they made connections with subjects or concepts related to mathematics in other disciplines, two of them did not answer the question at all, and five of them did not answer this question. Of the students who stated that connections were made with the mathematics lesson while the concepts of other disciplines were being taught, twenty-two of them indicated that they made connections with the subjects and concepts related to the science lesson, two of them in the social studies lesson, two of them in the physical education lesson, and one in the music lesson. Drawing attention to the connections related to the subjects and concepts related to the science lesson, the student E6 stated that the subject of velocity was connected with mathematics with the statement, "Science teacher made connections about the speed with subjects related to mathematics". The student E1, on the other hand, stated that the connection was made about equal-armed scales with the statement, "The math teacher and the science teacher made a connection between weight and force". However, although these students stated the subjects and concepts related to the science lesson, they did not use any statements about which subject and concept related to the mathematics lesson were connected. Similarly, the student E9, among the students who indicated that the social studies lesson was connected with the mathematics lesson, mentioned the subject related to mathematics in the statement "The parallels and meridians we studied in the social lesson were the same as coordinates in the mathematics lesson", but did not state that the teacher did this. In the same vein, the student E30, who referred to the connection made in the music lesson, did not mention the subject and concept connected to mathematics, although he stated that he made a connection with mathematics with his explanation "The music teacher made a connection with mathematics while he was explaining the beats". In general, when the students' opinions were examined before the application, many of the students specified that they made connections with mathematics in different courses. However, the students did not give any information about which subjects and concepts in mathematics were connected with at the time of the connection. As can be seen from the sample of students' expressions, although the students stated that they made connections between different disciplines and mathematics, these connections were generally superficial and specific mathematical concepts were not clearly expressed in the expressions used by

the students. This shows that students' awareness is mostly based on general knowledge and that they have difficulty in making deep connections with the concepts to which the mathematical connections are related. Students' explanations included more superficial relationships rather than specific mathematical concepts, suggesting that the connections made between mathematics and other disciplines are mostly based on the use of the four operational skills.

The students' answers to the open-ended questionnaire question "In your opinion, what kind of benefits will it be for you to connect mathematics with your different courses? Please explain with justifications and give concrete examples" in the pre-opinion form, and the findings obtained by creating codes and categories are presented in Table 6. Before the application, students' opinions on connecting mathematics with different courses were examined. While two of the students did not give answers to the question, one of them gave the answer that it is not useful, and thirty-one of them used various expressions about the benefits of connecting mathematics with other disciplines, but they did not include expressions to support their thoughts. When the opinions on the benefits of connection with other disciplines were examined, twelve students presented their opinions on the contribution of connection as course success. For example, the student E34 stated that "Our success in other lessons will increase even more" while referring to the contribution of the connection to the success of other lessons, while the student E8 stated that it contributes to the success of the mathematics lesson with the statement "It benefits mathematics success".

Table 6

Students' Opinions in the Pre-Opinion Form on Connecting Mathematics with Different Courses

Category	Subcategories	Codes	*f*
Benefits of connection	Contribution to course success	Math achievement, success in different courses	12
	Consolidation of concepts from different courses	Persistence, connection, prior knowledge, topic repetition	12
	Making everyday life easier	Using	2

Similarly, twelve students stated that connecting mathematics with other disciplines would contribute to consolidating the concepts of other disciplines. For example, the student E10 stated that the context of the statement "We are learning concepts about other courses that we do not know, we are learning the relationships between two courses" contributes to the consolidation and permanence of concepts from other disciplines. In the same manner, the student E33 mentioned the same topic with the statement as "It makes it more permanent in the mind. For example, it makes history more memorable in social studies class." Unlike these students, the student E24 stated that connection would contribute to our daily life and make our lives easier with the statement "Of course we use mathematics and other courses in our daily life, which makes our daily life easier". In the same vein, the student E30 mentioned the same topic with the statement "Of course, we use mathematics and other courses in our daily lives. This makes our daily life easier." Unlike these students, the student E14 stated that

connection contributes to the interpretation skill with the statement "It allows us to get out of the tests and use our thoughts now, we can make our own interpretations". The student E10, on the other hand, stated that connection would contribute to an entertaining lesson with the statement "I think it makes our lesson more detailed and more fun". The student E30, on the other hand, stated that "We learn more information in a little while" and pointed out that time can be saved with ease of connection. In general, when we look at the students' opinions before the application, it is revealed that the students think that it would be beneficial to connect mathematics with other disciplines. However, considering that many of the students do not explain their thoughts with their justifications, it can be thought that many of the students do not have clear knowledge about connection with other disciplines.

After the application, the students' answers to the open-ended question "Has making a connection between your mathematics course and your courses such as social studies, science, physical education, and visual arts contributed to your interest in mathematics and your success in mathematics? If so, how did it contribute? Please explain" in the final opinion form were subjected to content analysis, and the findings were submitted in Table 7 by creating codes and categories.

Table 7

Students' Opinions in the Post-Opinion Form on Connecting Mathematics with Other Courses

Category	Subcategory	Codes	*f*
The contribution of connection to mathematics	Contribution to math achievement	Open-ended questions, improvement in success	16
	Contribution to interest and motivation	Arousing curiosity, mathematical perspective, feeling happy	7
	Contribution to comprehension skills	Problem solving, thinking skills	6
	Understanding the importance of connection	Relevant course contents, providing subject repetition	3

According to Table 7, thirty-two students gave affirmative answers about the connection of mathematics with other disciplines, but two students did not answer the question. When the answers of the students who gave positive opinions were examined, seven of the students stated that connecting mathematics with other disciplines assisted their interest and motivation in mathematics. For example, the student E23 states that "Yes, I like mathematics more than before because it increased my curiosity by seeing it more in different courses" and states that his interest in mathematics has increased. The student E33, on the other hand, states that connecting mathematics with other disciplines improves his mathematical thinking skills and therefore his self-efficacy belief increases with the expression "Yes, I never thought of other subjects mathematically, but now I feel smarter when I think of them mathematically". Similarly, sixteen of the students think that connecting mathematics with other disciplines contributes to their mathematics achievement. Among these students, the

student E15 states that connecting mathematics with other disciplines contributes to the increase in their mathematics grades and their further development, with the statement "Yes, I started to get higher grades, especially in classical questions" as well as the student E14 with the statement "I was already successful, but I think this application improved me more". In addition, six of the students stated that the connection mathematics with other disciplines contributes to their understanding of mathematics and problem-solving skills. The E29 student's opinion, "Yes, I can understand and solve problems better" exemplifies this situation. On the other hand, three students stated that they understood the importance of connecting mathematics with other disciplines with expressions like the statement of the student E33 "It happened, I understood better that every lesson is related to each other". When the opinions of the students after the application process are examined in general, in the final opinion form, the students used clearer expressions in their opinions about the contribution of the connection of mathematics with other disciplines to mathematics. In this case, it can be said that the implementation process assisted the change of students' opinions on connection.

Students' opinions on whether the connection of mathematics with other disciplines contributes to students' interests and achievements in other disciplines are examined in Table 8. While ten of the students stated that making connection did not contribute to other disciplines, twenty-four students stated that connection assisted other disciplines in several ways.

Table 8

Students' Opinions in the Post-Opinion Form on the Contribution of Mathematics' Connecting to Other Courses

Category	Subcategory	Codes	*f*
Contributions of connection to other disciplines	Understanding the importance of connection	Related course content, facilitation	5
	Contribution to success of other disciplines	Grade increase, mathematical solution	6
	Contribution to comprehension skills	Problem understanding, comprehension of course and subject content	6
	Contribution to thinking skills	Mathematical solutions, problem solving, mathematical thinking	6

Six of the students who mentioned the contribution of connection stated that connecting mathematics with other disciplines assisted the increase in success of other disciplines. For example, the student E24 stated that making mathematical solutions would contribute to these lessons for questions related to mathematics in science and social studies lessons with the expression "We were able to apply mathematical concepts to solve problems in both science and social studies, thus making significant contributions to science and social studies during math lessons". The student D34 clearly stated that mathematical connections had a positive effect on his academic performance in other disciplines with the statement "Mathematics contributed more to my success in other courses". Similarly, five students stated that they realized that mathematics and other disciplines assisted each other through connection, and they

understood the importance of connection better. For example, the student E20 emphasized the importance of connection with the statement "If the speed and weight of the object were not in science, I could not solve math and science test questions" and stated that it assisted problem solving in mathematics and science. The student E24, on the other hand, emphasized the importance of connection, stating that mathematics assisted other disciplines thanks to the connection with the tasks done throughout the application process, with the statement "Mathematics course assisted science and social studies, since every course was related to mathematics". Six of the students who mentioned the contribution of the connection stated that the connection assisted comprehension skill. While the student E19 expressed that they better understood the course and subject content of other disciplines with the statement, "Yes, because I can understand the lessons better," the student E30 indicated that they had a clearer understanding of problems connected to other courses with the statement, "Yes, I understand the problems better.". Similarly, six students expressed opinions explaining that connection contributes to their thinking skills. For example, the student E14, one of these students, stated that connection with the statement "It happened. For example, I learned which ways I can think and follow mathematically" contributes to his thinking skills and mentioned that his mathematical thinking skills have improved. In addition to these students, the student E6 stated that connection contributes to both other disciplines and daily life with the expression "Mathematics course contributes to us even in daily life". The findings from the students' opinions show that connecting mathematics with other disciplines not only increases academic achievement, but also improves comprehension and strengthens thinking skills. When the students' statements were analyzed after the implementation process, it was found that many students stated that connecting mathematics with other disciplines would make a meaningful contribution to these disciplines; this situation emphasizes the importance of the connecting process in education and enriches the students' learning experience. Answers of the students to the open-ended questionnaire question "In your opinion, what kind of difficulties or challenges might there be when your mathematics teachers connect mathematics with your subjects such as social studies, science, physical education, visual arts? Explain your opinion with reasons. Give concrete examples" in the post-opinion form were subjected to content analysis and the findings were given by creating codes and categories in Table 9. Before the application, students' opinions about the difficulties that may be experienced in connecting mathematics with other disciplines were examined. In this question, nine of the students did not answer the question, ten of them stated that the reason for the difficulties to be experienced could be due to the lack of teachers and five of them due to reasons arising from the students.

Table 9

Students' Opinions in the Post-Opinion Form on Difficulties in Connection Mathematics with Other Courses

Category	Subcategories	Codes	*f*
Factors That Make Connection Difficult	No hassle	Relationship between courses, teacher efficacy	11
	Teacher shortage	Lack of information, lack of connection	10
	Student-related factors	Lack of information, concept confusion	5

Eleven students stated that there would be no difficulty in making connections. The student E13 stated that it would be difficult to make connections due to the lack of knowledge caused by teachers of other disciplines in his statement "There would be difficulties in some subjects because other teachers' math was weak". The student E14 stated that a math teacher might have difficulty in connection due to lack of knowledge by using the phrase "Maybe there can be difficulty in explaining the subject if the math teacher does not know much about lessons such as science lessons". Five of the students stated that there may be difficulties in making connections because of reasons for instance deficiency of knowledge and conceptual confusion caused by the students. Among these students, the student E7 stated that teachers might have difficulties in making connections due to the lack of knowledge caused by the students, with the explanation "For example, if we did not know the social lesson, there would be difficulties in the mathematics lesson when the map and area were taught. The teacher would not be able to cover the map and the area." The student E17, on the other hand, stated that the students may experience confusion of concepts and stated that there may be difficulties in making connections with the statement "It happens because one teacher explains, the other teacher says the same, we get confused and have difficulties". Unlike these students, there are also students who think that there is no difficulty in making connections. For example, the student E2 expressed his opinion that there would be no difficulty in connection with the statement "It would not be possible. Because a teacher could sometimes have something stuck in their minds because they read it and tell us.", while the student E22 expressed the same opinion as "I find the science lesson closest to mathematics. Our mathematics teacher explains the science lesson very well. Our science teacher explains mathematics very well". According to the findings from the table, the number of students who stated that there would be no difficulties in making connections between mathematics and other disciplines is higher than those who stated that there would be difficulties. While the majority of students did not see any problems in making connections, some students pointed out that teachers' lack of knowledge and inadequacies in other disciplines could make this process difficult. In addition, a few students highlighted student-induced difficulties due to lack of knowledge and conceptual confusion. These findings indicate that the process of making connections is an issue that needs to be addressed carefully, both in terms of teacher competence and student understanding.

Discussions, Conclusions, and Implications

The findings regarding the quantitative data of the study were obtained by using the mathematical connection self-efficacy scale. According to the before and after the application process, no meaningful difference could be found between the self-efficacy scores for the mathematical connection of the control and experimental group students. Similarly, In addition, within-group comparisons revealed no significant difference between the pre-test and post-test mathematical connection self-efficacy scores for either the experimental or control group. It is possible to see comparable results in studies conducted in literature. Yavuz-Mumcu and Aktaş (2018) found a low relationship between middle school students' ability to connect mathematics with daily life and their self-efficacy in doing so. Additionally, they identified an exceptionally lower-than-expected relationship between students' ability to connect mathematics with other disciplines and their self-efficacy in making these connections. In the study carried out by Hindun et al. (2019) aimed to examine the differences in mathematical connection ability and self-efficacy between control and experimental groups, and the relationship between them. However, their pre-test-post-test study with seventh-grade students found no significant difference in mathematics self-efficacy between the two groups.

In this study, although there was no significant increase in students' self-efficacy beliefs before and after the process, there was a significant improvement in their opinions of mathematical connections. This finding resonates with Kaya's (2020) study, which showed that as perceived teacher emotional support increased, students' self-efficacy difficulties in mathematical connections decreased, while their beliefs in relating mathematics to everyday life and other disciplines increased. Thus, while self-efficacy remained stable in our research, the qualitative improvement in students' perceptions of mathematical connections suggests a similar influence of supportive factors. In his study with pre-service teachers, Zengin (2019) concluded that learning concepts by creating materials in the GeoGebra application meaningfully increased self-efficacy for mathematical connection of pre-service teachers. When reviewing the studies in the literature, it is possible to come across studies where there is no significant increase in self-efficacy beliefs about mathematical connections as well as studies where there is an increase. In this study, although there was no significant increase in students' self-efficacy beliefs before and after the process, positive developments were observed in students' views of the mathematical connection. This may be because the qualitative improvement in students' self-efficacy beliefs about mathematical connections and their views on mathematical connections is influenced by many supportive factors, such as the emotional support of the teacher (Kaya, 2020).

The positive effects of mathematical modelling processes on students' mathematical connecting skills are often highlighted in the literature. Duman and Aydoğan Yenmez (2024) state that, in addition to students' use of interconnection skills between concepts and real-world connection skills in mathematical modelling processes, these processes enable them to make connections between different disciplines and different representations of concepts, thus enhancing their connection skills. Similarly, Czocher et al. (2019) argue that teaching processes based on mathematical modelling have a high potential to develop self-efficacy for disciplines such as science, engineering, and mathematics courses. In this context, modelling

activities are found to not only strengthen mathematical connections, but also increase students' self-efficacy beliefs. Takaoğlu (2015), in his study investigating the relationship between connections in physics courses using mathematical modelling and pre-service teachers' interests, found that these modelling activities contributed to pre-service teachers' better understanding of the relationships between physics and mathematics and everyday life in interdisciplinary connections. These findings suggest that modelling activities play an important role in developing students' interdisciplinary connection skills. Finally, studies of mathematical modelling in the context of making connections between different disciplines show that it contributes to participants beyond the regular curriculum (English, 2007). These studies support the idea that integrating mathematical modelling into educational processes can increase the potential for improving students' self-efficacy beliefs and connection skills. Indeed, in the experimental process carried out with the mathematical modelling process in our study, it is seen that students' views on mathematical connectedness emphasize the importance of the connectedness process and enrich students' learning experiences.

At the beginning of the study, it was observed that students' awareness of the connections between mathematics and other disciplines was limited. In addition, it was observed that teachers of other subjects such as social studies, science, physical education, visual arts, etc. did not mention the topics and concepts of mathematics while teaching mathematics-related subjects, and therefore students could not think about making connections with the topics and concepts of mathematics. An analogous situation was also found in the studies of Coşkun (2013) and Özgen (2013a, 2013b). In Coşkun's (2013) study, it was concluded that teachers mostly made connections between concepts and daily life, but almost no connections with other disciplines. In Özgen's (2013b) study conducted with pre-service teachers, it was observed that the participants could not make connections within mathematics at the desired level, and the connections with other disciplines and daily life remained at extremely low levels. Similarly, Özgen (2013a) concluded in his study with pre-service teachers that although pre-service teachers had opinions about the connection with other disciplines and the connection of mathematics within itself, it was at a limited level. Considering the studies in the literature, it can be said that participants have limited opinions about the types of mathematical connections before a specific application for mathematical connection is made. In addition, it can be said that students' views are also limited because teachers do not do enough work to connect them to other disciplines.

At the end of the process, the study found that students in the experimental group were more positive about making connections, had a better understanding of the importance of connections, and stated that interdisciplinary connections contributed to their success in mathematics and other courses. It was also found that almost all students stated that connecting mathematics with other disciplines increased their interest and motivation in mathematics. In addition, students stated that connecting mathematics to other disciplines in this context improved their higher order thinking skills and enabled them to better understand concepts in different disciplines. This change in perspective shows that the application process plays an important role in developing more positive attitudes towards mathematical connections. Students' better recognition of interdisciplinary connections highlights the success of the intervention in increasing their understanding and interest in mathematics. This suggests that both

mathematics teachers and teachers of other disciplines should enrich their course content to make interdisciplinary connections. In addition, it is predicted that longer-term interventions that focus on interdisciplinary connections can improve students' self-efficacy beliefs at a more significant level.

The positive effects of connecting mathematics with other disciplines on interest (Başkan Takaoğlu, 2015), motivation (Domínguez et al., 2015), retention (Deveci, 2010) and achievement (Dorn et al., 2005; Parr et al., 2009) have also been highlighted in the literature. For example, Sandalcı (2013) aimed to investigate the effect of mathematical modelling on middle school students' academic achievement and ability to relate mathematics to daily life and found that even students with moderate and low achievement increased their interest during discussions and improved their understanding. Domínguez et al. (2015) conducted an integrated course study of mathematics and physics with undergraduate students and found that participants' motivation increased and their skills, such as critical thinking and collaboration, improved.

According to the quantitative findings of the study, no significant difference was found in the 'difficulty' dimension of the mathematical relevance self-efficacy beliefs scale. However, the qualitative findings showed that students' beliefs about the difficulty of making mathematical connections decreased after the process. In particular, most of the students in the experimental group stated that there was no difficulty in making connections between mathematics and other disciplines at the end of the process. In the study conducted by Sandalcı (2013) with secondary school students, it was found that the students' ability to see the connection between real life and mathematics improved and that the difficulties experienced by the students at the beginning decreased over time. This shows that the activities used in the teaching process can have a positive effect on students' ability to make connections, but these activities should include more guidance in terms of accessibility.

When the qualitative and quantitative data of the study were analyzed separately, it was found that the modelling tasks prepared in the context of connections with other disciplines and the learning environment designed did not produce a statistically significant difference in students' beliefs about their self-efficacy in mathematical connections. However, positive developments were observed in the views of students in the experimental group regarding their connections with other disciplines. Another important finding is that although students had limited awareness of making interdisciplinary connections at the beginning, this awareness increased after the implementation process. Students stated that making mathematical connections not only increased their success in the course, but also increased their interest and motivation in mathematics. This change shows that the modelling activities were successful in developing students' awareness of mathematical connections. These results suggest that mathematical connections should be emphasized more in future teaching processes. Future studies can focus on long-term applications to make these connections more permanent and to further support students' self-efficacy beliefs.

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Conflicts of Interest

The authors have no competing interests to declare that are relevant to the content of this article.

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Appendix-1: Sample Modelling Task and Daily Lesson Plan

Course	Mathematics Applications Course
Class	Seventh Grade
Duration	80 min.
Learning Areas	Geometry and Measurement; Numbers and Operations; Algebra
Sub-Learning Areas	Measuring Length, Ratio, Linear Equations
Skills	Modelling, problem solving, relating, communication, reasoning
Methods And Techniques	Mathematical modelling, question and answer, problem solving, brainstorming, discussion, estimation strategies, presentation, lecture
Outcomes Related to The Mathematics Course	**5.2.3.1.** Recognizes the units of length measurement; Converts meter-kilometer, meter-decimeter-centimeter-millimeter units and solves related problems. **6.1.6.1.** Uses ratio to compare multiplicities and displays ratio in different ways. **7.2.2.2.** Expresses how one of two variables, which have a linear relationship between them, changes depending on the other, with tables, graphs, and equations. **M.U.7.1.4.1.** Solves problems related to direct or inverse proportion.
Outcomes Related to The Related Course(S)	**Visual arts:.6.1.5.** Uses perspective in visual artwork. Uses line perspective to create the effect of depth in space. **Social studies: 6.2.7.** Realizes the interaction between the settlement and economic tasks and social structures of the first civilizations that lived in Anatolia and Mesopotamia.
Tools	Worksheet, interactive whiteboard, video clip.
Objective Of the Task	The purpose of this modelling problem is to enable students to make connections between mathematics, visual arts, and social studies lessons. It is aimed for the student to establish a relationship with the social studies course by giving articles about historical places. Thus, to have information about historical textures, it is aimed to direct students to research by arousing their curiosity. In addition, the purpose of the expression "Assuming that the people in the photograph and the Keci Bastion are at the same distance" in the problem sentence, the students are expected to make a connection between the depth and perspective topics in the space in the visual arts lesson and the ratio-proportion topics in mathematics. Because perspective and proportion are naturally related in painting (Kabakçı & Demirkapı, 2016). In addition, the purpose of choosing the modelling problem is to realize that the subject of perspective and the ratio-proportion are related, and to realize that the ratio exists in the photographs and pictures that they will encounter in daily life.
Application Process of The Task	After the students are divided into upper, middle, and lower groups according to their first semester math report grades, they will be divided into groups of three, one from each level. The following preparatory questions will be given to the students from the previous week before the task and they will be asked to prepare assignments. During the preparation phase, students will be asked to present their assignments in the form of boards and presentations. Afterwards, the part of the video clip "Diyarbakır Walls on the Way to UNESCO" video clip prepared by the Diyarbakır Metropolitan Municipality will be shown to the students by the teacher, and the students will be drawn to the event. Then, "Keci Bastion" worksheets will be distributed to the students, and they will be asked to read the reading passage of the task and focus on the photograph. By brainstorming in the class about the sub-directions developed for modelling competencies in the task, the parts that are not understood will be tried to be found by the teacher with questions. After the sub-directions developed for modelling competencies are discussed step by step with the class, students will be given time to write their thoughts and solutions on the worksheets as a group.

Preparatory Work (20 Minutes):

Presentations of the students regarding the research topics given from the previous week are taken on the board work and homework. Studies are conducted for the readiness of the students.

- Make research on the Turkish-Islamic civilizations that ruled in Diyarbakır and turn it into a panel study.
- Do general research on the Diyarbakır Walls.
- What is "perspective" in Visual Arts? Please search.
- Explain the concept of ratio-proportion in mathematics. What is its relationship with the concept of "perspective" in the Visual Arts course? Please search.
- If the length of 1 cm on a map is 1 km, how many km is a line segment with a length of 10 cm on the same map?
- Investigate length measurement units.

Task Application (40 Minutes):

Worksheets will be distributed, and the problem will be solved in accordance with the steps.

The Keçi Bastion

In the photo above, a part of the Keci Bastion is seen on the hewn rock mass east of the Mardin Gate of the Diyarbakır city walls. The Keci Bastion is the oldest and largest of the bastions on the walls. There is an inscription on the bastion, whose exact date of construction is unknown, indicating that it was repaired by Mervanoğlu in 1223.

Mr. Ahmet, reading the information about the Keci Bastion above, wants to calculate the approximate height of the Keci Bastion. If we assume that the people in the photo and the Keci Bastion are at the same distance, can you help Mr. Ahmet to calculate the height of the Keci Bastion?

1) Interpret what is given to you and what is asked of you by expressing the problem in your own words.

2) Make up your own assumptions about the problem.
3) Explain how you will follow a mathematical path in solving the problem.
4) Solve the problem according to your assumptions.
5) Write your comments on the result of your solution.
6) Verify your solution.
7) What do you think is the relation of this problem with your following lessons? Please explain.

- Relationship with social studies:
- Relationship with visual arts:

Evaluation Study (20 Minutes):

After the worksheets are collected, students in separate groups will be asked to make a presentation about the solution of the task for the modelling problem. Then, in the presentations made about the task, questions such as "Can you follow a different way", "Why did you solve this way" and "Can you explain the reason for your solution" will be directed by the teacher in order to produce different solutions, sub-directives developed for modelling competencies in the task. In addition, various pictures will be shown by the teacher and a relationship will be made with the perspective subject of the visual arts lesson.

Example Solution of the Modelling Problem:

1) Understanding the problem

The height of the Keci Bastion, which is at the same distance in the photo, is proportional to the height of the people.

2) Simplifying the problem and making assumptions about the problem

In the problem, we are asked to find the height of the people and the Keci Bastion by ratio.

Assuming that the average human height is 170 cm = 1.7 m

Assuming the height of the Bastion is about ten times the height of humans

3) Mathematizing

The correct proportion is established so that: $\frac{\text{average human height}}{\text{height of the Keci Bastion}} \backsimeq \frac{1}{10}$

4) Mathematical working

$\frac{\text{average human height}}{\text{height of the Keci Bastion}} \backsimeq \frac{1}{10}$

Also, if we say x to Keci Bastion's height,

from the equation $\frac{\text{average human height}}{\text{height of the Keci Bastion}} \backsimeq \frac{1}{10} = \frac{1{,}7}{x}$

If 1.x=10.1,7m with the product of the insides and the outsides,

the length of Keci Bastion (x) =17 m.

5) Interpretation

After the assumptions were created in the solution, the height of the Keci Bastion was calculated. It can be understood that the sizes of objects located at the same distance in photographs and pictures are proportional.

6) Validating

Since we assume that according to the photograph, the average human height is equal to ten times the height of the Keci Bastion, the result is accordingly correct.

7) Connection between outcomes

Social studies: Since the article given to the students mentions the history of Anatolia and Mesopotamia, it has a connection with the social studies course. In addition, students are expected to realize the importance of our cultural values.

Visual arts: In the content of the problem, a connection was established between the concept of perspective in visual arts and the concept of ratio in mathematics. The students are expected to state that if the distances of the Keçi Bastion and the people in the image to the camera are equal, the heights of the Keçi Bastion and the people are proportional.

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Effectiveness of Early Intervention Programs in Developing Early Mathematical Skills: A Meta-Analysis

Erken Matematik Becerilerinin Geliştirilmesinde Erken Müdahale Programlarının Etkililiği: Bir Meta-analiz Çalışması

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ABSTRACT: Early intervention includes approaches to responding to young children may profit from targeted services. This study aims to synthesize recent evaluations of intervention programs of Big Math for Little Kids, Building Blocks, and Prekindergarten Mathematics Intervention Program in preschool and kindergarten children to determine the effectiveness of early intervention programs including experimental studies in last 15 years in developing early mathematical skills. Among 146 studies, 10 studies that met the inclusion criteria, which included experimental studies, publication bias, effect size, heterogeneity, moderator type of intervention program, the duration of the intervention, and the participants' age. The results indicated a large effect size (Hedges'*g*=1.217) for the effectiveness of intervention programs according to random effects model and Cohen's classification. While the results of moderator analyses highlighted a statistically meaningful difference in implementation periods, no significant differences were observed in terms of type of intervention program and age variables. Although meta-analyses regarding the effects of math interventions on school age students are available, there are hardly any meta-analyses addressing early intervention programs for enhancing preschool and kindergarten children's math skills. The outcomes of the current study provided an evidence of the effectiveness of early intervention programs on math skills.

Keywords: Early intervention, mathematical skills, meta-analysis.

ÖZ: Erken müdahale, planlanan hizmetlerden fayda sağlayabilecek küçük çocukları desteklemeye yönelik yaklaşımları içerir. Bu çalışma, okul öncesi ve anaokulu çocuklarına yönelik Big Math for Little Kids, Building Blocks ve Prekindergarten Mathematics Müdahale programlarını sentezleyerek son 15 yılda deneysel çalışmaları içeren erken müdahale programlarının erken matematik becerilerini geliştirmedeki etkililiğini belirlemeyi amaçlamaktadır. 146 çalışma arasından deneysel çalışma, yayın yanlılığı, etki büyüklüğü, heterojenlik, müdahale programının aracı değişkeni, müdahale süresi ve katılımcı yaşları gibi dâhil edilme kriterlerini karşılayan 10 çalışma değerlendirilmiştir. Sonuç olarak, rastgele etkiler modeline göre ve Cohen'in sınıflandırmasına dayalı olarak müdahale programlarının etkililiğine ilişkin büyük bir etki büyüklüğü (Hedges'*g*=1.217) bulunmuştur. Moderatör analizleri sonuçları uygulama süreleri arasında istatistiksel olarak anlamlı bir farklılık ortaya koyarken, müdahale programı türü ve yaş değişkenleri açısından anlamlı bir farklılık gözlenmemiştir. Matematik becerilerine yönelik müdahalelerin ilkokul öğrencileri üzerindeki etkilerine ilişkin meta-analizler mevcut olmasına rağmen, okul öncesi ve anaokulu çocuklarının matematik becerilerini geliştirmeye yönelik erken müdahale programlarını ele alan meta-analizler neredeyse yoktur. Bu çalışmanın sonuçları, erken müdahale programlarının matematik becerileri üzerindeki etkililiğine dair bir kanıt sağlamıştır.

Anahtar kelimeler: Erken müdahale, matematik becerileri, meta-analiz.

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Mathematics is a powerful tool for understanding and exploring the world. The knowledge, skills and behaviors that children gain in the early childhood period form the basis of their future lives. Children need math skills in order to use analytical thinking and reasoning skills in the early childhood period. Analytical thinking refers to the ability to analyze cause-effect relationships in our environment and to think critically about the world (Brown et al., 2014). This skill has an important place in children's daily lives. Many skills in life, such as washing hands after the toilet and brushing their teeth before sleeping, require analytical thinking skills. In addition, mathematical concept development includes many cognitive processes involving early math skills such as perceiving similarities and differences, finding these similarities and differences, arranging, classifying, generalizing, counting and measuring skills (Kandir & Orcan, 2011). In fact, mathematics is not limited to numbers and figures. Mathematical words (such as hot, cold) are so common that they are often not even considered to belong to mathematics. Concepts such as "before", "soon", "later", "little", "in" and many more that are used dozens of times every day include math skills (National Council of Teachers of Mathematics [NCTM], 2010). Although mathematical development in the early childhood period shows individual differences, this development takes place in predictable stages. These stages include the skills of matching, classification, seriation, sorting and patterning. On the other hand, the concept of number appears as a prerequisite skill for many other math skills. It is necessary for children to have a good understanding of numbers in the early years so that they can learn mathematics in later years (Young & Loveridge, 2004). Therefore, it is clear that mathematics help preschoolers develop an understanding of spatial concepts, numbers and the ability to classify, sort and solve problems (NCTM, 2010). Moreover, there is a direct relationship between children's early math skills and their future academic success., higher grades, higher employment, and professional success (Harris & Petersen, 2019). Thus, gaining cognitive-based early math skills to young children is a strong predictive of later math achievement (Duncan et al., 2007). As in math success, some factors that influence math failure can begin to operate from an early age (Morgan et al., 2011). Therefore, early childhood math education is expected to meet the individual needs of students at different readiness stages, taking into account the effects of cultural backgrounds, previous experiences, learning styles, and cognitive abilities. Accordingly, it requires learning environments to be organized and orchestrated by teachers and other professionals (Björklund et al., 2020). As many children enter compulsory education with the need for early intervention, the importance of early intervention programs, supports and services for young children and their families is increasingly emphasized in early childhood (VanDerHeyden & Snyder, 2006). Quality interventions increase the chances of changing young children's developmental trajectories.

Early intervention is a term used to specify approaches to defining and responding to young children and their families who may profit from targeted services or supports to accelerate learning and growth (IDEA, 2004; as cited in VanDerHeyden & Snyder, 2006). Early intervention includes prevention rather than remediation, improving math learning for all young children, addressing the inequalities children face, and identifying young children who may need special help in participating meaningfully in early learning experiences (Clements & Sarama, 2009; VanDerHeyden

& Snyder, 2006). As the intervention programs, Big Math for Little Kids (BMLK), Building Blocks (BB) and Pre-K are included in this study as the programs that focus on math skills and are used in preschool and kindergarten children. BMLK is an intervention program developed by Ginsburg et al. (2003) to support the mathematical development of preschool children aged 61-72 months. It is a research oriented, well planned, comprehensive as well as entertaining math program. The program is to exploit the connections between young children's existing knowledge, experiences and skills, and their mathematical thinking involved in their daily experiences and other activities (Ginsburg et al., 2003). It ensures supporting opportunities for children to make mathematical explorations in an environment supported by rich as well as various stimuli. It purposes to help children reason and discuss their own explorations (Ginsburg et al., 2003). In the development of BMLK, the following principles of math curriculum were taken into account: (a) structuring children on their knowledge and interests; (b) integration with daily routine activities; (c) teaching and diversifying in a planned way; (d) supporting the development of complex mathematical ideas; (e) allowing them to use the language of mathematics; (f) supporting children to think like a mathematician; (g) allowing repetition (Greenes et al., 2004). The content of the BMLK curriculum consists of activities planned in six areas: numbers, shapes, measurement, patterns and reasoning, operations with numbers, position and direction relations (Morgenlander & Manlapig, 2006). Storybooks have been developed for each of these activities. The stories are designed to help children understand the deeper and bigger ideas associated with mathematical language. Children are given the opportunity to tell stories to each other, to complete the missing parts in the pictures, and to take the book home and read it with their families (Greenes et al., 2004). In line with the importance of early intervention in mathematics, there has been an increase in experimental studies on BMLK supporting math education in recent years (i.e., Altındag Kumas, 2020; Altındag Kumas & Ergul, 2021; Celik & Kandir, 2013; Kandir et al., 2017; Khomais, 2014; Kilickaya & Avci, 2021).

Developed by Sarama and Clements (2002) for young children aged 4-8, BB is a program designed by considering the mathematics standards developed by the National Council of Mathematics Teachers (NCTM, 2000). In the process of designing the program and materials, a research-based model was used. This model bases the instructional program and computer software program on a certain theoretical and empirical basis (Sarama & Clements, 2004). Considering this aspect, testing the effectiveness of the developed curriculum with experimental studies can be considered as another determinant of "research-based" status. In addition, the basic approach of BB is to reveal and develop mathematics from children's interests and experiences (Clements & Sarama, 2007). According to Sarama and Clements (2004), BB intervention program should: (a)be built on children's mathematical experiences; (b) provide a solid foundation for further mathematical studies; (c)deal with evaluation as an integral dimension of the learning process; (d) develop a strong conceptual framework that enables skill acquisition; (e) adopt the fact that children are doing math; (f) allow the development of children's reasoning abilities and mathematical thinking; (g) have an extensive content and; (h) be available for use of appropriate and continuous technology including computers and calculators. Some experimental studies evaluating the effectiveness of BB (i.e., Arteaga et al., 2019; Bojorquea et al., 2018; Clements &

Sarama, 2007, 2008; Sarama & Clements, 2002) have revealed positive effects on developing math skills in young children.

Pre-K was developed by Klein et al. (2002) in accordance with NCTM's standards. Pre-K is a support program arranged to improve the informal math knowledge and skills of preschool children (O'Dell, 2005). The primary goal of the program is to close the gap in mathematics achievement between children from low-income families and those from middle-class families (Klein et al., 2002). Pre-K was designed on a research basis and on the axis of sequence. Being research-based and sequence defines both the elimination of conceptual deficiencies in mathematics in children of low-income families and being associated with the development of mathematical concepts that they will need in formal mathematics education in primary school (Starkey et al., 2004). Pre-K program consists of activities organized in seven units related to mathematics. These are numbers and counting, understanding arithmetic operations, spatial perception and geometry, patterns, understanding arithmetic operations (higher level), measurement-data collection and reasoning (Klein et al., 2002). Based on these seven units, 32 small group activities and 21 home activities were designed. The activities have been prepared on the basis of children's interests and experiences and in a way that supports the development of mathematical thinking. The education program continues with both classroom activities involving manipulatives and painting completion activities at home. Home activities can be held in English or Spanish. Math concepts and skills presented in classrooms continue throughout the year as small group activities under teacher guidance. Children are presented with a new math activity twice a week as small group activities, and these presentations involve about 20 minutes of work with groups of 4 to 6 children. There are experimental studies showing that this program is especially effective on the math skills of economically disadvantaged children. In this regard, Nicoll (2007) stated that mathematical achievement levels of children from low-income families, where the Pre-K Program was applied for one year, reached almost the same level as the mathematics achievement level of middle-class family children who did not apply the program. Some experimental studies (i.e., Karakus, 2020; Kermani & Aldemir, 2015; Klein et al., 2011; Starkey et al., 2004) also revealed the effectiveness of the program.

Longitudinal studies of early math skills have indicated that they are definitive predictors of later math achievement (Braak et al., 2022; Navarro Soria et al., 2021, Ozcan & Dogan, 2018). Similarly, a meta-analytic study carried out Duncan et al. (2007) to reveal the strongest predictors of later achievement of preschoolers showed that early math skills came first as having the most considerable predictive power, followed by reading skills and then attention. On the other hand, a number of meta-analysis studies have focused on the effects of mathematics interventions on the mathematics achievement of school age students with diagnosed learning disabilities (i.e, Gersten et al., 2009; Kroesbergen & Van Luit, 2003; Methe et al., 2012; Swanson et al., 1999; Xin & Jitendra, 1999) or students at risk of math difficulties (Baker et al., 2002; Kunsch et al., 2007; Mononen et al., 2014). The literature review has clearly demonstrated that only two of these meta-analysis studies included preschool and kindergarten children's math skills (Malofeeva, 2005; Mononen et al., 2014). While the former meta-analysis study belonging to Malofeeva (2005) dealt with preschool and kindergarten children's mathematics learning, the latter belonging to Mononen et al.

(2014) included a meta-analysis of early numeracy interventions for preschool age children at risk for mathematics difficulties. However, a meta-analysis study to reveal the effect of intervention programs on early math skills of normally achieving preschoolers or kindergarteners has not conducted so far. Therefore, the aim of this study is to fill the research gap by synthesizing the studies using intervention programs within the context of the study designed to improve the early mathematics skills of normally achieving young children through meta-analysis.

Moderators a forehand in the current study include type of intervention program, duration of the intervention, frequency of application and participant's age. Early mathematics intervention programs exist to promote the development of basic math skills among young children in early childhood (Sarama & Clements, 2009). Thus, type of intervention program was defined as a program engaging young children in mathematical experiences. BMLK, BB and Pre-K intervention programs were considered as early intervention programs used to develop math skills. Duration of the intervention was based upon the time of intervention that each individual study reported. Durations were categorized as 6 weeks, 11 weeks, one semester and one school year. Frequency of application were categorized as 2 or 3 days in a week and every day in a week. Participant's age was defined as the age of the participant, as reported in the studies included. Age range was considered as 36-72 months, 48-72 months and 60-72 months for the study. These moderators are vital importance on effectives of intervention programs. This study will show us which type of intervention, duration, frequency and age are the most effective for children. Thus this study guides for policy makers, educators, teachers as soon.

The primary aim of this synthesis was to procure a systematic, extensive review of the present findings concerning the efficiency of early intervention programs (BMLK, BB and Pre-K) in developing early math skills. A secondary aim was to determine moderators of early intervention programs by investigating such possible moderators as type of intervention program, duration of the intervention, and participant's age. In this context, the following questions were included in the study:

1. What is the average/overall effect size level of the studies conducted between 2006 and 2021?
2. What effect does a type of intervention program have on early mathematical skills?
3. What effect does the duration of the intervention have on early mathematical skills?
4. What effect does age have on early mathematical skills?

Method

Meta-analysis provides a summary of data from a variety of quantitative studies by applying a structured and systematic process to provide more profound information than conventional qualitative descriptions (Lipsey & Wilson, 2001). In this regard, meta-analysis is a method of combining results of independent primary quantitative studies that share a similar subject area and performing a statistical analysis of the research findings obtained (Borenstein et al., 2009).

Data Collection

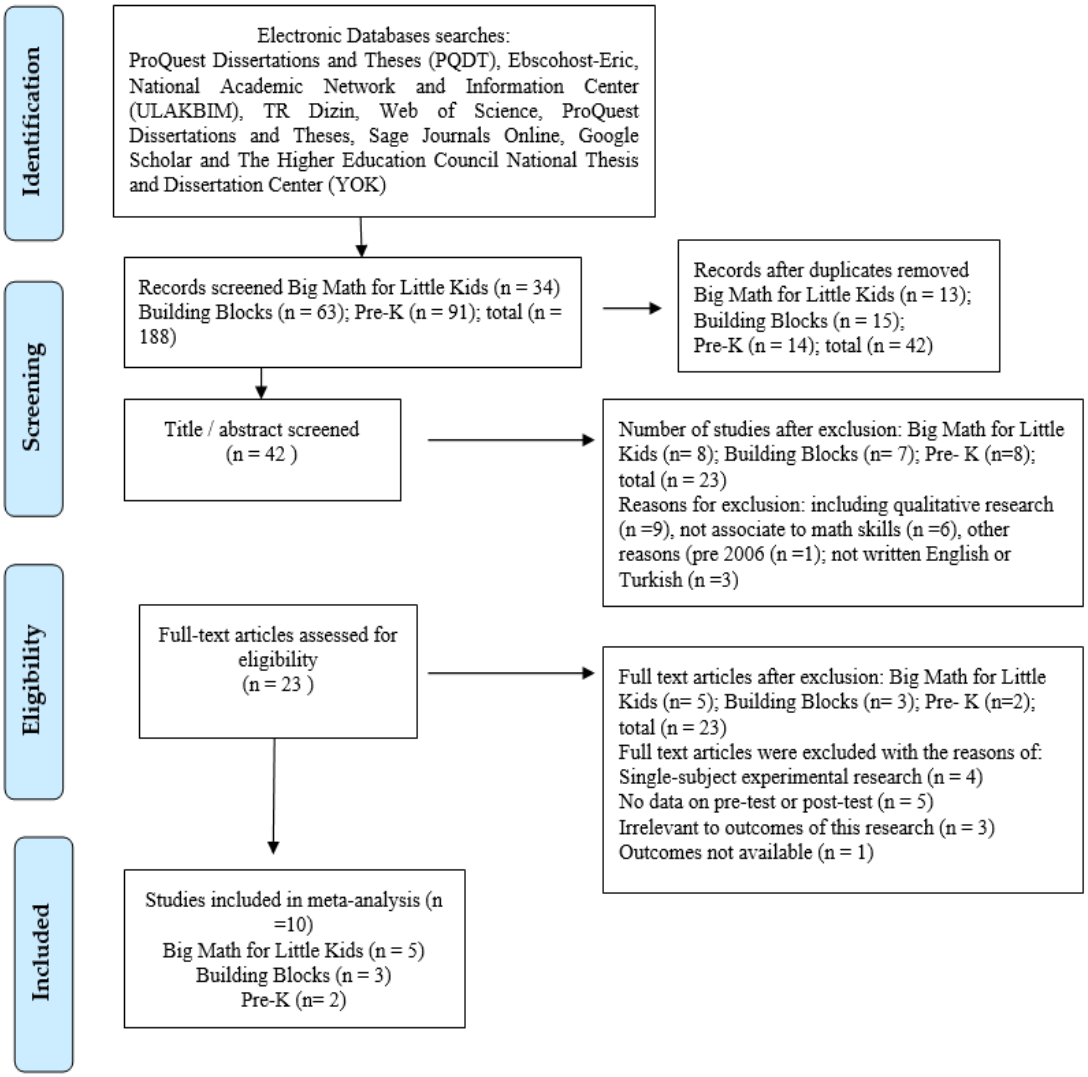
The studies on early intervention programs were detected in the databases of the Ebscohost-Eric, National Academic Network and Information Center (ULAKBIM), TR Dizin, Web of Science, ProQuest Dissertations and Theses, Sage Journals Online, Google Scholar and The Higher Education Council National Thesis and Dissertation Center (YOK) in January 2021. To obtain the relevant studies, the concepts of "early intervention programs" "use of early intervention programs", "intervention programs and preschoolers," "intervention programs and kindergartners", "intervention programs and effectiveness", and "intervention programs and early mathematical skills" were searched in the abstracts, index, and title search parts of the databases. As a result of the scanning, it was revealed that the studies gained intensity in three programs (The Big Math for Little Kids, the Building Blocks and The Pre-K). Therefore, electronic scanning was continued by including keywords "The Big Math for Little Kids and early mathematical skills", "The Building Blocks and early mathematical skills" and "The Pre-K and early mathematical skills". Then, all studies were sought out for inclusion of additional studies.

Inclusion and Exclusion Criteria

A set of inclusion criteria included: (1) The intervention programs of BMLK, BB and Pre-K used to develop preschoolers' or kindergartners' math skills. (2) Studies in which the recipients of the intervention were identified as normally achieving students. (3) Studies published in international peer-reviewed journals in English and non-English (Turkish) and unpublished theses and dissertations conducted in the last fifteen years (2006-2021). (4) Experimental studies that include sample sizes, and standard deviations, means or t-test values of both experimental and control groups belonging to pretest- posttest measurements. On the other hand, studies involving intervention programs other than these three programs, studies that were not used in mathematics, and studies that didn't meet other inclusion criteria of this study were excluded.

Figure 1

The Flowchart of the Literature Review Obtained According to the PRISMA Flow Diagram



Note. (Moher et al., 2009).

As a result of scanning the electronic databases indicated in Figure 1, a total of 188 studies, BMLK (*n*=34), BB (*n*=63) and Pre-K (*n*=91), were reached. After removal of 146 studies that did not meet the inclusion criteria or were duplicates, the remaining 42 studies were screened. The studies that used early intervention programs but did not address the effect on math skills, the studies that were conducted only qualitatively and the studies that were not written English or Turkish were excluded. Finally, 23 full text articles were evaluated for their eligibility and quality. Eleven studies that did not include required data for statistical calculations or relevant outcomes were excluded and the remaining 10 publications consistent with the inclusion criteria were included in the meta-analysis. The sample of this research consisted of 1081 participants from experimental (*n*=527) and control (*n*=554) groups.

Coding Method

Before statistical analysis of the studies involved in the research, a comprehensive coding form was developed to ensure the reliability and validity of this

study. A coding form containing two parts as "study identity" and "study data" was prepared (see Table 5, Appendix 1). In the "study identity" part; author information, study year, study type, and the name of the intervention program were included, while the "study data" part included the application period, population size and effect size calculations.

To obtain the coding reliability value, two independent coders were asked to review all research separately and to enlist the results to the final evaluation form. After that, the conformity of the form was checked over by comparing the evaluations of the two coders. The inter-rater reliability between the coders was calculated according to Miles and Huberman's (1994) formula [number of agreements/(number of agreements+disagreements)X100] and found 100% agreement.

Data Analysis

The data to be used in the meta-analysis were inputted into a Microsoft Excel Spreadsheet for coding and tabulation. In addition to percentage and frequency calculations, through the CMA (3.0) software program (Borenstein & Rothstein, 1999), statistical values (effect sizes with corresponding confidence intervals, *p*-values, *Q*-value, and I^2 values), effect size calculations according to random and fixed effects models, heterogeneity calculations and publication bias calculations were performed (Bax et al., 2007). Cohen's (1992) standards suggesting that ≤ 0.20 is considered a 'small' effect size, 0.50 is a 'medium' effect size and ≥ 0.80 is a 'large' effect size, were used as guidelines to categorize effect sizes.

Heterogeneity and Effect Sizes

The control of heterogeneity is one of the basic steps of meta-analysis studies. The heterogeneity test reflects the variation in study outcomes that goes beyond what is expected between studies included in the meta-analysis (Deeks et al., 2021). The classical measure of heterogeneity test is Cochran's *Q* test distributed as the Chi-square ($\chi 2$) statistic with degree of freedom (k-1). The *Q* value obtained in the meta-analysis is compared with the chi-square value corresponding to the k-1 degree of freedom. The fact that *Q* value is greater than the value in the chi-square table is interpreted as the studies involved in the meta-analysis indicate heterogeneous distribution. In addition, the p value being less than 0.05 indicates that the effect sizes included in the analysis are heterogeneously distributed (Sullivan & Feinn, 2012). The heterogeneity test (*Q* test) is stated to be statistically significant in the use of large samples by many researchers (Gavaghan et al., 2000). Conversely, *Q* test has low power especially in studies performed with small samples (Higgins et al., 2003). Unlike *Q* statistic, I^2 statistic is not influenced by the number of studies and allows to comment on the amount of variance. I^2, representing the ratio of variance owing to systematic differences (Shadish & Haddock, 2009), gives a distinct result for heterogeneity and shows the total variance ratio of the effect size (Petticrew & Roberts, 2006). In other words, while *Q* test only provides information about the presence or absence of heterogeneity, it does not provide information about the extent of heterogeneity. Therefore, the I^2 statistic has recently been used to measure the degree of heterogeneity in a meta-analysis (Huedo Medina et al., 2006). Effect sizes are the standard measurement values used to specify the power and direction of the studies involved in the meta-analysis (Borenstein et al., 2009). Fixed effects model (FEM) and random

effects model (REM) are employed to estimate effect sizes in the meta-analysis. FEM assumes that all studies in the meta-analysis share a common (real) effect size. The difference between studies is due to sampling error. In FEM, all factors that can affect effect sizes are similar across all studies, and therefore the real effect size is the same across all studies (Borenstein et al., 2009). REM presumes that all studies taking part in the meta-analysis have different real effect sizes. The difference between studies is not only due to sampling error but also due to the difference between studies (Field & Gillett, 2010). In cases where the researcher wants to generalize, REM is recommended especially in social sciences (Cumming, 2012; Field & Gillett, 2010). Due to heterogeneous distribution and being carried out in the field of social sciences, REM was taken into account in the interpretation of the effect sizes of the studies taking part in the present meta-analysis.

In meta-analysis studies, effect sizes belonging to intergroup differences are calculated with Cohen's d or Hedges'*g* formula (Borenstein et al., 2009). In the present research for the prediction of effect size, Hedges'*g* formula was used (Hedges & Olkin, 1985).

Results

Descriptive Data

The descriptive data of the studies are given in Table 1.

Table 1

Descriptive Data of the Studies in the Meta-Analysis

Study Variables		Frequency	Percent
Publication Year (*k* = 10)	2007-2014	2	20
	2015- 2021	8	80
Study Type (*k* = 10)	Doctoral Dissertations	2	20
	Research Articles	8	80
Intervention Program (*k* = 10)	BMLK	5	50
	BB	3	30
	Pre-K	2	20
Duration of the Experimental Process (*k* = 10)	6 weeks	2	20
	9 weeks*	1	10
	11 weeks	2	20
	One Semester	2	20
	One School Year	3	30
Age (*k* = 10)	36-72 Months	3	30
	48-72 Months	3	30
	60-72 Months	4	40

* Since there was only one study of 9 weeks, this study was not included in the analysis during the implementation period.

According to the descriptive data given in Table 1, there has been an increment in the number of experimental studies on the early mathematics skills of preschool children in the last 7 years. Of the studies, while 20% (*f*=2) were carried out between the years of 2007-2014, 80% (*f*=8) of them conducted between 2015 and 2021. On the other side, while 80% (*f*=8) of the studies were research articles, 20% (*f*=2) were doctoral dissertations. Of the studies, 50% (*f*=5) were regarding the use of BMLK, 30% (*f*=3) were BB and 20% (*f*=2) were Pre-K. According to the duration of the experimental process, it was determined that the time spent on the most experimental implementations was one school year (30%; *f*=3). This is followed by the 6 weeks (20%; *f* = 2), 11 weeks (20%; *f*=2) and one semester (20%; *f*=2) and 9 weeks (10%; *f*=1). With regard to age, while the most studies were conducted at the age range of 60-72 months (40%; *f*=4). Of the rest studies, 30 % (*f*=3) were carried out at the range of 36-72 months and other 30% (*f*=3) at the range of 48-72 months.

Heterogeneity Analyses

Heterogeneity analysis results of 10 studies are given in Table 2.

Table 2

Heterogeneity Analyses Results

Heterogeneity				Tau- Squared			
Q	df	*p*	I^2	τ^2	Standart Error	Variance	Tau
73.927	9	0.000*	87.826	0.345	0.203	0.041	0.587

*p< .05

As given in Table 2, the p value (p<.05), was first examined to evaluate the heterogeneity in the study and this result indicated that the 10 studies included in the analysis show heterogeneity with respect to effect size. *Q* statistic value conducted to determine homogeneity in meta-analysis studies was found to be 73.927. The effect size distribution was not homogeneous, since *Q* statistical value was observed to exceed the critical value of the chi-square distribution ($\chi 2$(.05)=16.92) at 9 degrees of freedom. On the other hand, I^2 value calculated for this study was 87.826 indicating a high level of heterogeneity. In accordance with the Higgins and Thompson (2002) classification, I^2 indicates 25% low, 50% medium, and 75% high heterogeneity. These results (Q=73.927, p<.05, I^2=87.826) show that the distribution is heterogeneous.

The Results of Analysis Models

Table 3 presents effect sizes of analysis models which are FEM as well as REM. In both approaches, all weighted effect sizes were significant than zero. In this research the *Q*-value is 73,927 and 9 degrees of freedom (p<.001). The result of alpha null hypothesis rejected and the true effect size is the same in all these studies. The I-squared statistic was found the value of 88%, which means some 88% of the variance in observed effects reflects variance in true effects. Because of these results REM was used in the current study.

Table 3

Results of the Overall Effect Size

Model type	*k*	Hedges'*g*	*SE*	95% Confidence Interval		*Z*	*p*	*Q-value*	*df*	I^2
				Lower	Upper					
FEM*	10	1.159	.067	1.09	1.29	17.413	.000	73.927	9	87.826
REM**	10	1.217	.203	.818	1.615	5.983	.000			

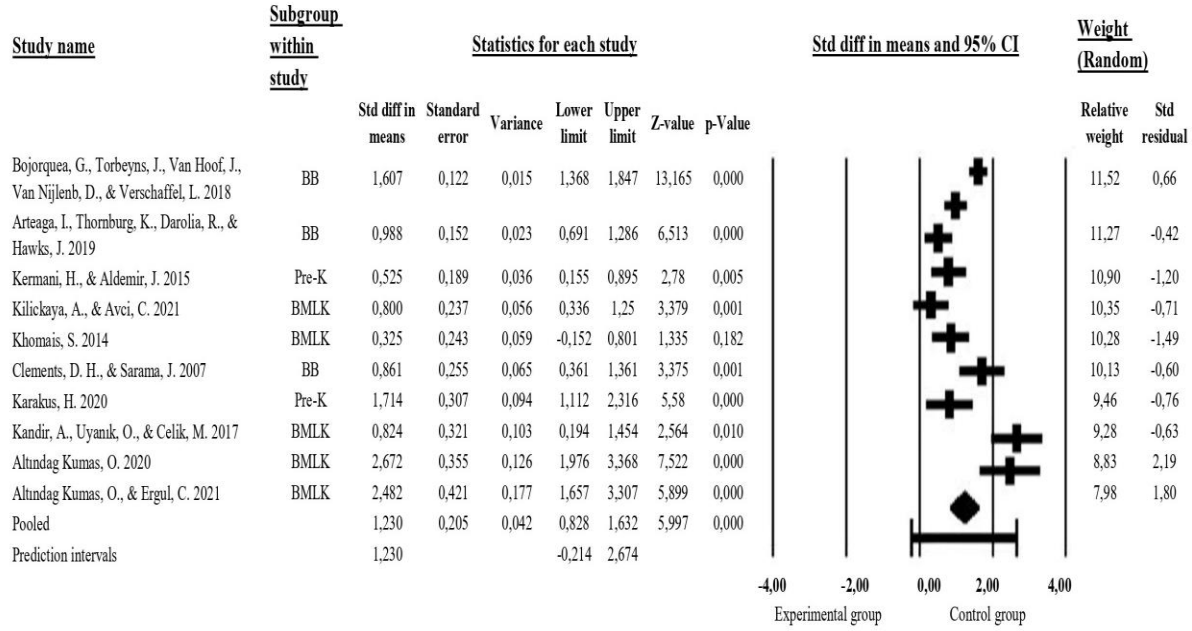
*Fixed Effects Model

**Random Effects Model

As given in Table 3, the overall effect size calculated according to REM was Hedges'*g*=1.217 with the standard error of .203. According to Cohen's (1992) classification, this effect size is a powerful positive value at a large level. For 95% of the confidence interval, the upper limit was 1.615 while the lower limit was .818. The test statistics results (Z=5.983, p<.001) revealed the statistical significance of the analysis. These results given in Table 3 indicate the existence of a positive, largely effective and significant (p<.05) effect in favor of using early intervention programs in developing preschoolers' or kindergartners' math skills. A forest plot for each of the studies taking part in the meta-analysis of the studies is given in Figure 2.

Figure 2

Forest Plot of the Studies



In Figure 2, the forest plot of the 10 studies within the scope of the meta-analysis includes Hedges'*g* effect sizes and confidence intervals of each study. Forest plots are a graphic interpretation of a meta-analysis results which denote studies with boxes and whiskers along a y-axis showing their effect size along the x-axis showing the lower and upper limits of the 95% confidence interval. When the 95% confidence interval from studies crosses the vertical line it means that intervention and comparator is not statistically significant and no effect on samples (Dettori et al., 2021). Weights are percentage values that indicates the individual study have how much influence on the overall effect. A summary point denoted with a diamond below the studies represents the overall pooled effect from the included studies. (Guddat et al., 2012). First of all, it whether there were outliers in the data set and it was determined that there were no outliers in the studies. 95% confidence interval of Khomais' study crosses the line of no effect and that is there is no clear differences between experimental and control groups in this study. Therefore, Khomais's study individually were not significant (p>.05). Other studies' 95% confidence interval do not cross the line of no effect and the result of these individual studies are significant (p<.05). In Figure 2, the pooled point estimate and 95% confidence interval lies entirely to the right of the line of no effect. Overall effect located at the bottom left which is .00 and 95% confidence intervals are .828 and 1.632. Since 95% confidence intervals do not cross the line of no effect and so the overall effect is significant (p<.05). The result show that there is a statistical difference in the outcome between groups and satisfaction favor the experimental group. While the widest range of confidence interval, with the effect size (Hedges'g=2.672) belonged to Altındag Kumas' study, the narrowest one (Hedges'g=.325) belonged to Khomais's study. Effect sizes of the studies are close to each other and overlap quite. Therefore, there is little to no study heterogeneity. Considering the weights of the studies, the result shows that the weight values are between 7.98 and 11.52. That is the influence of studies are individually similar on pooled result. In conclusion, as given in the forest plot, all the effect sizes of the studies have a positive effect that indicates the effectiveness of the use of early intervention programs is in favor of the experimental groups. Many variables involved intervention program play a role in the effectiveness of the intervention program mentioned above.

Moderator Analyses

Moderator analyzes can add a lot to meta-analyses as they provide clues as to the conditions that foster larger effects or for whom certain interventions may be more efficient (Bloch, 2014). Moderators in the current study include type of intervention program, the duration of the intervention, frequency of application and the participant's age (See Table 4). Due to the use of REM to assess overall effect sizes, heterogeneity test was performed to search the need for moderator analyses. Since the results confirmed the existence of heterogeneity the Q-value is 73.927 with 9 degrees of freedom and p<.001.

Table 4

The Results of Moderator Analyses

Moderators	Groups	Effect Size and 95% Confidence Interval				Test of Null		Heterogeneity		
		k	Hedge's *g*	Lower	Upper	*Z*-Value	*P* -Value	*Q*-value	df	*P*-Value
Type of Intervention program	BMLK	5	1.362	.509	2.216	3.128	.002			
	BB	3	1.173	.679	1.666	4.659	.000			
	Pre-K	2	1.082	-.063	2.227	1.852	.064			
	Tot. Betw. Overall	10	1.203	.803	1.604	5.894	.000	.191	2	.988
Implementation Periods	6 Weeks	2	0.627	.34	.914	4.282	.000			
	9 Weeks	1								
	11 Weeks	2	2.009	1.29	2.729	5.474	.000			
	One Semester	2	1.717	-.075	3.508	1.877	.06			
	One School Year	3	1.173	.679	1.666	4.659	.000			
	Tot. Betw. Overall	9	0.911	.679	1.144	7.679	.000	14.561	3	.002
Frequency of Application	Two or three days in a week	6	1.455	.863	2.047	4.819	.000			
	Every day in a week	4	0.902	.247	1.556	2.701	.007			
	Tot. Betw. Overall	10	1.206	.767	1.645	5.385	.000	1.512	1	.219
Age	36-72 Months	3	1.324	.423	2.225	2.879	.004			
	48-72 Months	3	0.936	.188	1.684	2.452	.014			
	60-72 Months	4	1.368	.758	1.978	4.395	.000			
	Tot. Betw. Overall	10	1.223	.805	1.642	5.726	.000	.830	2	.66

As given in Table 4, it was found that while studies used BB intervention program (*n*=3; Hedges'*g*=1.173, 95% CI [0.679, 1.666], *p*=.000) and Pre-K intervention program (*n*=2; Hedges'*g*=1.082, 95% CI [-0.063, 2.227], *p*=.064) had the smallest effect on mathematics learning outcomes, those used BMLK intervention program had the largest effect (*n*=5; Hedges'*g*=1.362, 95% CI [0.509, 2.216], *p*=.002) of the three programs. The overall effect size of all three programs were at a large level (Hedges'*g*=1.203) based on Cohen's (1992) classification. In addition, the inter-group homogeneity test results revealed that since the *Q* value (0.025) did not surpass the critical value of the chi-square distribution ($\chi 2$(.05)=5.99) at 2 degrees of freedom, the distribution was homogeneous. On the other side, no significant differences amongst the inter groups were detected (*p*=.988), indicating that these three programs don't have statistically significant overall effect sizes.

Studies with an implementation period of 11 weeks (*n*=2; Hedges'*g*=2.009, 95% CI [1.290, 2.729], *p*=.000) were found to have the largest effect while those with an

implementation period of 4-5 week (*n*=2; Hedges'*g*=0.212, 95% CI [-0.157, 0.581], *p*=.261) had the smallest effect. Studies with an implementation period of 12-14 weeks (*n*=3; Hedges'*g*=1.377, 95% CI [0.325, 2.428], *p*=.010) and one school year (*n*=3; Hedges'*g*=1.173, 95% CI [0.679, 1.666], *p*=.000) had also large effect in accordance with Cohen's (1992) classification. On the other hand, those with an implementation period of two months (*n*=2; Hedges'*g*=0.627, 95% CI [0.340, 0.914], *p*=.000) had a medium effect. In addition, the overall effect size was Hedges'g=0.723 that is regarded as large based on Cohen's (1992) classification. When the intergroup homogeneity test was analyzed according to implementation periods, the *Q* value was found to be 24.757. Since this value was larger than the chi-square distribution ($\chi 2$(.05)=9.488) at 4 degrees of freedom, it can be said that the distribution was heterogeneous. A statistically significant difference (*p*=.000) in favor of both two or three days in a week and every day in a week.

Table 4 also shows the frequency of application of the intervention programs. Studies with the frequency of application two or three days in a week (*n*=6; Hedges'*g*=1.455, 95% CI [0.863, 2.047], *p*=.000) and every day in a week (*n*=4; Hedges'*g*=0.902, 95% CI [0.247, 2.701], *p*=.007). In addition, the overall effect size was Hedges'*g*=1.206 that is regarded as large based on Cohen's (1992) classification. When the intergroup homogeneity test was analyzed according to frequency of application the *Q* value was found to be 3.841. Since this value was larger than the chi-square distribution ($\chi 2$(.05)=1.158) at 1 degrees of freedom, it can be said that the distribution was heterogeneous. A statistically significant difference (*p*=.000) in favor of the 11-week implementation period (Hedges'*g*=2.009) was observed.

In age moderator analysis, although all studies have a large effect, studies that included those aged 36-72 months (*n*=4; Hedges'*g*=1.147, 95% CI [0.569, 1.726], *p*=.000) and those aged 60-72 months (*n*=5; Hedges'*g*=1.116, 95% CI [0.440, 1.791], *p*=.001) had larger effect than studies involving those aged 48-72 months (*n*=3; Hedges'*g*=0.936, 95% CI [0.188, 1.684], *p*=.014). Besides, the overall effect size was Hedges'*g*=1.083. This value was also at a large level based on Cohen's (1992) classification. The intergroup homogeneity test results according to age revealed that since the *Q* value (0.204) didn't exceed the critical value of the chi-square distribution ($\chi 2$(.05)=5.99) at 2 degrees of freedom, the distribution was homogeneous. No significant differences occured amongst the inter groups (*p*=.903), indicating that overall effect sizes of these three groups are not statistically different.

The Reliability of the Study

While carrying out meta-analysis, it is substantial to evaluate for publication bias, which expresses the relationship between statistically significant study results and the probability of publication (Sterne & Harbord, 2004). Sutton (2009) stated that ignoring the effect of publication bias could potentially lead to inflated results. In order to examine publication bias, a funnel plot was used. Funnel plots (see Figure 3) are scatter plots that plot effect sizes with respect to the standard errors or a precision statistic.

Figure 3

Funnel Plot to Detect Publication Bias

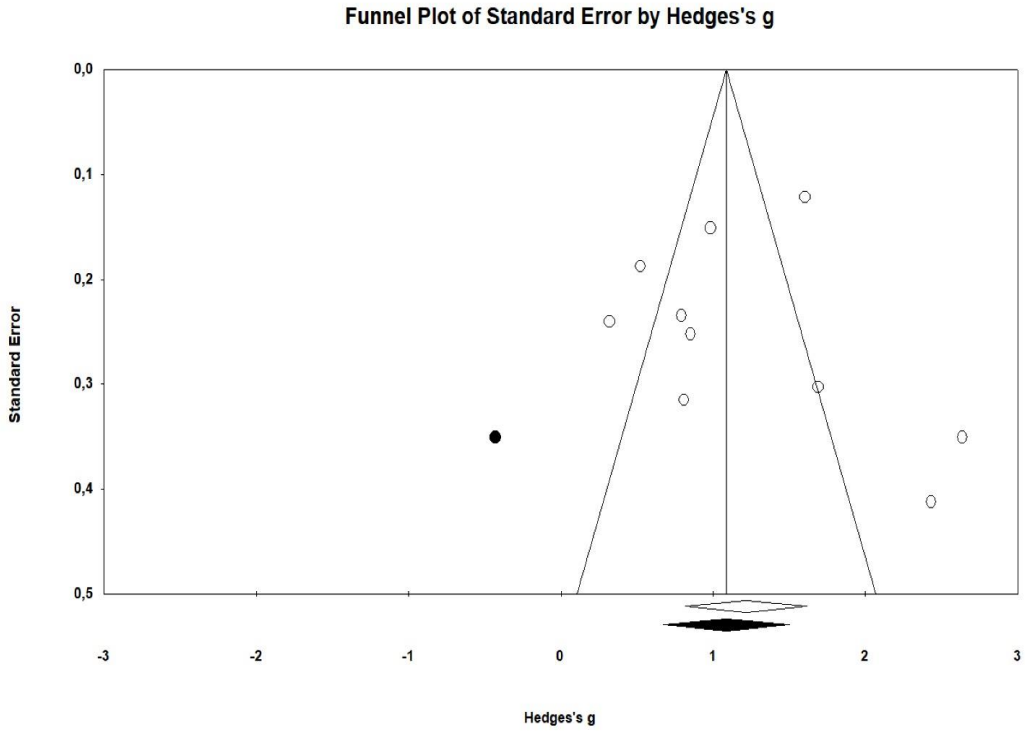


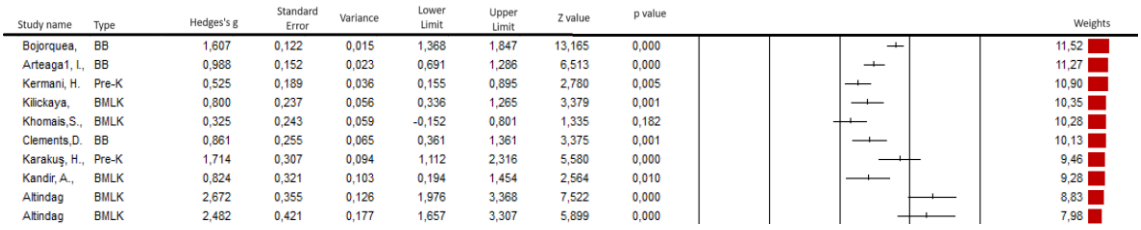
Figure 3 shows the visual inspection of the funnel plot. In this funnel plot, the majority of the plots are clustered symmetrically around the united effect size and towards the top of the plot. If publication bias does not occur, studies are anticipated to be distributed symmetrically around the combined effect size (Borenstein et al., 2009). If there is publication bias, then a higher concentration of studies belonging to smaller sample sizes will be seen at the bottom of the plot (Borenstein et al., 2009). The funnel plot indicates an outlier (Weber, 2009) and figure 3 shows that the funnel plot does not include the outlier. Therefore, it can be said that this funnel plot provides supportive evidence that publication bias is not a potential apprehension in the studies involved in the current research. In order to provide statistical tests to accompany the funnel plot, Egger et al. (1997), Begg and Mazumdar (1994) have developed tests that assess the relationship between sample size and effect size. Thus, each test is functionally similar to the funnel plot (Sterne et al., 2011). The results of Egger's regression tests conducted as a statistical method to test for asymmetry and bias were not statistically significant (95% confidence interval between -5.51333 lower limit and 6.70172 upper limit, Intercept=0.5942, t=0.22435 and p=.41405>0.5), showing that potential publication bias and asymmetry were not detected (Egger et al., 1997). According to Rothstein et al., (2005), "p value of 0.5 or less indicates that asymmetry is statistically significant" (p. 102). In Begg and Mazumdar (1994) test, the calculation of Kendall's tau b coefficient was made. The results (Tau b=.31; p=.105>.05) did not provide sufficient evidence of a positive correlation that exists in case of publication bias between effect size and variance. Consequently, Egger, Begg and Mazumdar values, which are not statistically significant, indicate that there is no publication bias (Sedgwick, 2013). A different approach to sensitivity analysis considers the 'fail-safe number' which was calculated to determine the extent to which publication bias could impact the entire results of the meta-analysis. The Fail-safe N ensures a statistic assessing the stability of study findings (Sutton, 2009). The Fail-safe N reports the number of additional studies,

especially those that were unpublished or not significant that would nullify the results (Carson et al., 1990). Mullen et al. (2001) claimed that according to $N/(5k+10)$ formula if the result greater than 1 the likelihood of publication bias would be low. In line with $N/(5k+10)$ formula 1327/(5.10+10)=1327/60=22.12, which is greater than 1 and so the result indicated lack of publication bias. In Rosenthal (1979) claimed that if $N_R>5k+10$, the probability of publication bias would be decreased. The Fail-safe N pointed out that 16.479 studies were required to nullify the present study's findings. Given the confined research in early intervention programs and particularly, early math skills for young children, it is improbable that a notable number of unpublished studies will be available. Further, 16.479 additional studies to nullify the results indicates that there would be no possible changes in the findings from the present study, even if they are newly discovered studies (Sutton, 2009). Orwin's Fail-safe N was also calculated to address publication bias. Orwin's Fail-safe N attempts to quantify publication bias by determining the number of unpublished studies with the mean effect size of zero that is required to be incorporated into the meta-analysis before the mean effect size reduces to a trivial magnitude (Orwin, 1983). Based on the results of Orwin's Fail-safe N, 1158 more studies with a mean risk ratio of 0.001 are required to be added to the analysis before the pooled effect size becomes insignificant. For additional studies, when the effect size value is changed from null to 0.005, a minimum of 1158 studies are needed to bring the overall treatment effect to non-significance. These results may be inferred that the estimate is unlikely to be compromised by publication bias. Finally, to evaluate if publication bias was present, trim and fill method, based on estimating the number of missing studies in the study and the effect of these missing studies on the entire outcome (Duval & Tweedie, 2000), was performed. This method allows studies that do not have symmetrical counterparts on the opposite side of the effect size estimation to be trimmed from the analysis and then, provides backfilling of matching studies on either side of the mean to obtain symmetry in the distribution. No studies were trimmed or deleted from the analysis because this sensitivity analysis showed that no studies were missing. Under REM, the point estimate for the combined studies was 1.217(CI95% .818, 1.615). Under FEM, no studies were also missing and the point estimate for the combined studies was 1.159(CI95% 1.029, 1.29). Since trim and fill completes the funnel plot to assess publication bias, it is reasonable to assume there is a low possibility of publication bias in the present results.

Sensitivity analysis is another way to prevent publication bias. Vevea and Woods (2005) carried out sensitivity analyses to across a stable range of parameters rather than estimating these parameters. The sensitivity parameters in the model are a glaring remnant of its initial intent to estimate these parameters as opposed to doing sensitivity analysis across preset parameters (Hedges, 1992). Sensitivity analysis was used to reveal for the influence of outliers (Thabane et al., 2013) by using 'remove one study' procedure of the CMA (Aleknaviciute et al., 2023).

Figure 4

Sensitivity Analyses Results

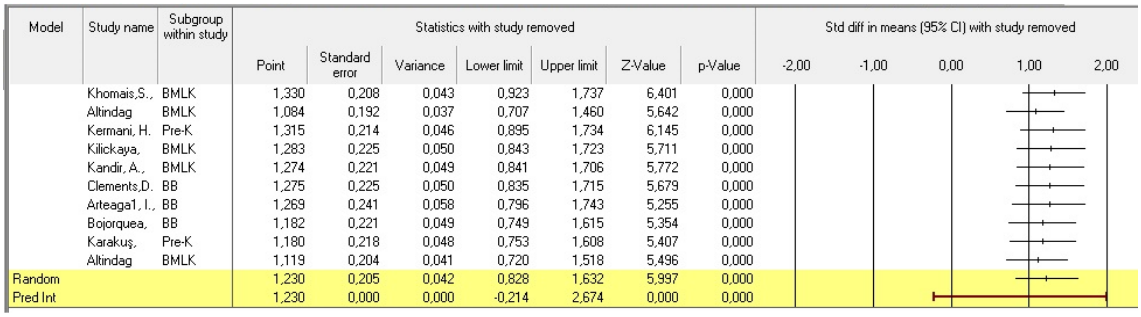


Study name	Type	Hedges's g	Standard Error	Variance	Lower Limit	Upper Limit	Z value	p value	Weights
Bojorquea,	BB	1,607	0,122	0,015	1,368	1,847	13,165	0,000	11,52
Arteaga1, I.,	BB	0,988	0,152	0,023	0,691	1,286	6,513	0,000	11,27
Kermani, H.	Pre-K	0,525	0,189	0,036	0,155	0,895	2,780	0,005	10,90
Kilickaya,	BMLK	0,800	0,237	0,056	0,336	1,265	3,379	0,001	10,35
Khomais,S.,	BMLK	0,325	0,243	0,059	-0,152	0,801	1,335	0,182	10,28
Clements,D.	BB	0,861	0,255	0,065	0,361	1,361	3,375	0,001	10,13
Karakuş, H.,	Pre-K	1,714	0,307	0,094	1,112	2,316	5,580	0,000	9,46
Kandir, A.,	BMLK	0,824	0,321	0,103	0,194	1,454	2,564	0,010	9,28
Altindag	BMLK	2,672	0,355	0,126	1,976	3,368	7,522	0,000	8,83
Altindag	BMLK	2,482	0,421	0,177	1,657	3,307	5,899	0,000	7,98

Figure 4 shows that how much weight was assigned to each study. Weights of studies are between 11.52 and 7.98. Any study exceeds more than 11 of the weight. That means any one study dominated the analysis. Every study gets at least 7% of the weight and so most of the studies played roles to predict to mean effect and heterogeneity. Therefore, basic conclusions are not depending on other studies.

Figure 5

The Results Effect Size When Studies Are Removed One By One



Model	Study name	Subgroup within study	Point	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
	Khomais,S.,	BMLK	1,330	0,208	0,043	0,923	1,737	6,401	0,000
	Altindag	BMLK	1,084	0,192	0,037	0,707	1,460	5,642	0,000
	Kermani, H.	Pre-K	1,315	0,214	0,046	0,895	1,734	6,145	0,000
	Kilickaya,	BMLK	1,283	0,225	0,050	0,843	1,723	5,711	0,000
	Kandir, A.,	BMLK	1,274	0,221	0,049	0,841	1,706	5,772	0,000
	Clements,D.	BB	1,275	0,225	0,050	0,835	1,715	5,679	0,000
	Arteaga1, I.,	BB	1,269	0,241	0,058	0,796	1,743	5,255	0,000
	Bojorquea,	BB	1,182	0,221	0,049	0,749	1,615	5,354	0,000
	Karakuş,	Pre-K	1,180	0,218	0,048	0,753	1,608	5,407	0,000
	Altindag	BMLK	1,119	0,204	0,041	0,720	1,518	5,496	0,000
Random			1,230	0,205	0,042	0,828	1,632	5,997	0,000
Pred Int			1,230	0,000	0,000	-0,214	2,674	0,000	0,000

The study of Altındag Kumas is the highest effect size. The 10 studys' overall effect size is 1.23. When the study of Altındag Kumas removed the mean effect size is 1.20. That is the effect size of 10 studies which is 1.23 as same as the effect size of 9 studies which is 1.20. This shows that if the one study removed the effect size will not change significantly. Any study in this research does not show the impact of outlier because when one study removed the effect size do not change.

Conclusion and Recommendations

In this study, a meta-analytical examination was applied to reveal the effectiveness of early intervention programs (BMLK, BB and Pre-K) in developing early math skills of young children. The results showed that intervention programs have a positive effect in developing math skills of young children and the effect is at large level (Hedges'*g*=1.082). This significant and positive effect has provided consistent result with the effect coefficients of the studies included in the analysis, which revealed that the effectiveness of early intervention programs on math achievement was in favor of the experimental group (i.e., Altındag Kumas, 2020; Altındag Kumas & Ergul, 2021; Arteaga et al., 2019; Bojorquea et al., 2018; Celik & Kandir, 2013; Clements & Sarama, 2007, 2008; Kandir et al., 2017; Khomais, 2014; Kilickaya & Avci, 2021; Papadakis et al., 2017). This result is also consistent with the results of the studies that were excluded

from the analysis (i.e., Ginsburg & Audley, 2020; Hamilton & Liu, 2018; Mwaura et al., 2008; Presser et al., 2015; Scalise et al., 2017; Sollom, 2021; Zippert et al., 2021). Similarly, this result coincides with the meta-analysis studies revealing the effect of early intervention programs on math achievement. For example, Codding et al. (2009) examined specific interventions that could be used with students identified as needing additional support in mathematics. The results revealed that these interventions were effective and had a large effect size. Another meta-analysis results by Codding et al. (2011) on mathematics fluency suggested that drill and practice with modeling produced the largest effect sizes. In Kroesbergen and Van Luit's (2003) meta-analysis study regarding mathematics interventions for elementary special needs students, the results yielded a large effect size indicating that the interventions were effective. Mononen et al. (2014) conducted a meta-analysis regarding early numeracy interventions in children aged four- to seven-years old at risk for math difficulties and included 19 peer-reviewed studies in their analysis. The interventions showed, to various degrees from moderate to large, the promoted effect in improving the early numeracy skills in at-risk children. The study by Malofeeva (2005), the only meta-analysis to address the mathematics learning of preschool and kindergarten children, yielded that on average, early mathematics instruction was effective for all intervention types and students.

On the other hand, according to the results of moderator analyses, a statistically significant difference was found in implementation periods. The highest overall effect size was observed in the 11-week implementation period (g = 2.009). Similarly, in Altındag Kumas and Ergul's (2021) and Karakus' (2020) studies, the time allocated for application of early intervention programs was limited to 11 weeks to assess early mathematical development of young children. In terms of type of intervention program and age variables, no significant differences were observed. In this regard, the meta-analysis results by Malofeeva (2005) indicated that none of the variables of the study such as number of weeks of treatment, age, and type of design were significant predictors. Considering the developments of children, it is thought that the effectiveness of very long-term programs decreases. In addition, when the content of the 11-week study, which was found to be effective as a result of the research. The program is more effective than 1 semester and 1 school year due to the fact that the application intensity is higher than the others. Researches assume that the intensity of intervention significant role on effectives of intervention programs rather than duration of intervention (Coban et al., 2023).

Although a number of studies have been conducted on the efficiency of early intervention programs on math achievement of young children, the meta-analytic review of these primary studies is quite limited. Most of these studies have focused on children diagnosed with learning difficulties or mental retardation. However, although this study has addressed normally achieving young children, it has some limitations. One considerable limitation is that only the studies involving any of the three early intervention programs of BMLK, BB, and Pre-K were included in the current meta-analysis. In this regard, studies that examined the effectiveness of these early intervention programs were included. Second limitation is that this study focused on math skills rather than effective educational techniques used. Additionally, only the use of these programs in the studies was taken as a basis, without limiting the use of a

specific data collection tool. Third limitation is that early math skills were addressed here as counting, comparison, classification, enumeration, computation, and measurement skills expressed in the studies within the scope of this meta-analysis. Therefore, estimation, writing numerals, geometry and fractions were not emphasized. One more limitation is that studies that include the development of language skills as well as early math skills and that compare the development of these two skills were excluded. The last limitation is that the current study carried out type of intervention program, the duration of the intervention, and the participants' age as moderators. More various moderators can be considered in future studies.

Implications

The outcomes of the current study provided an evidence of the effectiveness of early intervention programs on math skills. No notable differences were found among the early intervention programs and age groups considered in this study. However, a significant difference was found in favor of the 11-week implementation period. It is possible to include some implications for future research within the scope of this synthesis. Although early intervention studies in math with younger children do exist, relatively few studies have focused on enhancing the early math skills of normally achieving young children. Therefore, more empirical research of early intervention on normally achieving young children are required in the future. The intervention programs may have planned according to short term rather than one semester and one school year. This creates advantages in terms of saves time, resources and workforce. Although meta-analyses regarding the effects of math interventions on school age students are available, there are hardly any meta-analyses addressing early intervention programs for enhancing preschool and kindergarten children's math skills. In this regard, more early intervention meta-analyses to promote the learning of this age group and to meet their needs in acquiring important skills such as math or language skills is needed in the future. On the other hand, future meta-analysis research may compare the contribution of early intervention programs to the development of math skills in children of this age group with their later achievement in the first or second grades of primary school.

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Statement of Responsibility

Conceptualization: [Ensar Yıldız]; Methodology and validation: [Şenel Elaldı & Ensar Yıldız]; Formal analysis and investigation: [Şenel Elaldı & Ensar Yıldız]; Writing - original draft preparation: [Özge Koca]; Writing - review and editing: [Özge Koca]; Supervision: [Şenel Elaldı]

Conflicts of Interest

No potential competing interest was reported by the authors.

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Note: *One asterisks (*) was used for the studies involved in the meta-analysis.*

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The Relationship Between Teachers' Digital Literacy Levels and Research Literacy Skills*

Öğretmenlerin Dijital Okuryazarlık Düzeyleri ile Araştırma Okuryazarlığı Becerileri Arasındaki İlişki

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ABSTRACT: In the information age, individuals' ability to access, use, and transfer information is fundamental for personal and professional success. Digital and research literacy are critical skills that strengthen teachers' professional competencies in contemporary educational processes. This study examines the correlation between teachers' proficiency in digital literacy and their proficiency in research literacy. A quantitative research approach is utilized, employing a relational survey design. The study sample consists of all subject-area educators who are employed in a central district within the eastern region of Türkiye. A total of 604 teacher participated in the study online Data gathering entails the utilization of a "Personal Information Form" devised by the researchers, in conjunction with the "Digital Literacy Scale" and "Research Literacy Scale," all of which have undergone meticulous testing to ensure their validity and reliability. According to normality analyses, the data are not normally distributed. Mann-Whitney U, Kruskal-Wallis H tests, Spearman Correlation Analyses were used as analyses The findings reveal substantial disparities in the digital literacy skills of instructor based on demographic parameters including gender, department, age, computer ownership, and daily internet usage time. Likewise, there are differences in instructors' research literacy skills based on gender, level of education, and ownership of computers. Moreover, a strong positive association is seen between digital literacy and research literacy skills, suggesting that when one ability improves, the other skill also improves. These findings emphasize the importance of addressing digital and research literacy in teachers' professional development processes.

Keywords: Digital literacy, research literacy, literacy, teachers.

ÖZ: Bilgi çağında, bireylerin bilgiye erişme, bilgiyi kullanma ve aktarma becerileri kişisel ve mesleki başarı için temel önem taşımaktadır. Dijital ve araştırma okuryazarlığı, çağdaş eğitim süreçlerinde öğretmenlerin mesleki yeterliliklerini güçlendiren kritik becerilerdir. Bu çalışma, öğretmenlerin dijital okuryazarlık becerileri ile araştırma okuryazarlığı yeterlilikleri arasındaki ilişkiyi incelemeyi amaçlamaktadır. Nicel araştırma yaklaşımının kullanıldığı çalışmada ilişkisel tarama modeli kullanılmıştır Çalışmanın örneklemi, Türkiye'nin doğu bölgesindeki bir merkez ilçede görev yapan tüm branş öğretmenlerinden oluşmaktadır. Çalışmaya toplam 604 öğretmen çevrimiçi olarak katılmıştır. Verilerin toplanmasında araştırmacılar tarafından geliştirilen "Kişisel Bilgi Formu" ile geçerlilik ve güvenilirliği titizlikle test edilen "Dijital Okuryazarlık Ölçeği" ve "Araştırma Okuryazarlığı Ölçeği" kullanılmıştır. Normallik analizlerine göre veriler normal dağılmamaktadır. Analizlerde Mann-Whitney U, Kruskal-Wallis H testleri ve Spearman Korelasyon Analizleri kullanılmıştır. Bulgular, cinsiyet, bölüm, yaş, bilgisayar sahipliği ve günlük internet kullanım süresi gibi demografik parametrelere dayalı olarak öğretmenlerin dijital okuryazarlık becerilerinde önemli farklılıklar olduğunu ortaya koymaktadır. Benzer şekilde, öğretmenlerin araştırma okuryazarlığı becerilerinde de cinsiyet, eğitim düzeyi ve bilgisayar sahipliğine dayalı farklılıklar bulunmaktadır. Ayrıca, dijital okuryazarlık ve araştırma okuryazarlığı becerileri arasında güçlü bir pozitif ilişki görülmekte, bu da bir beceri geliştiğinde diğer becerinin de geliştiğini göstermektedir. Bu bulgular, öğretmenlerin mesleki gelişim süreçlerinde dijital okuryazarlık ve araştırma okuryazarlığının ele alınmasının önemini vurgulamaktadır.

Anahtar kelimeler: Dijital okuryazarlık, araştırma okuryazarlığı, okuryazarlık, öğretmenler.

* This study is adapted from a master's thesis completed in 2021.

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The features brought by the new era are more than just storage; the practical emergence of features and, as a result, their genetic use and the production of new information have become important. Changing and developing technology: The methods of accessing information have changed the methods used in storing and transferring the acquired information (Albion et al., 2015), and different methods (browsers, databases, etc.) have become important United Nations Educational, Scientific and Cultural Organization [UNESCO] (2017).

The teaching profession is the basis of social change and development (Mikkilä-Erdmann et al., 2019). For this reason, it becomes mandatory for teachers to keep up with technological developments (Escudero et al., 2019) and evaluate information using various methods. (Admiraal et al., 2017). Educators should be trained by considering what the age brings (Seferoğlu, 2001). The education provided by well-trained teachers before and during the service will ensure the training of a qualified workforce that ensures the development of society (Mutlu & Erdem, 2013; Seferoğlu, 2001). At this point, teachers need to have these competencies. Only by developing these skills can teachers maintain their professional progress and benefit their students (Rodriguez-Gomez et al., 2018). The utilization of computer-based technology in the global information society has been steadily rising daily. As a result, information and communication technologies in educational institutions have also come to the agenda (Starkey, 2016). Teachers' digital literacy skills are essential in keeping up with these changes (JISC, 2018; Kaufman, 2014; Lund et al., 2014).

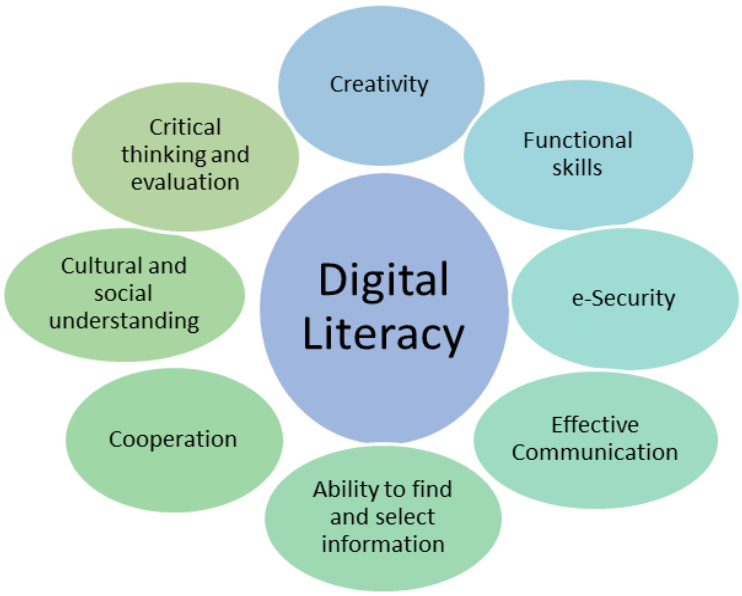
Educational research is essential for obtaining valid and reliable experiences free from personal illusions (Tatto & Furlong, 2015). Therefore, in the interest of all groups affected by education, teachers who shape society have adequate skills in the emergence of scientific experiences (Holincheck, 2012). In line with 21st-century requirements (Akın & Solmaz, 2019; Shidiq & Yamtinah, 2019), education and training in a scientific way can only be done with teachers with high research skills (Christie et al., 2012). Instead of providing students with access to knowledge (Kılıç, 2006) and transferring knowledge, teachers take the task of guiding students in accessing knowledge (Gömleksiz & Fidan, 2013) and making students active in this process (Ulvik, 2014). Therefore, it can be said that teachers should be good research-literate (Boyd, 2021).

Digital Literacy

Digital literacy refers to proficiency in utilizing various sources to retrieve information (Hutchinson & Novotny, 2018), to make connections between the information accessed, and to have the necessary functional and digital skills to access information (Polizzi, 2020). Digital literacy is understanding and using large-scale multimedia information presented through computers (Knobel & Lankshear, 2006). Digital literates should be able to access digital content in digital environments and should be individuals who can make decisions on sites with simulations, multimedia and interactive graphics by interacting with links (Hamutoğlu et al., 2017; Pérez-Escoda et al., 2019; Zhang et al., 2023). Digitally literate individuals should be able to choose the right tools to share information and transfer information to others effectively and safely. (Hague & Payton, 2010). Figure 1 shows the components which form the basis of digital literacy and are related to each other.

Figure 1

Elements of Digital Literacy (Hague & Payton, 2010)



It is seen that digital literacy, which has become an indispensable element of daily life with its components, has attracted more attention in Türkiye after 2005 with applications such as the Ministry of National Education's Opportunities Enhancement and Technology Improvement Movement (FATİH) Project (Ministry of National Education [MoNE], 2017). MoNE emphasized the importance of teachers training this skill in digital literacy (Kulaca, 2023). With digital literacy skills, teachers can transform students from consumer mode to active and creative students by using different types and forms of multimedia (List, 2019). In addition, digital tools facilitate the teaching and learning process by improving two-way communication between teachers and students (Mellati & Khademi, 2020).

According to the literature review, many studies have been done on digital literacy in recent years. When the domestic and foreign studies on technology use and digital literacy are examined; in the study groups, parents (Öçal, 2017), secondary school students (Kulaca, 2023), high school students (Kaya, 2020), education faculty students (Kara, 2021; Kartika et al., 2021; Kozan & Özek, 2019; Özerbaş & Kuralbayeva, 2018; Üstündağ et al., 2017; Utama & Nurkamto, 2019) and teachers from different subject groups (Allen & Berggren, 2016; Arslan, 2019; Cote & Milliner, 2018; Goh & Sigala, 2020; Kibici, 2022; Kilincer, 2021; Korkmaz, 2020; Potyrała & Tomczyk, 2021). In the studies conducted with teachers, it is generally understood that teachers perceive their digital literacy skills adequately. While it is seen that gender, age, seniority, and educational status variables are included in the studies, variables such as department, having a computer, and daily internet usage time are included in a few studies. Since there is a need for studies to include these variables, this research is expected to make a valuable contribution to the existing body of literature.

Research Literacy

According to O'Brien and Rugen (2001), research literacy is the capacity to carry out new research without referencing the outcomes of earlier studies that have been analyzed and concluded. Evans et al. (2017) define it as the ability of individuals

to engage in active research. Research literacy encompasses not just cognitive abilities such as creativity, critical thinking, and problem-solving, but also the capacity of individuals to actively and proficiently engage with their surroundings (Lillejord & Børte, 2016; Westbury et al., 2005). Yıldız et al. (2019) state that persons who possess research literacy are anticipated to effectively handle all research procedures about their specific area of knowledge.

Educators assume the duty of nurturing the next generation in the process of teaching and training. In many countries, teachers and pre-service teachers are expected to make research-based, professional, and personal choices and develop inquiry-based thinking skills as part of their 21st century skills. This expectation for teachers and pre-service teachers is clearly expressed in Finland (Niemi, 2016), Türkiye (Görgülü-Arı & Arslan, 2020; Kazancı-Tınmaz & Sezgin, 2023; Kır-Yiğit & Özalemdar, 2022; Velioğlu & Özdemir, 2023; Yıldız et al., 2019) Norway and Ireland (Conway & Munthe, 2014), China (Cui et al., 2023; Liu et al., 2024). It discussed how research literacy can influence teacher education in developing a way of thinking. (Eriksen & Brevik, 2023). Research literacy is more than engaging with research through research-based education (Waring & Evans, 2014). To ensure the development of research literacy in education and teacher training institutions, it is argued that there should be an emphasis on linking research and education by actively involving students in research (Shank & Brown, 2013). Instructors and pre-service instructors must possess research literacy (Furlong, 2015) to effectively guide their students in conducting research.

The correct evaluation of the information obtained from educational practices is possible with the researcher's teacher behavior, who knows the school's functioning and the students. According to Bilgili (2005), teachers who conduct research shape their behaviors, and beliefs in classroom practices according to research results. This situation is seen as a reform for teacher education. The fact that teachers have a research structure contributes to them giving the right direction to the teaching process, implementing new strategies to be used in the classroom and gaining competencies for solving the problems experienced (Cain & Allan, 2017).

For a considerable amount of time, several countries have enforced laws about research literacy (British Educational Research Association [BERA], 2014; Organisation for Economic Co-operation and Development [OECD], 2007) and have accentuated the significance of research-based methodologies. However, further research is needed to determine Turkish teachers' level of research literacy. Furthermore, studies demonstrate the beneficial effects of teachers' involvement in research on students' education (Cordingley, 2015; Crain-Dorough & Elder, 2021; Evans et al., 2017; Rose et al., 2017). According to systematic reviews, student results are positively impacted by instructors' involvement in research (Bell et al., 2010; Heikkilä & Eriksen, 2024).

In the literature, it has been determined that many studies have been conducted on research literacy with pre-service teachers (Aşiroğlu, 2016; Çakmak et al., 2015; Dombaycı & Ercan, 2017; Groß-Ophoff et al., 2017; Gyurova, 2020; Küçükoğlu et al., 2013; Kürşad, 2015; Taşdemir & Taşdemir, 2011). Studies conducted with teachers are limited, especially in Türkiye (Baş & Kıvılcım, 2017; Görgülü-Arı & Arslan, 2020; Sadıç, 2019), while there are more studies on this subject abroad (Bell et al., 2010; Booher et al., 2020; Katayev et al., 2023; Koshmaganbetova et al., 2020; Kostoulas et

al., 2019; Nikola, 2021; Roman, 2021; Syahrial et al., 2022; Waite & Davis, 2006; Williams & Coles, 2007). The scarcity of studies investigating research literacy in Türkiye hinders comparing studies.. In similar concepts such as research skills, attitudes towards educational research, and research competencies, it is seen that studies in which variables such as age and gender of teachers were used in the study. At the same time, the differentiation according to departments is determined were very few in the literature. The study is essential in associating variables such as having a computer and daily internet usage time with research literacy and examining differences according to departments.

Importance of Study

Compared to the studies in the literature, this study addresses different variables in digital literacy and research literacy skills. This study is expected to enhance the existing literature by examining the correlation between these two forms of literacy. In addition, since the limited number of studies examining research literacy makes it difficult to compare studies, this study is considered significant. This study is thought to inform teachers from all departments about the significance of digital literacy and research skills. The subject and findings of the study are also considered significant for teacher training institutions, as they will guide them.

Purpose of the Study

This research investigates digital literacy proficiency and research literacy competencies among educators. The research problem "Is there a significant relationship between teachers' digital literacy levels and research literacy skill levels?" is determined as the problem statement of the research.

Based on this problem, the following sub-problems were formed:

1. Do teachers' digital literacy levels significantly differ according to gender, departments, age, having a computer and daily internet usage time?
2. Do teachers' research literacy skill levels significantly differ according to gender, educational level, and having a computer?
3. Is there a significant relationship between teachers' digital literacy levels and research literacy skills?

Method

Research Model

This study is a relational survey, a type of quantitative research method. Quantitative research aims to reach facts through description or causality by measuring events externally, experimenting, or observing (Creswell, 2014; McMillan & Schumacher, 2010). This study used the relational survey model to determine the current situation and reveal the relationship between variables.

Study Group

The study population consists of teachers working in a province east of Türkiye. According to the official data announced by the Provincial Directorate of National Education, in 2021, teachers from various specialties were working in schools in the

central district. The study's sample was determined by convenient sampling, which is one of the non-random sampling methods. The convenience sampling method to select the sample from easily accessible and applicable units due to limitations such as time, cost, and labor force (Büyüköztürk, 2010). Six hundred-four teachers participated in the study. Gender, department, education level, and age variables of the teachers were considered.

Data Collection Tools

Personal Information Form

The researcher has devised a "Personal Information Form" to collect data voluntarily provided by educators participating in the study. This form gathers information regarding participants' gender, age, department, educational background, computer ownership status, and daily internet usage habits. The distribution of teachers in the sample participating in our research according to different variables is given in.

Table 1

Distribution of the Sample by Various Variables

Variable		*f*	%
Gender	Female	344	57
	Male	260	43
Education level	Undergraduate	535	88.6
	Postgraduate	69	11.4
Year	21-30 years old	354	58.6
	31-40 years old	195	32.3
	41 years and above	55	9.1
Departments	Language departments	41	6.7
	Art/Sport	70	11.5
	Numerical departments	111	18.3
	Verbal departments	176	29.1
	Class departments	206	34.1
Having a computer	Yes	535	88.6
	No	69	11.4
Daily İnternet Usage Time	Less than 1 hour	20	3.3
	1-2 hours	153	25.3
	3-5 hours	262	43.3
	Over 5 hours	169	27.9
Total		604	100

57% of the teachers participating in the study were female and 43% were male. It is seen that more than half of the teachers participating in the research are between the

ages of 21-30. Most of the teachers participating in the research are classroom teachers. Most of the teachers have a computer. 43% of the teachers use the internet 3-5 hours a day.

Digital Literacy Scale

The scale created by Hamutoğlu et al. (2017) is divided into four different domains: attitude, cognitive capacity, technical knowledge, and social interaction and consists of 17 items. It is a modified version of Ng's (2012) first scale. The 5-point Likert scale does not have any items that are scored in the opposite direction. The study included both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to assess convergent validity. The overall score had a high level of internal consistency as indicated by the Cronbach's alpha value of .93. When the fit indices of the CFA model were analyzed, a statistically significant minimum chi-square value ($\chi 2$=268.45, *Sd*=113, *p*=0.00) was found. However, other indices such as RMSEA, GFI, AGFI, CFI, NFI, NNFI, and SRMR indicated a satisfactory or acceptable fit. In this study, Cronbach's alpha coefficient of the scale was .84.

Research Literacy Scale

The scale developed by Yıldız et al. (2019) assesses educators' competencies in research literacy. Exploratory factor analysis was performed, and as a result, the Research Literacy Skills (RLS) scale, which consisted of 26 items, was developed. The reliability of the scale was evaluated using Cronbach alpha, Spearman-Brown, and Guttman Split Half tests, and it was found to be reliable with a result of .898. The scale covers four dimensions: conduct of the study, rationale for conducting the research, understanding of the research methodology, and accessibility of resources. The results of the confirmatory factor analysis of the scale: chi-square 696,296, degrees of freedom, 288 (*p*=.00), chi-square/degree of freedom=2.418, the goodness of fit index GFI .912, comparative fit index CFI .953, adjusted fit index AGFI .892, root mean square of approximate errors RMSEA .052 and root mean square of standardized residuals SRMR .043.In the study, Cronbach's alpha coefficient of the scale was found to be .82.

Data Collection

In the implementation of this research, Firstly, the necessary permissions were obtained for the Digital Literacy Scale, Research Literacy Scale, and Personal Information Form. The researcher converted the data collection tools into an online application format, and data were collected over approximately three months

Analysing the Data

In this inquiry, the first phase evaluates whether the data conform to a normal distribution. The data is assessed for normality using various statistical tests such as the Kolmogorov-Smirnov and Shapiro-Wilk tests and by examining the arithmetic mean and median values. While interpreting the results, the confidence interval was accepted as 95%. When looking at the results obtained from Kolmogorov-Smirnov and Shapiro Wilk tests, if $p>.05$, it was accepted that the distribution was normal, and $p<.05$ was accepted that the distribution was not normal (Tabachnick & Fidell, 2007). Based on these analyses, it is concluded that the data does not follow a normal distribution.

In the analyses, the Mann-Whitney U test, one of the nonparametric tests used in non-normal distributions, examines the significant difference between a two-category variable and a continuous variable. Kruskal Wallis H analysis examined the significant difference between a continuous variable and a variable with more than two categories. Finally, we test the direction and level of the relationship between the two scales with Spearman Correlation Analysis.

Results

The total mean value of the teachers' Digital Literacy Scale is 4.09, and the total mean value of the Research Literacy Scale is 4.15. Table 2 gives the results of the Mann-Whitney U test to determine whether the digital literacy levels of teachers differ according to gender.

Table 2

Mann-Whitney U Test Results for the Examination of Teachers' Digital Literacy Levels According to Gender Variable

	Gender	*n* (604)	Mean Rank	Sum of Ranks	*U*	*p*
Attitude	Female	344	315.13	108404.50	40375.500	.040
	Male	260	285.79	74305.50		
Technical	Female	344	287.49	98896.50	39556.500	.015
	Male	260	322.36	83813.50		
Cognitive	Female	344	316.23	108781.50	39998.500	.022
	Male	260	284.34	73928.50		
Social	Female	344	288.83	99358.50	40018.500	.024
	Male	260	320.58	83351.50		
Total	Female	344	299.88	103159.50	43819.500	.671
	Male	260	305.96	79550.50		

Upon scrutinizing Table 2, which presents the results of the Mann-Whitney U Test concerning the digital literacy levels of participating teachers categorized by gender, no statistically significant disparity is observed in the overall scale score (p>.05). However, upon further examination of the sub-dimensions, it becomes apparent that women's rank mean values significantly differ in the attitude and cognitive dimensions of the digital literacy scale (p<.05), whereas men's rank mean values significantly differ in the technical and social dimensions (p<.05). Kruskal-Wallis H results for the examination of teachers' digital literacy levels according to the department variable are given in Table 3.

Table 3

Kruskal-Wallis H Test Results Regarding the Examination of Teachers' Digital Literacy Scale According to Department Variable

	Departments	*n* (604)	Mean Rank	*df*	X^2	*p*	Significant difference
Total	1. Language departments	41	354.89	4	9.497	.048	1>4, 5>4
	2.Art/Sport	70	291.42				
	3. Numerical departments	111	314.97				
	4. Verbal departments	176	275.28				
	5. Class departments	206	312.37				

English and German teachers are included in the language departments group, music, painting, and physical education teachers in the art/sport departments group, mathematics, science, physics, chemistry, biology, and information technologies teachers in the numerical departments group and the remaining branches in the verbal group. The Kruskal-Wallis H Test was conducted to assess whether there were variations in digital literacy levels across different departments, yielding a significant difference between the groups' rank averages in the overall score of the digital literacy scale (X^2=9.497, p<.05). Further pairwise comparison tests revealed that the mean ranks of teachers from language departments (354.89) were significantly higher than those from verbal departments (275.28), and the mean ranks of classroom departments (312.37) were also significantly higher than those of verbal departments (275.28) in the total mean ranks of the digital literacy scale. Kruskal-Wallis H results for the examination of teachers' digital literacy levels according to age variable are given in Table 4.

Table 4

Kruskal-Wallis H Test Results for the Examination of Teachers' Digital Literacy Levels and Sub-Dimensions According to Age Variable

Survey	Classified Age	*n* (604)	Mean Rank	*df*	X^2	*p*	Significant difference
Total	1.21-30	354	318.41	2	8.584	.014	1>2 1>3
	2.31-40	195	287.07				
	3.41 and above	55	254.81				

Kruskal Wallis H Test was performed to test whether the digital literacy levels of the teachers differed according to the age variable in total. It is understood that there is a significant difference between the rank averages of the groups in the total digital literacy scale (X^2=8.584, p<.05). As a result of the pairwise comparisons test to examine the difference in detail, it is seen that the mean ranks of teachers aged 21-30 years (318.41) are significantly higher than those of teachers aged 31-40 years (287.07)

and teachers aged 41 and over (254.81) in the total mean ranks of the digital literacy scale. In this direction, it can be interpreted that younger teachers have higher digital literacy levels. The Mann-Whitney U results of the digital literacy levels of the teachers in terms of having a computer are given in Table 5.

Table 5

Mann-Whitney U Test Results of Teachers' Digital Literacy Levels According to Having a Computer in Total

Survey	Having a Computer	*n*	Mean Rank	Sum of Ranks	*U*	*p*
Total	Yes	538	312.77	168269.50	12229.50	.000
	No	66	218.80	14440.50		

Upon reviewing Table 5, which displays the outcomes of the Mann-Whitney U Test concerning the digital literacy levels of participating teachers categorized by computer ownership status, a statistically significant disparity is observed in the total digital literacy scale ($p<.05$). As indicated in the table, teachers who possess computers exhibit higher levels of digital literacy. The results of the Kruskal-Wallis H test for examining the total score of teachers' digital literacy levels according to the variable of daily internet usage time are given in Table 6.

Table 6

Kruskal-Wallis H Test Results for the Examination of Teachers' Digital Literacy Levels According to the Variable of Total Daily Internet Usage Time

	Daily Internet Usage time	*n* (604)	Mean Rank	*df*	X^2	*p*	Significant Difference
Total	1. Less than 1 hour	20	219.25	3	16.970	.001	3>1, 3>2 4>1, 4>2
	2. 1-2 hours	153	266.11				
	3. 3-5 hours	262	310.33				
	4. Over 5 hours	169	333.16				

The Kruskal-Wallis Test is conducted to assess whether there exists a discrepancy in the digital literacy levels of teachers based on their total daily internet usage time. It becomes evident that there is a significant difference between the groups' rank averages in the total digital literacy scale (X^2=16.970, $p<.05$). Upon conducting pairwise comparisons to delve deeper into this distinction, it is observed that teachers with a daily internet usage time of 3-5 hours (310.33) exhibit significantly higher mean ranks compared to those with less than 1 hour (219.25) and 1-2 hours (266.11) daily internet usage times. Similarly, teachers with a daily internet usage time of more than 5 hours (333.16) have significantly higher mean ranks than those with less than 1 hour (219.25) and 1-2 hours (266.11) daily internet usage times. The Mann-Whitney U test

results for examining teachers' research literacy skill levels based on gender are provided in Table 7.

Table 7

Mann-Whitney U Test Results for the Investigation of Teachers' Research Literacy Skill Levels According to Gender Variable

Factor	Gender	*n* (604)	Mean Rank	Sum of Ranks	*U*	*p*
Research Process	Female	344	301.72	103792.00	44452.000	.899
	Male	260	303.53	78918.00		
Research Preparation	Female	344	299.01	102859.00	43519.000	.569
	Male	260	307.12	79851.00		
Methodology	Female	344	299.01	102859.00	43519.000	.570
	Male	260	307.12	79851.00		
Accessing Resources	Female	344	285.03	98051.50	38711.500	.004
	Male	260	325.61	84658.50		
Total	Female	344	295.51	101655.00	42315.000	.257
	Male	260	311.75	81055.00		

In Table 7, when the results of the Mann-Whitney U Test are analyzedanalyzed according to the gender of the teachers participating in the research in research literacy total score, there is no statistically significant difference ($p>.05$). Research literacy skill does not make a difference in total score according to gender variable. When the sub-dimensions are analyzed, it is seen that in the dimension of accessing the sources, the mean values of men's ranks created a significant difference ($p<.05$). Mann-Whitney U Test Results for the Examination of Teachers' Research Literacy Skill Levels and Sub-Dimensions according to Education Level Variable are given in Table 8.

Table 8

Mann-Whitney U Test Results for the Investigation of Teachers' Research Literacy Skill Levels and Sub-Dimensions according to Education Level Variable

Factor	Education level	*N*	Mean Rank	Sum of Ranks	*U*	*p*
Research Process	1. Undergraduate	535	295.88	158297.50	14917.50	.009
	2. Postgraduate	69	353.80			
Accessing Resources	1. Undergraduate	535	295.27	157971.00	14591.00	.004
	2. Postgraduate	69	358.54			
Total	1. Undergraduate	535	297.84	159343.00	15963.00	.067
	2. Postgraduate	69	338.65			

Upon reviewing Table 8, which presents the outcomes of the Mann-Whitney U Test regarding the research literacy skill levels of participating teachers categorized by their educational attainment, no statistically significant discrepancy is observed in the overall scale score (p>.05). It appears that research literacy does not vary based on the level of education. However, it is noted that the mean rank values of teachers holding postgraduate degrees exhibit a significant difference in the research process and access to resources dimensions of the scale (p<.05). The results of the Mann-Whitney U Test concerning teachers' research literacy skill levels and sub-dimensions concerning computer ownership are provided in Table 9.

Table 9

Mann-Whitney U Test Results of Research Literacy Skill Levels and Sub-Dimensions of Teachers' Having a Computer

Factor	Having a Computer	*n*	Mean Rank	Sum of Ranks	*U*	*p*
Research Process	Yes	538	304.28	163701.00	16798.00	.472
	No	66	288.02	19009.00		
Research Preparation	Yes	538	305.53	164374.00	16125.00	.220
	No	66	277.82	18336.00		
Methodology	Yes	538	304.51	163824.00	16675.00	.418
	No	66	286.15	18886.00		
Accessing Resources	Yes	538	308.27	165851.00	14648.00	.020
	No	66	255.44	16859.00		
Total	Yes	538	306.23	164696.50	15802.50	.145
	No	66	272.93	18013.50		

Upon examination of Table 9, which presents the results of the Mann-Whitney U Test concerning the research literacy skill levels of participating teachers categorized by computer ownership, no significant disparity is observed in the total score of the Research Literacy Skill Scale based on computer ownership (p>.05). However, in the sub-dimension of accessing resources, it is evident that teachers who possess a computer attain higher rank total scores, leading to a significant difference (p<.05). Spearman Correlation Analysis values to about the association between Digital Literacy Scale Scores and Research Literacy Scale scores are provided in Table 10.

Table 10

Spearman Correlation Analysis Values Related to the Relationship Between Digital Literacy Scale Scores and Research Literacy Scale Scores

		Research Process	Research Preparation	Methodology	Accessing sources	Research Literacy
Attitude	*r*	.402**	.391**	.326**	.346**	.421**
Technical	*r*	.544**	.512**	.515**	.511**	.604**
Cognitive	*r*	.498**	.482**	.405**	.323**	.495**
Social	*r*	.479**	.455**	.471**	.529**	.552**
Digital Literacy	*r*	.541**	.517**	.486**	.502**	.591**

**$p<.01$

According to the Spearman correlation analysis, a positive, medium, and strong significant relationship exists between teachers' digital literacy levels and the sub-dimensions of research literacy skills. There is a positive and robust ($r=.591$; $p<.05$) significant relationship between digital literacy and total research literacy skills.

It is seen that there is a positive, medium level ($r=.421$; $p<.05$), positive, strong level ($r=.604$; $p<.05$), positive, medium level ($r=.495$; $p<.05$) and positive, strong level ($r=.552$; $p<.05$) significant relationship between research literacy skills and "attitude", "technical", "cognitive", "social", "cognitive" and "social".

There is a positive and strong relationship between digital literacy and "research process" ($r=.541$; $p<.05$); the positive and strong relationship between "preparation for research" ($r=.517$; $p<.05$); the positive and moderate relationship between "method knowledge" ($r=.486$; $p<.05$); the positive and strong relationship between "accessing resources" ($r=.502$; $p<.05$). Although there are various classifications in the literature, generally (.00-.30) is interpreted as weak, (.31-.49) as moderate, (.50-.69) as vital, (.70-.100) as powerful relationship (Tavşancıl, 2006).

Discussion and Conclusion

This study's primary goal is to discover how educators' digital and research literacy skills relate to one another. 'Within the framework of the first sub-problem of the research, teachers' digital literacy and research literacy levels are investigated. The mean value of the digital literacy scale is 4.09. According to the 5-point Likert-type scale scoring, since the median value corresponds between completely agree (5) and agree (4), it is understood that teachers' digital literacy levels are at a reasonable level. This is an indication that teachers have a good level of digital literacy. According to the findings, 58.6% of the teachers participating in the study are in the 21-30 young age group. The median score of digital literacy is reasonable because the young teachers participating in the study are closely related to technological tools. Several investigations (Cote & Milliner, 2018; Doğan & Benzer, 2023; Karanjakwut & Sripicharn, 2024; Öçal, 2017; Şad & Nalçacı, 2015; Su, 2023) have produced findings that align with the conclusions of this study. Across several countries and samples, in

multiple research, it is found that teachers have problems with technology use (Hutchison & Reinking, 2011; Kibici, 2022; Kilincer, 2021; Syvänen et al., 2016) and do not see themselves at a reasonable level in the use of digital technology (Basargekar & Singhavi, 2017; Buabeng-Andoh, 2012; Goh & Sigala, 2020).

The mean value of teachers' 'research literacy is found to be 4.15, considered reasonable. Similar to this study, Görgülü-Arı and Arslan (2020) find that graduate science teachers' research literacy skills are at a medium level, and their attitudes towards conducting research are at a reasonable level. Armağan, on the other hand, concluded in 2012 that most teachers do not consider themselves sufficient to conduct a scientific study. Kazancı-Tınmaz (2019) determined that the theoretical and research-based knowledge utilization levels of school administrators and utilization teachers are medium. In addition, it was concluded that teachers do not use research method techniques widely. There are studies in different countries (Freebody, 2007; Koshmaganbetova et al., 2020; Nag et al., 2014; Nikola, 2021; Roman, 2021; Syahrial et al., 2022; Waite & Davis, 2006) that concluded that teachers have moderate and low research skills. Inadequate resource availability, inadequate professional development and research capabilities, and reduced motivation (Koshmaganbetova et al., 2020; Nag et al., 2014; Nikola, 2021; Syahrial et al., 2022) have been identified as key factors leading to reduced research effectiveness among educators.

In this study, gender, department, age, education level, computer ownership status, and daily internet usage time variables are analyzed. Gender does not have a notable impact on digital literacy levels. However, there is a significant difference between the attitude and cognitive dimensions of female participants and the technical and social dimensions of male participants in terms of mean scores. Similar to the study, the findings of Arslan (2019), and Kozan and Özek (2019) do not make a difference in digital literacy levels in gender variables. There are studies that men have higher digital literacy and bit proficiency than women (Kara, 2021; Korkmaz, 2020; Özerbaş & Kuralbayeva, 2018; Tzafilkou et al., 2023). It was determined that the research findings differed according to the gender of teachers' digital literacy levels. This is thought to be due to the sample group with different characteristics in the studies.

Departmental variables and digital literacy levels show significant disparities. It is discovered that teachers in the verbal department group are less digitally literate than teachers in the language branch group. Teachers in the classroom branch group have better digital literacy skills compared to teachers in the verbal department group. In line with Arslan (2019) and Üstündağ et al. (2017) this study also reveals that computer and science teachers possess advanced digital literacy skills. Additionally, similar to the findings of this study, it is observed that teachers of English, French, and German rank second in terms of their high levels of digital literacy.

According to the results obtained, it is determined that the digital literacy levels of teachers aged 21-30 are higher than those of teachers aged 31-40 and teachers aged 41 and over. According to the data, there is an inverse proportion between age and digital literacy. The digital literacy levels of these teachers aged 21-30 are high because young teachers are intertwined with digital tools from childhood to adulthood. It is seen that the data obtained are consistent with the literature (Boyacı, 2019; Öçal, 2017). Similarly, it is concluded that digital literacy levels decreased with increasing age. This

phenomenon can be elucidated by the fact that young folks of the contemporary generation are deeply interconnected with technology from an early stage of their lives.

Statistical analysis reveals a considerable disparity in the digital literacy levels of instructors based on whether they possess a computer. Specifically, teachers who own computers demonstrate greater levels of digital literacy. This finding aligns with the outcomes derived from the studies conducted by Arslan (2019), Özerbaş and Kuralbayeva (2018), and Elçi and Sarı (2016) in the existing body of literature. As instructors increasingly utilize digital tools on computers, their digital literacy skills also experience a favorable improvement.

There appears to be a notable distinction in teachers' digital literacy levels based on the duration of their daily internet usage.'. The data suggests that as time spent online increases, proficiency in digital literacy also escalates.. Teachers who use the Internet frequently have high digital literacy levels because they use technological devices such as phones, computers, etc., more frequently. Çetin et al. (2012) and Özerbaş and Kuralbayeva (2018) found similar results in their studies.

In the study of teachers' research literacy skill levels according to gender variable, research literacy skill does not make a difference in total score. In the sub-dimensions, it is observed that men's rank mean values created a significant difference in the dimension of accessing resources of the scale. In the studies of Rawls (2008) and Sadıç (2019), male teachers' research competence levels are higher than female teachers. Mutlu (2019), Konokman et al. (2013), and Petko et al. (2020) find that gender does not make a significant difference in research efficacy. These results coincide with the findings obtained.

In the research process and access to resources dimensions of the research literacy scale, it was seen that the rank mean values of the teachers with postgraduate education created a significant difference ($p<.05$). It can be said that teachers with postgraduate education have better research skills than others in terms of mastering the research process and accessing resources. This finding is an expected situation. Because the purpose of postgraduate education is to conduct comprehensive studies related to the field of research by scientific problem-solving steps, it is normal for teachers who have completed their postgraduate education to have better research literacy skills. This finding coincides with the study conducted by Mutlu (2019) on teachers with administrative duties.

In the dimension of access to resources, it is seen that the rank total scores of the teachers who have computers are high and there is a significant difference. It can be said that teachers who have computers can access resources more easily and effectively while doing research. This result is similar to the study of Günsel (2019), who found a significant relationship between pre-service teachers' personal computer ownership and information seeking. The information-seeking and research skills of pre-service teachers who have computers are better than other pre-service teachers.

It was found that there is a strong and significant relationship between teachers' digital literacy levels and research literacy skills. Aydemir (2017) found a strong and significant relationship between research skills and the capacity to obtain and verify information from the Internet. Kara (2021) found a moderate positive relationship between the digital literacy skills of pre-service teachers and their ability to search and

understand materials on the internet. In line with the findings of the study, Katayev et al. (2023) discovered a positive and moderate relationship between instructors' research competencies and their degree of ICT use. These results are similar to the results of the study.

Recommendations

According to the teachers' digital literacy proficiency results, it can be said that teachers aged 41 and over need activities to increase their digital literacy levels. In-service training programs might be recommended to improve the digital literacy skills of humanities teachers (those teaching history, religion studies, Turkish, social sciences, etc.) who need to improve in this area. Moreover, there is a clear correlation between the digital literacy scores of instructors and the duration of their daily internet usage, indicating that higher digital literacy scores are linked to increased online involvement. MoNE should develop initiatives to facilitate trainers' internet access. The study's findings indicate that teachers with computers exhibit high levels of digital literacy. However, there needs to be more research literacy levels. Consequently, it is advisable to furnish teachers with computers.

When the results are analyzed, postgraduate educators attain higher scores than undergraduate teachers regarding the dimensions of the research process and access to resources within the Research Literacy Scale. In this direction, MoNE should c conduct studies for teachers to receive postgraduate education.

Limitations

Since this research coincided with the pandemic, online data collection tools became mandatory. However, it became difficult to reach the participants while collecting the data. In addition, the study's sample is limited to 604 teachers working in a province in eastern Türkiye.

Statement of Responsibility

Conceptualization MCD; Data collection AT, MCD; Data Analysis MCD, Methodology AT; Visualization MCD; Writing—original draft SK, AT, MCD; Writing—review and editing AT. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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Data Literacy at School: A Scale Development Study

Okulda Veri Okuryazarlığı: Bir Ölçek Geliştirme Çalışması

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ABSTRACT: The purpose of this study is to develop a valid and reliable scale to determine and evaluate the different dimensions of data literacy at school. The study is a quantitative descriptive survey model. The sampling for exploratory factor analysis was formed of 307 and confirmatory factor analysis 338 teachers and school administrators who are on active duty in 2023-2024 educational year in Kastamonu. Data was collected through a five item likert data collection tool. A three-dimension structure was formed and it was confirmed by CFA. The dimensions of data culture at school are; "data identification", "data use" and "data management". Internal reliability and validity was verified through Cronbach Alpha (Cronbach's α=.882), split half method (r=.837), Spearman-Brown correlation coefficient (R=.911) and Guttman's lambda (λ=.904). The external reliability and validity was verified by test-retest technique (first application n=44, second application n=39, r=.800, p≤.05, R=.961, p≤.05, and Kendal's tau-b is τb=.904, p≤.05). The findings confirmed the validity and reliability of the scale.

Keywords: Data literacy, data identification, data culture, data management.

ÖZ: Bu çalışmanın amacı okulda veri okuryazarlığının farklı boyutlarını ortaya koymak ve bu farklı boyutları değerlendirebilmek adına geçerli ve güvenilir bir ölçek geliştirmektir. Çalışma nicel betimsel tarama modelinde bir araştırmadır. Çalışmanın örneklemini Kastamonu'da 2023-2024 eğitim öğretim yılında aktif görevde olan, açımlayıcı faktör analizi için 307, doğrulayıcı faktör analizi için 338 öğretmen ve okul yöneticisi oluşturmuştur. Veri beşli Likert formunda bir veri toplama aracı ile elde edilmiştir. Analiz sonucunda üç boyutlu bir ölçek geliştirilmiş ve bu ölçek doğrulayıcı faktör analizi ile doğrulanmıştır. Ölçeğin boyutları "verinin tanımlanması", "verinin kullanılması" ve "veri yönetimi" olarak adlandırılmıştır. Ölçeğin iç tutarlılığı ve geçerliliği Cronbach Alfa (Cronbach's α=.882), split half yöntemi (r=.837), Spearman-Brown korelasyon katsayısı (R=.911) ve Guttman's lambda (λ=.904) ile doğrulanmıştır. Ölçeğin dış geçerliğinin test edilmesinde test-tekrar test yönteminden yararlanılmıştır (ilk uygulama n=44, ikinci uygulama n=39, r=.800, p≤.05, R=.961, p≤.05, ve Kendal's tau-b τb=.904, p≤.05). Bulgular ölçeğin geçerli ve güvenilir olduğunu ortaya koymuştur.

Anahtar kelimeler: Veri okuryazarlığı, verinin tanımlanması, veri kültürü, veri yönetimi.

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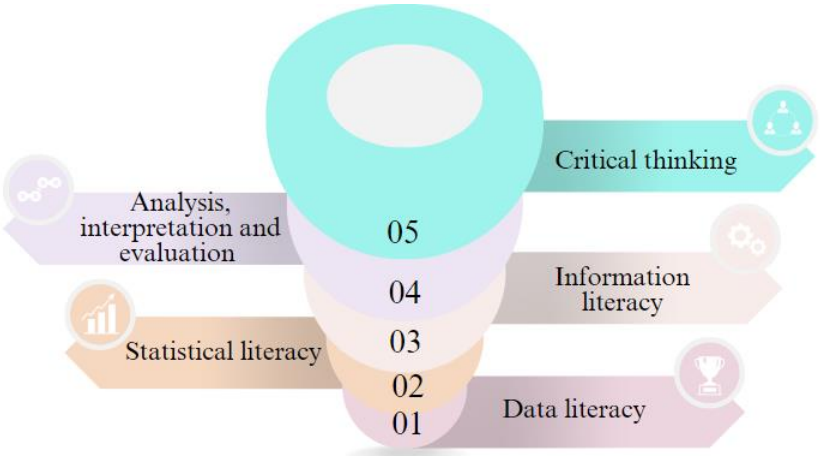
As in all other organizations, data play a key role in the development of and have crucial functions for educational institutions. First of all, student achievement data is one of the key references to assess whether educational institutions' performance comply with the set standards. It is also essential for school administrators and policy makers to have a healthy understanding for the effectiveness of curriculums and educational implementations and improve teaching and learning processes. Data driven assessments for educational implementations are central to justify the decisions (Knapp et al., 2007, p. 77) and thus data are vital assets for decision making processes in educational institutions. In this regard, data also add to the accountability of the educational institutions. Data can also contribute to the allocation of the resources in the right domains in educational institutions by revealing the priority areas (Custer et al., 2018, p. 4). Data based needs analysis could optimize the use of organizational resources. Student achievement data is the key for effective guidance for students as well as the areas of professional development of teachers (Breiter & Light, 2006, p. 213). Performance data form the basis for determining attainable performance standards for educational institutions (Armstrong & Anthes, 2003, as cited in Datnow & Park, 2014, p. 19). Data can also enable the establishment of a data based communication ecosystem at educational institutions (Earl & Katz, 2006, as cited in Datnow & Park, 2014, p. 19). It is important for the mission statement of the educational institutions to be measurable and data in this regard are central to compare and contrast the realized performance of the educational institutions with the goals set in the mission statement (Goldring & Berends, 2009, p. 185). All in all, data is a key component for the development of educational institutions. Despite its significance, members of the educational institutions should have developed a form of data literacy to benefit from data obtained or generated.

Data literacy involves the collection, processing, management, and evaluation of data for the purpose of scientific enquiry and providing access to actionable information (Qin & D'Ignazio, 2010, p. 5). Data literacy is a concept which corresponds to the skills for utilizing data in solving problems related to real life (Wolff et al., 2016, p. 10). Data literacy may be perceived as a discipline which requires less technical skills compared to computer technologies and information management systems. However, data literacy entails having a set of skills related to accessing, processing, analyzing and transforming data into information. Data literacy also forms the basis of critical thinking. The relationship between data literacy and critical thinking can be presented in Figure 1 (Shields, 2005, p. 8).

Figure 1

Critical Thinking Perspective

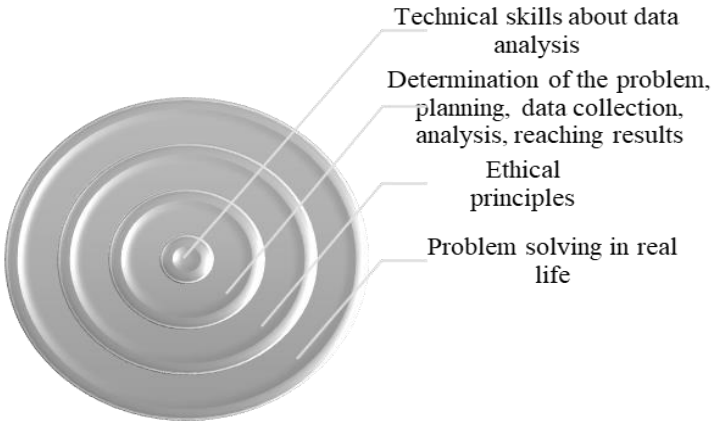


Note. (Shields, 2005, p. 8).

When Figure 1 is analyzed, it can be alleged that data literacy constitutes the basis of critical thinking. Data literacy basically focuses on increasing individuals' understanding and awareness of systems, events and phenomena which can be explained based on data (Pangrazio & Sefton-Green, 2020, p. 213). Data literacy not only affects individuals' questioning processes towards events and phenomena, but also plays a functional role in reaching healthy judgements as a result of questioning (Fontichiaro & Oehrli, 2016, p. 22). Data literacy does not mean collecting, processing, transforming and analyzing data. On the contrary, it is based on having some basic technical skills in the process of accessing information from raw data. Data literacy encompasses also the issues such as considering ethical principles in the process of accessing information from data. Wolff et al. (2016, p. 19) put forward the components of data literacy as shown in Figure 2;

Figure 2

Components of Data Literacy



Note. (Wolff et al., 2016, p. 19)

Data literacy plays an active role in the healthy execution of decision-making processes at both individual and organizational levels. The global economy attaches significance to a structure which is based on information. In this respect, data literacy is

regarded as an important dexterity in all sectors and disciplines (Ridsdale et al., 2015, p. 2). Data literacy refers to individuals' conceptual knowledge of data and a set of skills for utilizing data in solving problems (Matthews, 2016, p. 54). Data literacy is composed of skills related with knowledge and skills about data concept and data use (Vanhoof et al., 2013, p. 116). In this respect, it can be claimed that improving data literacy at the organizational level can accelerate the identification of organizational problems via a data-based approach and decision making in management processes.

Considering the organizational value of data and data literacy, it can be argued that educational institutions are no exception to this situation. Improving the knowledge and skills of teachers and school administrators in data literacy can pave the way for the development of strategies which can play an effective role in identifying and solving educational problems. Efforts aimed at increasing the competences of teachers and school administrators for data use in schools can mediate the development of data literacy at the institutional level (Vanhoof et al., 2013, p. 132).

Data literacy is important for both school administrators and teachers as it enables the establishment of a data culture at school (Anderson, 2015, p. 203). It paves the way for an organizational level awareness for the functions of data use. Data literacy could encourage and foster data based decision making in educational institutions. Data use at school is possible only if the teachers and administrators have data literacy to a certain extent. Data play a vital role in school feedback cycle and effective data based feedback could be ensured through data literacy at the school level. Data literacy is crucial for both teachers and administrators to base their assessments on objective, verifiable data rather than subjective personal opinions and judgments. Data literacy can also have a positive impact on the attitudes of the school members towards data use and facilitate and enforce the adoption of data use at school. Data literacy is also significant for establishing a data driven communication ecosystem at school. Both teachers and administrators should have basic skills such as interpreting visual data and making comparisons based on verifiable data to ensure a data informed communication system at school.

Despite the awareness of the significance of data literacy at school, school leaders feel themselves inefficient about the data literacy and data based guidance and this brings about a sense of insecurity among the them (Earl & Fullan, 2003, p. 393). Schildkamp and Poortman (2015, p. 232) also found out that individual teachers lack data literacy skills. Training for data literacy is significant both for all educational professionals, including teachers and school leaders (p. 243). The data based evaluation of the current situation of data literacy level at school could be an important step for a healthy needs analysis for data literacy training. The most fundamental function of data literacy at school is the role it plays in data based decision making processes (van Geel et al., 2017, p. 187). Thus, scales for data based decision making prevail the literature, which are functions of data literacy (Yılmaz & Jafarova, 2022, Doğan & Ottekin Demirbolat, 2021, Bennett et al., 2010).

Though it is one of the most significant pre-requisites of data based decision making, there is only one scale development study in literature about data literacy which was carried out by Abrams et al. (2021), which was also adapted to Turkish culture by Naillioğlu Kaymak and Doğan (2023). The original scale was formed of 18 items five sub-components (identifying problems through data use, converting data to information,

decision making based on data and assessing the outcomes) and exploratory and confirmatory factor analyses were not carried out in the creation of the scale. The study group was formed of 28 teachers and 15 administrators who completed a professional development program and provided data about data literacy in groups of nine (Abrams et al., 2021, p. 3). A case study design was applied to explore teachers' data use practices and scale was developed through collecting data from various sources such as individual opinions and team discussions (p. 10). It was observed that the some items concentrated on research skills of teachers and administrators rather than their data literacy competencies (for instance the items "Engage in a cycle of inquiry to continually support learning" and "Communicate to colleagues or communicate to colleagues or supervisors about instructional adjustments"). Moreover, some items focused on teaching and learning processes though the aim is to assess data literacy of both teachers and administrators (For instance items "understand the factors that influence test scores", "diagnose teaching and learning issues using student data" and "plan instruction based on findings from data analysis") (p. 12). In our scale though, we aimed at depicting a true picture of data literacy levels of both teachers and administrators to enable a healthier planning for data literacy training. In the Turkish adaptation of the scale which was carried out by Naillioğlu Kaymak and Doğan (2023), items focused on only teaching and learning processes were omitted, Also the last item which focuses on research skills (Engage in a cycle of inquiry to continually support learning) was omitted as its error variance is high. The final version of the adapted scale though misses an important dimension of data literacy, which is data management. Data management is the coordination and the control of data generation processes, which are targeted to solve a organizational problem (Gordon, 2007, p. 54). The scale in this study was designed to address all integral dimensions of data literacy and thus could enable a more vivid picture of the prevalent situation of data literacy at schools.

Method

The research is a quantitative research in a descriptive survey model. Descriptive research aims at revealing the components and characteristics of the subject in detail (Howitt & Cramer, 2017, p. 29). Researches in descriptive survey model aim at determining issues such as participants' thoughts, attitudes and skills towards a particular subject (Büyüköztürk et al., 2008, p. 226). The aim of this study is to develop a scale of data literacy at school based on the views of teachers and school administrators. The development process of the scale was carried out in three different stages: the development of a draft data collection tool based on the literature and expert opinions, exploratory factor analysis and confirmatory factor analysis. Issues such as population and sample, data collection process, data collection tools and data analysis were discussed separately for each stage.

Ethical Procedures

The ethical commission permission for the research was obtained from Ordu University Ethics Committee for Educational Studies on the date 23.02.2024 with the number 2024-32. The ethical principles were attached significance in all phases of the research, beginning with the data collection and reporting the results. No personal data which will allow to expose the identity of the researcher was collected and informed

consent was added to the data collection tools. Permission from the principals of the schools was also obtained before the application of the data collection tool.

Development of the Draft Data Collection Tool

In the process of developing the draft data collection tool, as the initial step, a comprehensive literature review was conducted. As a result of the literature review, a 61-item draft data collection tool was developed. The developed tool was submitted to the experts' opinions. The experts to whose opinions were received are associate professor Ümit Dilekçi Nartgün, Batman University, Dr. Gökhan Savaş, Karabük University, and Dr. Erhan Dolapçı Ministry of National Education. Based on the expert's opinions, items 11, 13, 27, 29, 38 were removed from the draft data collection tool in view of the fact that they were not clear and understandable, and items 46 and 54 were combined into a single item. Similarly, items 20, 21 and 6, 17 were combined into single items. Since item 24 met items 22, 23, 25 and 26 in terms of meaning and scope, the related items were removed from the data collection tool. Since the expression "data storage tools" in item19 covers the concepts of "database", "data warehouse" and "data market" in items 42, 43 and 44, items 42, 43 and 44 were removed from the draft tool. Within the framework of expert opinions, it was concluded that it would be appropriate not to include the items 47, 52 and 53 in the draft tool on the grounds that they are met by item 51 in view of meaning and scope. Items 12, 30, 31, 32, 36, 48, 56, 58 were removed from the draft scale based on expert opinions that they were not directly related to data literacy. Items 5 and 16 were removed on the grounds that they contained more than one concepts. Items 2, 3 and 4 were removed from the draft scale due to the fact that they are not related with data, and item 28 was removed from the draft scale due to referring to a stage of data analysis. Item 60 was removed from the draft tool on the grounds that it did not address both teachers and administrators at the same time in terms of data literacy. Item 40 "I can explain what data management is" was rephrased as "I can list the stages in the data management process". Within the framework of expert opinions, the item "I can explain the concept of knowledge pyramid" was added to the draft data collection tool and the draft data collection tool was finalized before the principal components analysis. The final draft data collection tool was composed of 29 items.

The First Application: Exploratory Factor Analysis

The teachers and school administrators in Kastamonu city center (first educational area) and its three different districts (Tosya, İnebolu and Taşköprü) constituted the population of this research. Sample size of the first application is 307 participants. Hair et al. (2014, p. 100) denote that for factor analysis, sample size should be 100 or over. They also allege that the observations should be at least five times more than the total number of items to be analyzed, which equals to 145 observations. Field (2009, p. 647) denote that sample size for factor analysis should be at least 300. In all cases, the proper number for sample size was attained and sample size was assumed to be appropriate for the factor analysis. Different sampling methods were utilized together in the study. Stratified sampling was applied to represent participants from different subgroups such as different duties and school levels. In the similar way, quota sampling was applied to represent the participants from different sub groups in

correlation with their ratio in the population. The demographic data about the participants of the first application are presented in Table 1;

Table 1

Demographic Data About the Participants of the First Application

		n	%
Duty	Teacher	231	75.2%
	Administrator	76	24.8%
Seniority	1-10 Years	51	16.6%
	11-20 Years	124	40.4%
	21-30 Years	122	39.7%
	31 years and over	10	3.3%
School Level	High School	169	55.04%
	Secondary School	78	25.4%
	Primary School	60	19.54%

Data was collected through a google survey. Informed consent was added to the online survey. The participants were warned not to include any details to expose their identity in the form. Moreover, they were assured that they would be mentioned as only the case numbers in the data set and data set will be stored in a computer which can be accessed through a code special to the researchers. The survey is in the form of a five item likert scale, extending alternatives from “totally agree” to “totally disagree”. The school principals were informed before the application and their permission was received. The data on online form were transferred to SPSS program. Before the main analyses, data preparation phase was carried out. Firstly, the data sets were checked by means of observation and then missing value analysis was realized. In none of the data sets, the missing values exceeded the threshold of 5% (Tabachnick & Fidell, 2013, p. 63). The highest percentage for missing values was 0.3% in only seven cases of the data set. The EM statistics value is p=.158 and p≥.05. The findings denote that the missing values in the data sets signify a random distribution and mean substitution which is one of the most commonly applied methods to replace missing values (Hair et al., 2014, p. 51) can be applied to replace missing values.

As the second step, outlier analysis was carried out. First of all, Z scores were calculated. The highest Z score has been calculated to be -2,52429. Field (2009, p. 153) allege that values over 3.29 signify the existence of an outlier. Mahalanobis distances were also checked. Tabachnik and Fidel (2013, p. 75) suggest that for a case to be an outlier in terms of Mahalanobis distance, p value should be less than .001 for χ^2 value. In the analysis, it was found out that p=.000. Field (2009, p. 218) denote that with samples smaller than 500, values over 15 should be regarded as problematic according to Mahalanobis distance. The highest value for the data set was calculated to be 9.33530, signifying that there are no outliers in the data set. As the final stage for outlier

analysis, Cook' distance was calculated, in which a value over 2.5 denotes the existence of an outlier (Hair et al., 2014, p. 64). The highest value for Cook's distance is .03784.

To test normality of distribution, skewness and kurtosis values were checked. In none of the sub groups, skewness and kurtosis values exceeded the threshold values of +1 and -1 (Cohen et al., 2018, p. 736). The highest value is for skewness (-.900) in secondary school group. Normality of distribution was also tested through Kolmogorov-Smirnow and Shapiro Wilk tests. Kolmogorov-Smirnov test indicated abnormal distribution for four groups (high school, p=.019, secondary school, p=.003, 11-20 years of seniority, p=.019 and 21-30 years of seniority p=.012 and teacher, p=.000). The tests denoted a normal distribution for all other groups $p \geq .05$. Kolmogorov Smirnov test is influenced by sample size and might not put forth reliable results with small sample sizes (Engmann & Cousineau, 2011, p. 3). The homogeneity of the variances was tested by Levene test. In duty group, the score was calculated to be p=.985, which can be regarded as the indication of the homogeneity of the variances (Stockemer, 2019, p. 104). In institution and seniority groups, p=.000 and $p \leq .05$, which signify that homogeneity of variances is not met. Nordstokke and Colp (2014, p. 361) denote that Levene test is robust in highly skewed samples. Hatchavanich (2014, p. 191) put forward that Levene test could be affected by the sample size and it might not be the best solution to test homogeneity of variances with all samples. As the result of these analyses, data set was regarded to be ready for the principal component analysis. The results of the principal component analysis are presented under the following heading.

Results

To test sphericity, Bartletts' test was applied. The result (p=.000 and $p<.05$) signified that there is a sufficient correlation between the variables (Bartlett, 1950, p. 112). Field (2009, p. 647) allege that a value close to 1 is as the results of the KMO test, it signifies the adequacy of the sampling. KMO test result is p=.905. As the rotation method, direct oblimin was applied. In the first step of principal component analysis, communalities were checked. Field (2009, p. 638) regards 0.4 as the threshold value for the eligibility of an item. The communality values of five items were calculated to be lower than 0.4, item 8=.395, item 11=.395, item 12=.333, item 20=.389 and item 21=.369. These items were excluded from the data and the analysis was repeated. In the second analysis, item 7 had the communality value of .379 and was omitted from the data set. When the analysis was repeated, the communality value of item 4 dropped to .388 and item 9 to .305. The analysis was repeated omitting these two items. In the analysis, none of the items signified communality values lower than 0.4 and the lowest value was calculated to be .422 (item 26). In this phase, KMO was p=.887 and Bartlett's test of sphericity is p=.000.

In this phase a six-factorial structure was formed. The total variance explained by the factors which have eigenvalues greater than 1 is 53.724%, factor 1=26.598%, factor 2=5.948%, factor 3=5.642%, factor 4=5.529%, factor 5=5.085% and factor 6=4.922%. When pattern matrix was examined, it was found out that some items had close factor loadings under more than one factor, item 17, -.469 for factor 2 and .429 for factor 6, item 28, .366 for factor 2, -.312 for factor 4 and .349 for factor 6 and item 22, .305 under for 1 and .358 for factor 6. These items were regarded to be overlapping and were excluded from the data set. The analysis was repeated omitting these items.

In this phase, a five factor structure was formed. The total variance explained by the five factors is 50.472%. In this phase, item 14 had close factor loadings for factor 1 (.353) and for 5 (.321). In the same way, item 6 had close factor loadings for factor 1 (-.452) and for factor 3 (.417) and factor 4 (.377). Item 2 had factor loadings of .437 for factor 4 and .468 for factor 5. These items were excluded from the data set and the analysis was repeated. In this phase, a four factor structure was observed but item 25 had close factor loadings for factor 1 (.344) and factor 4 (-.321) and item 13 factor 2 (.367) and factor 4 (-.393). They were regarded to be overlapping items and excluded from the data set.

The omitted items were also assessed if they could have an overall impact on the content validity of the draft scale. The analysis results supported the literature as for example item 17, which is about big data, is a domain of expertise in data management. In the same way, item 28 focuses on the role of data in educational management processes, though the school administrators are not the only target group in our scale development study. All in all, it can be alleged that items excluded contributed to the content validity of the scale.

Finally, the analysis was repeated. In this phase a three factor structure was found out and the factors with eigenvalues over 1 explained 44.005% (factor 1=27.092%, factor 2=8.812%, factor 3=8.101%). Hair et al. (2014, p. 107) allege that the percentage of variance explained by a factor should be over 5% of the total variance explained and this verifies that all factors could be independent factors. Çokluk et al. (2018, p. 197) denote that in social sciences, the threshold value for the total variance explained could be 30%. The KMO value of three factorial structure is p=.845, p≥.05 and Barttlett's test of sphericity value is p=.000, p≤.05. None of the items had close factor loadings for different factors. Results of the principal component analysis are presented in Table 2.

Component correlation matrix was scrutinized to figure out if there is a high correlation among the factors. Values closer to -1 and +1 denote strong association among factors (Heiman, 2011, p. 142). In literature, the shared notion is that correlation coefficient lower than .30 denote weak correlation, values between .30 and .70 signify intermediate correlation and values higher that .71 signals high correlations (Büyüköztürk et al., 2013, p. 92). In the analysis, the correlation between factor 1 and 2 was calculated to be *r*=-.359, factor 1 and 3, *r*=.298 and factor 2 and 3, *r*=-.308. It was concluded that the factors did not have high correlations with each other and can be handled as distinctive and separate variables. For reliability AVE (average variance extracted) and CR (composite reliability) values were calculated for each factor. The online system created by Aydoğdu (2023) was used to calculate AVE and CR values. The values were calculated for factor 1, AVE value is 0.324 which is below the acceptable threshold and CR is 0.733, which denotes that the factor's reliability is high. For factor 2, AVE is 0.438, which is below the threshold value of 0.50 and CR value is 0.756, which refers to the reliability of the test. And AVE for factor 3 is 0.410 and CR value is 0.674, both are below the threshold values. After the analyses, the factors were denominated.

Table 2

The Findings of the Principal Component Analysis for Data Literacy at School Scale

Item	Factor 1	Factor 2	Factor 3
3	.753		
1	.627		
16	.606		
26	.518		
27	.471		
5	.358		
15		-.717	
29		-.712	
23		-.622	
24		-.587	
19			.826
10			.584
18			.486
Eigen value	3.522	1.146	1.053
Variance explained by each factor %	27.092%	8.812%	8.101%
Cumulative variance explained 44.005%			

The factors were denominated based on literature. Pangrazio and Selwyn (2019, p. 420) identify five dimensions for data literacy: 1) data identification, 2) data understandings, 3) data reflexivity, 4) data uses, and 5) data tactics. The ability to identify data sets and form an understanding towards the data collected, its scope and functions could constitute an integral part of data literacy. Wolf et al. (2016, p. 10) define data literacy as "the set of abilities around the use of data as part of everyday thinking and reasoning for solving real-world problems". Van Audenhove et al. (2020, p. 2) put forward two important components of data literacy: understanding data and using data. It can be alleged that both components entail having knowledge and skills for the term "data" and for making use of them in organizational processes or real life. Mandinach and Gummer (2013, p. 30) define data literacy as "a specific skill set and knowledge base which enables educators to transform data into information and ultimately into actionable knowledge". This definition refers to the basics of data management, which can be defined as the process of transforming raw data into functional and actionable information (Duygulu, 2023, p. 78). In the light of the literature, factors were denominated as follows; factor 1, data identification, factor 2, data use and factor 3, data management.

Data identification is an integral component of data literacy as it is related with the ability to distinguish various types data. At school context, various data have distinctive functions, so the dexterity to distinguish between the types of data plays a key role in optimizing data use. For data literacy, it is not enough to distinguish between

types of data, it is crucial to use it. Data use implicates a number of processes, conditions, and contexts which encompasses interpretive processes carried out using data to construct implications for next steps for an organizational implementation (Coburn & Turner, 2011, p. 173). Data use by educational professionals is a component which constructs and guides institutional structures, processes, and logics (Little, 2012, p. 143) and thus constitutes a significant parameter of data literacy. Data management can be regarded as the highest level of data literacy as it encompasses all processes in which data are handled in an organization (Duygulu, 2023, p. 75). Thus, having a basic knowledge about the data life cycle in an organization is among the basics of data literacy. In this regard, the scale presents a logical order for the various levels of data literacy and can guide the educational leaders with a better understanding for trainings targeted to increase data literacy as it can offer a better professional needs analyses.

The three dimensions discovered in the development of the scale are interrelated concepts and they focus on distinctive components of data literacy. They form a hierarchical structure depending on the extent of the expertise in data literacy. Data identification is an important prerequisite for data use since defining and describing data forms the basis for deciding on the domains and issues for which the available data could be functional to act on. Data use is also a prerequisite for a more comprehensive competence in terms of benefiting from data in organizational level, which is data management. Data management encompasses all processes and procedures in which raw data is transformed into functional information which could guide organizational decision making processes. To sum up, the tree different dimensions of the scale are interconnected based on the extent of expertise and competence in the context of data literacy.

As the final phase of exploratory factor analysis, Cronbach Alpha coefficient was tested. Cronbach's Alpha reliability coefficient was calculated to be .772. A value over .60 denote the reliability of a scale (Hair et al., 2014, p. 90; DeVellis, 1991, Kline, 1986 as cited in McNeish, 2018, p. 423). Kline 1999 (as cited in Field, 2009, p. 675) notes that for ability tests a cut-off point of .7 is suitable. In the light of the findings, the three factorial scale was regarded to be reliable and valid. To confirm the three factorial structure, second application was implemented.

The Second Application: Confirmatory Factor Analysis

The sampling is composed of 338 teachers and school administrators from four different educational areas in Kastamonu; Kastamonu city center (schools in the second educational area), Devrekâni, Daday and İhsangazi. Stratified and quota sampling methods have been utilized together. Maximum variation has been attached importance during the sampling process and various variables such as "duty", "seniority" and "school level" were taken into consideration to be able to reach the maximum variety. The demographic data about the participants of the second application are presented in Table 3.

Table 3

Demographic Data about the Participants of the Second Application

		n	%
Duty	Teacher	286	84.6%
	Administrator	52	15.4%
Seniority	1-10 Years	61	18%
	11-20 Years	123	36.4%
	21-30 Years	131	38.8%
	31 years and over	23	6.8%
School Level	High School	182	53.8%
	Secondary School	87	25.7%
	Primary School	69	20.4%

Data was collected by means of a google survey questionnaire. Before the implementation, principals of the schools were informed and asked for permission. Informed consent was also included in the questionnaire and participants were assured to keep their data private. Data was transferred to SPSS 20.0 program for preliminary analyses.

As the first stage of data preparation, missing value analysis was carried out. It was found out that in none of the data sets, the missing values are not more than 5%. The highest percentage of the missing values was calculated to be 0.9% for the data set of item 4. The EM statistics is p=.861 and p≥.05. As the result of the missing value analysis, it was concluded that data has a random distribution and averaging (series means) has been applied to replace the missing values. For outlier analysis, first of all Z scores were examined. One case (Demographic data about the case excluded, institution=high school, seniority=11-20 years and duty=teacher) exceeded the threshold values of + and -3 with a value of -3,03206 and it was excluded from the data set. Z scores changed between -2,81958 and 1,74867. Mahalanobis distances were also checked and none of the cases were out of the threshold values of +15 and -15. The highest value was calculated to be 12,56280. In the same way, Cook's distance signified no outlier in the data set as the highest value has been .03511.

Skewness and kurtosis values were checked for normality of distribution. Skewness values for all groups were between the threshold values of +3 and -3 (Bai & Ng, 2005, p. 49). For kurtosis, in two of the groups, values were out of +3 and -3. For primary school, it was calculated to be 4.011 and for 31 years and over seniority to be 4.526. The kurtosis values could have been affected by sampling as both groups have fewer participants (primary school n=69, 31 years and over seniority=23). Normality of distribution was also tested by normality tests. The Kolmogorov-Smirnow and Shapiro Wilk tests presented abnormal distribution, p≤.05 in teacher, 11-20 and 21-30 years of seniority and in all sub groups of institution. Homogeneity of variances was tested by Levene test and for institution group p=.867, for seniority p=.106 and for duty p=.184 values were obtained and the homogeneity of variances was attained, p≥.05 for all groups. As the result of these analyses, the data set was regarded to be ready for the

confirmatory factor analysis. The results of the confirmatory factor analyses are presented under the following heading.

Results

For confirmatory factor analysis, path diagram has been applied to test the model. First of all, to test the adequacy of the sampling, critical N was calculated and it was found out to be CN=220.85. In view of CN, the sampling size was assumed to be adequate, n=337. As the estimation method, maximum likelihood method was applied as it is a robust estimation method especially when normality of distribution assumption cannot be met (Hair et al., 2014). Asymptotik covariance matrix was applied in the analysis. The results of the analysis were presented in the Table 4.

Table 4

The CFA Results of the Data Literacy at School Scale

	Factor 1: Data identification			
Item	t-scores	Error Variance	Standardized Loadings	R^2
1	17.55	.42	.90	.66
2	16.53	.51	.89	.61
3	16.78	.57	.96	.62
4	15.40	.58	.84	.55
5	16.61	.51	.89	.61
6	16.22	.49	.84	.59
	Factor 2: Data use			
Item	t-scores	Error Variance	Standardized Loadings	R^2
7	15.00	.42	.72	.56
8	18.35	.31	.95	.75
9	14.98	.55	.83	.55
10	13.83	.63	.78	.49
	Factor 3: Data management			
Item	t-scores	Error Variance	Standardized Loadings	R^2
11	16.15	.49	.91	.63
12	14.58	.55	.80	.54
13	13.69	.57	.74	.49

As presented in Table 4, t scores are meaningful ($t>2.56$, $p<.05$) Çokluk et al. (2018) note that t values over 2.56 are significant at the significance level of .05. The lowest standardized factor loading is .72 Hair et al. (2015, p. 115) denote that factor loadings over .30 are considered to meet the minimal level, factor loadings over .50 are practically significant and factor loadings over .70 are regarded as the indication of a well-defined structure. In the light of the findings, it can be alleged that the model is

robust. The highest error variance is .58, which is below threshold value of 1 (French & Finch, 2006, p. 383). The goodness of fit statistics for the first order confirmatory factor analysis are presented in Table 5.

Table 5

Goodness of Fit Statistics for the First Order CFA Analysis

Model	X^2	(X^2 /sd)*	RMSEA	SRMR	NFI	NNFI	CFI	GFI	AGFI
First Order	137.86	2.224	0.060	0.045	0.97	0.98	0.98	0.94	0.91

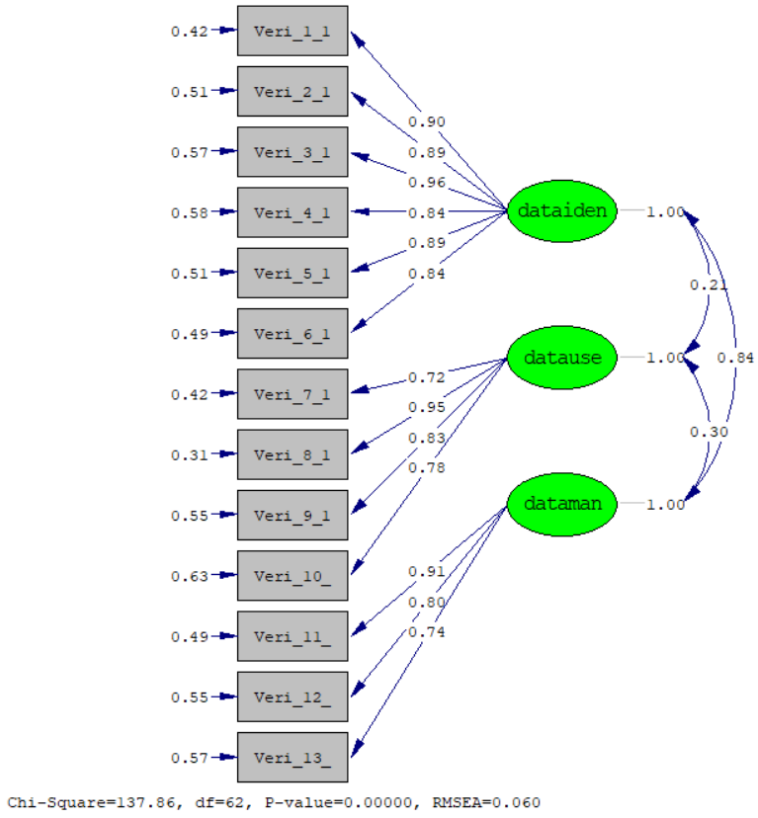
*df=137.86, p=.000

As presented in Table 5, (X^2 /sd) value is lower than 3, which signifies that the model is robust (Prudon, 2015, p. 9), X^2 /sd=2.224. As the value of X^2 could be influenced by the sample size, it should not be regarded as the only indication of good fit (Harrington, 2009, p. 80). A value for root mean square error of approximation close to .00 indicate the existence of a good fit (Brown, 2006, p. 84). The cut-off value for RMSEA is .05 (Browne & Cudeck, 1993, as cited in Li & Bentler, 2011, p. 119). Thus RMSEA score (.0060) verifies the goodness of fit. For standardized root mean square residual (SRMR), a value close to 0 is regarded as the sign of a good fit (Brown, 2006, p. 83). Kline (2016, p. 277) denote that a value over .10 signals as a serious problem. The value could be increased to .12 in smaller than 150 samples (Sivo et al., 2006, p. 276). As a result, it can be alleged that SRMR index proves a good fit (SRMR=.045) The value for NFI should be equal to .90 or over in a good fit model (Shek & Yu, 2014, p. 198). Normed fit index (NFI) denotes a good fit, having the value of .97. In the same way, non-normed fix index (NNFI) should be .90 or over (Obst & White, 2004, p. 699). The value is .98, which verifies the goodness of fit.

The comparative fit index (CFI) has a range of values between 0.0 to 1.0, and values over .90 imply a good model fit (Cheung & Rensvold, 2002, p. 235). The model has a CFI value of .98. Cheung and Rensvold (2002 p. 235) note that a score over .90 for goodness of fit index (GFI) is regarded as the robustness of the model and the value in our model is .94. The adjusted goodness of fit index (AGFI) penalizes more complicated models and favors the ones with a minimum number of free paths. AGFI values are generally lower than GFI values regarding the complexity of the model (Hair et al., 2014, p. 581). Schreiber et al. (2006, p. 330) allege that adjusted goodness of fit index (AGFI) score should be over .90 for a good fit. The score in the model is .91. In the light of the goodness of fit indexes, it can be alleged that the model is robust. The first order path diagram of the model is presented in Figure 3;

Figure 3

The First Order Path Diagram of the Data Literacy at School Scale



To test multi-collinearity, correlations among the factors were checked. Hair et al. (2014, p. 196) allege that for the presence of multi-collinearity, the correlation coefficients should be .90 or over. A correlation value of +1 and -1 refers to singularity (Martin & Bridgmon, 2012, p. 414). Brown (2006, p. 32) denote that an inter-correlation score over .85 imply poor discriminant validity. In the model, the highest correlation coefficient score is .84 between factors 1 and 3. The correlation between factors 1 and 2 is very low; .30 and .21. The findings verify that there is no multi collinearity among factors. Based on the findings, the three-factorial structure formed through exploratory factor analysis was confirmed. The goodness of fit indexes of CFA signify that the three-factorial model established is robust.

As the final stage, reliability tests were carried out. Cronbach Alpha coefficient was tested to find out the internal validity of the scale. Singh (2007, p. 78) suppose that a figure of .75 or more usually is treated as an accepted level of reliability. Cronbach's α was calculated to be .882. The internal validity and reliability were also tested by split-half method. Split-half is a reliability test in which "half of the indicators, tests, instruments, or surveys, are analyzed assuming it to be the whole thing" (Singh, 2007, p. 78). The correlations between the two halves are calculated and high correlations are regarded to be the sign of reliability (Field, 2009, p. 674). Split half method is preferable to Cronbach alpha when the items are in a multi-dimensional form (Thompson et al., 2010, p. 235). A high correlation coefficient must be met in split half reliability test to verify a goodness of fit. In the analysis, the correlation between the two halves is *r*=.837 and Spearman-Brown coefficient is R=.911. The findings verify that the model is robust. As the last internal validity and reliability technique, Gutman

split-half coefficient was calculated and Guttman's lambda has been found out to be λ=.904, signifying the goodness of fit.

Test-retest technique was applied to examine the external validity of the scale. The scale was applied to the same group of teachers and administrators twice in an interval of two weeks and the correlations between the results of the two applications were calculated. The demographic data about the test-retest are presented in Table 5;

Table 5
Demographic Data about the Participants of the Test-Retest

		n	%
	First	44	53.01
	Second	39	46.99%
Duty	Teacher	71	85.5%
	Administrator	12	14.5%
Seniority	1-10 Years	9	10.8%
	11-20 Years	32	38.6%
	21-30 Years	35	42.2%
	31 years and over	7	8.4%
School Level	High School	51	61.4%
	Secondary School	17	20.5%
	Primary School	15	18.1%

The missing value analysis was carried out and in none of the cases the rate of the missing values exceeded the value of 5%. The EM statistics is p=.763 and p≤.05. The Z scores are between the threshold values of +3 and -3. The averaging method was utilized to replace missing values. The skewness and kurtosis values are out of the threshold values only in 31+ years of seniority groups, which consists of six participants, skewness=1.461, kurtosis=3.948. After data cleaning processes, correlations between the two tests were calculated between the two applications. Pearson correlation coefficient is r=.800, p≤.05, Spearman-Brown correlation coefficient is R=.961, p≤.05, and Kendal's tau-b is τ_b=.904, p≤.05. The findings of test-retest technique verified the external validity of the scale. The final scale was sent to language experts for translation and the draft was reviewed by the researchers and the final version of the "data literacy at school scale" was formed. The language experts to whose opinions applied are Dr. Kerem Tekşen, Ministry of National Education, Dr. Gökhan Savaş, Karabük University and Dr. Erhan Dolapçı, Ministry of National Education. The final version of the scale is presented in Appendix 1.

Discussion and Conclusion

Data based decision making is significant for instructional processes and thus, it is crucial for teachers and school leaders to be trained not only for statistical techniques but also for how data should be utilized to inform instruction (Henderson & Corry, 2021, p. 242). Data literacy is a prerequisite for data-based decision making (Kippers et al., 2018, p. 21). Data literacy requires skills related to understand data and its graphical representations (Stephenson & Schifter Caravello, 2007, p. 525). It is vital to improve data literacy both for teachers and school administrators to make use of data in educational and instructional processes. In this context, to put forth a realistic picture of the current situation of data literacy at school could be handled as a significant first step to manage efforts to improve data literacy of school members. Therefore, the scale could be functional in determining the current situation of data literacy at school.

The development of the scale was carried out in four main phases. First of all, an item pool was created and it was revised and improved with the help of the experts. In the second phase exploratory factor analysis was carried out and the draft scale was structured to be applied to confirmatory factor analysis. The confirmatory factor analysis proved that the three dimensional structure formed by the exploratory factor analysis is robust. As the final stage, validity and reliability analyses were carried out. Cronbach's α was calculated to be .882, which denoted the internal validity of the scale. For internal validity, spit half method and Guttman's lambda tests were carried out. The results of the split half test proved the internal validity of the scale; r=.837 and Spearman-Brown coefficient is R=.911. Moreover, Guttman's lambda was calculated to be λ=.904, which is the indication of the internal validity. A test-retest technique was applied to test external validity. As the results of the analyses, it has been found out that Pearson correlation coefficient is r=.800, p≤.05, Spearman-Brown correlation coefficient is R=.961, p≤.05, and Kendal's tau-b is τb=.904, p≤.05.

The scale has three dimensions, which have different functions. First of all, it can help school leaders form a clear understanding for competencies of school administrators and teachers for data identification. Data identification refers to skills about distinguishing and describing various data types, visualizing data and figuring out their functions in educational and instructional processes. The ability to distinguish among different data types, representing them with visual instruments and discovering their possible functions could be regarded as an integral part of data literacy.

Data use implicates processes, conditions, and contexts in which data are interpreted and next steps are determined based on the implications from data (Coburn & Turner, 2012, p. 99). Data use at school could have positive impact on educational and instructional processes especially when actions are performed through data informed decisions (Anderson et al., 2010, p. 321). The level of data use could be affected by such factors as accessibility and timeliness of data, perceived validity of data and staff capacity and support (Ikemoto & Marsh, 2007, pp. 120-121). Therefore, increasing data literacy capacity of staff at schools could have a positive impact on data use and data use could be regarded as an integral component of data literacy. Data literacy capacity refers to individual skills and competencies of the members of an organization as well as the overall competence of the organization itself to manage data and reach actionable information from raw data. On the organizational level data

literacy is the collective ability of school staff to effectively engage with data across its lifecycle, from identification to application.

Data management refers to all processes, procedures and implementations regarding handling data. The final objective of data management is to extract value which can be put to work in organizational processes (Duygulu, 2023, p. 75). Components such as defining a data policy, collection, standardization and documentation of data, data access and data share are involved in data management (Fary & Owen, 2013 as cited in Chigwada et al., 2017, p. 2). When components of data management are scrutinized, it can be alleged that data management and data literacy involve similar skills and thus having an understanding for basics of data management could shed light on the current situation of data literacy levels of schools. Data management at the school context refers to the processes of turning data obtained through such sources as student achievement tests and teacher performance evaluations to actionable information and reflect information on schools' routine implementations to improve teaching and learning as well as to manage change processes.

Depicting the current picture of the data literacy at schools can guide school leaders for providing the teachers with the necessary and appropriate training for data literacy . Filderman et al., 2022, p. 337) found out that trainings on data literacy have a positive impact on teachers' knowledge and skills about data use. Based on the insights obtained from assessing the current situation of data literacy level at schools, school-based training programs could be designed to meet the needs of the teachers and school leaders. For example, based on a meta-analysis carried out on articles about data literacy between 2010-2018, Henderson and Corry (2021, p. 241) have put forth four recommendations for data literacy training for teachers and school leaders; "(1) create more skill-focused educator preparatory programs at colleges and universities, (2) encourage opportunities for collaboration between educators, (3) model and encourage data use from both quantitative and qualitative sources and (4) investigate the role of technology and big data on data literacy".

The scale could realize significant functions at school. To embody the hypothesis, some real life examples from school ecosystem could be given. Performance evaluation constitutes an integral part of instructional processes and it forms the basis for reshaping and redesigning instructional implementations. Teachers are encouraged to carry out process assessments with the rise of the constructivist approach. The teachers can apply to various tolls such as excel and google forms to carry out process assessment activities and these tools provide them with automatically created visuals and data about the assessment. Though, to interpret the data provided in various forms, teachers need to have data literacy to an extent, to interpret the data formed in various types by the software used. The situation is the same for school leaders as they are bombarded by data from various sources during their professional lives. The schools could organize trainings on data literacy though as the data literacy competencies might change drastically for each individual, it requires a healthy needs analyses to discover areas of improvement for each teacher and school leader. The scale in this context could provide the school members with valuable insights to concentrate on the right domains of data literacy for training. Taking the data obtained through the scale, training programs targeted at school members with different levels of data literacy

could be designed. In the same way, depending the on the data, topic based training sessions such as data visualization or data tabulating could be designed.

Consequently, the scale could help figure out data literacy competencies and deficiencies of school members. A data based needs analysis could be functional in developing data literacy capacity of schools by shedding light on the areas of development. Data based needs analysis refers to providing feedback for the target group based on objective, verifiable data obtained through scientific measurement instruments. It is a systematic evaluation process to identify gaps in data literacy skills among school staff, informed by objective data. To integrate trainings into the school in-service training activities, it could be essential to develop a healthy understanding towards the data literacy levels of teachers and school administrators. The scale could contribute to the processes of improving data literacy at schools by providing objective data about the areas of improvement with a view to data literacy. The developed scale offers school leaders a practical tool to assess current data literacy levels within their institutions. This assessment provides a foundation for designing targeted strategies to enhance data literacy skills, thereby improving overall competency and capacity in data-informed decision-making. It can also help individualize data literacy trainings at schools, figuring individual needs of the shareholders at school.

Limitations

The study has some limitations. One of the most significant limitation is that owing to the nature of the data literacy, the basic criteria might change drastically depending on the socio-economic structure of the community in which it was evaluated. Though maximal variation in sampling, they are all state schools and new research could also include private schools, which can be sometimes better equipped with information management systems and sometimes employ younger teachers who are more equipped with data analysis tolls and software. Another limitation of the research is the geographical area where data was collected. As socio-economic structure of the society could affect the components of data literacy levels of individuals and organizations, the districts could be varied in a way that it will encompass provinces which are more developed in relation to Kastamonu.

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Statement of Responsibility

Each of the authors of the research contributed equally in the process, extending from literature review to revising the final draft of the article.

Conflicts of Interest

As the authors of the article, we confirm that there are no conflicts of interest in the research.

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Appendix

Appendix 1

Factors and Items of the Data Literacy at School Scale

Items	Factor 1: Data identification
3	I can tabulate textual data
1	I can explain the concept of "data".
16	I can define the concept of "factual data".
26	I can list the types of data used in educational and instructional processes.
27	I can list the functions of data in teaching processes.
5	I can convert textual data into visual tools.
Items	Factor 2: Data use
15	I can explain the concept of "secondary data sources".
29	I can explain the concept of information pyramid.
23	I have knowledge about data storage tools at school.
24	I can benefit from digital data sources at school.
Items	Factor 3: Data management
19	I can list the specific characteristics of data.
10	I have knowledge about data storage tools.
18	I can list the stages in the data management process.

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Digital Game Addiction and Peer Interaction: The Role of Parents' Education Levels*

Dijital Oyun Bağımlılığı ve Akran Etkileşimi: Ebeveynlerin Eğitim Düzeylerinin Rolü

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ABSTRACT: This study investigates the impact of digital game addiction on peer play behaviors and social skills in early childhood, focusing on parents' education levels. Using a relational screening model, the sample consists of 405 preschool children attending kindergartens in Afyonkarahisar, Türkiye. Data were collected using the Digital Game Addiction Tendency Scale and the Penn Interactive Peer Play Scale (Parent Form). Significant negative correlations were found between the sub-dimensions of disconnection from life and conflict in the Digital Game Addiction Scale and play interaction, indicating that increased digital game addiction tendencies correspond to decreased positive peer play behaviors. No direct correlation was observed between the continuous play and reflection in life dimensions of digital game addiction and peer play interaction. The study emphasizes the importance of balancing digital and peer play experiences for children's social development. Additionally, it explores how parental education levels influence these dynamics, providing insights and recommendations for families, educators, and policymakers to monitor digital game use and promote balanced play activities. This research adds to the growing literature on digital game addiction and its implications for early childhood development, highlighting the critical role of parental education.

Keywords: Digital game addiction, peer play, early childhood, parental education.

ÖZ: Bu çalışma, dijital oyun bağımlılığının erken çocukluk dönemindeki akran oyun davranışları ve sosyal beceriler üzerindeki etkisini, ebeveynlerin eğitim düzeylerine odaklanarak incelemektedir. İlişkisel tarama modeli kullanılarak gerçekleştirilen araştırmanın örneklemini, Afyonkarahisar ilindeki anaokullarına devam eden 405 çocuk oluşturmaktadır. Veri toplama aracı olarak Dijital Oyun Bağımlılığı Eğilimi Ölçeği ve Penn Etkileşimli Akran Oyunu Ölçeği (Ebeveyn Formu) kullanılmıştır. Analizler sonucunda, Dijital Oyun Bağımlılığı Ölçeği'nin hayatla bağlantının kopması ve çatışma alt boyutları ile oyun etkileşimi arasında anlamlı negatif ilişkiler bulunmuştur. Bu durum, artan dijital oyun bağımlılığı eğilimlerinin olumlu akran oyun davranışlarının azalmasıyla ilişkili olduğunu göstermektedir. Dijital oyun bağımlılığının sürekli oyun oynama ve yaşamda yansıma boyutları ile akran oyun etkileşimi arasında doğrudan bir ilişki gözlemlenmemiştir. Çalışma, çocukların sosyal gelişimi için dijital ve akran oyun deneyimlerinin dengelenmesinin önemini vurgulamaktadır. Ayrıca, ebeveyn eğitim düzeylerinin bu dinamikleri nasıl etkilediği araştırılmış ve ailelere, eğitimcilere ve politika yapıcılara dijital oyun kullanımını izleme ve dengeli oyun aktivitelerini teşvik etme konularında öneriler sunulmuştur. Bu araştırma, dijital oyun bağımlılığı ve erken çocukluk gelişimi üzerindeki etkileri konusundaki literatüre katkı sağlamaktadır.

Anahtar kelimeler: Dijital oyun bağımlılığı, akran oyunu, erken çocukluk, ebeveyn eğitimi.

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The early childhood education period is defined as a critical process during which children make rapid progress in all areas of development, acquire the foundations of their personality, are maximally influenced by their socio-cultural environment, and strive to develop their existing potentials to the highest extent possible (Gander-Gardiner, 1981). One aspect that significantly influences children's development during this period is parental education levels, which can shape children's digital game addiction tendencies and peer interactions. One of the most sensitive aspects of a child's development during this period is socialization, and at the core of socialization lies play. When considering the physical, cognitive, linguistic, social, and emotional development of children, play holds a position as important as their basic needs (Koçyiğit et al., 2015). Therefore, play has a significant impact on a child's comprehensive development at the early childhood education level (National Association for the Education of Young Children [NAEYC], 2001). Play occupies an indispensable place in the lives of all children. Through play, children not only complete their developmental processes but also learn about their community, its rules, their own rights, the rights of their friends, sharing, cooperation, empathy, mutual assistance, and the development of creative skills. When we think of play, we often envision activities where children come together in open spaces, enjoying themselves with materials like balls and ropes. However, today, it can be observed that the concept of play has evolved from its traditional meaning, with more emphasis on indoor, individual, screen-based, and often non-interactive activities due to the advancement of technology. Changes in the way individuals acquire knowledge, communicate, shop, and entertain themselves have accompanied technological advancements, and some problems have arisen from the misuse of technology. One of the primary issues is digital game addiction, particularly among children, which can be influenced by the educational levels of both mothers and fathers. Parents with higher education levels might have better awareness and strategies to regulate their children's digital game use. Aslan (2016) pointed out that in our era, the internet, which is indispensable for everyone, captures children's attention from an early age, offering numerous opportunities for activities and catering to all age groups.

The popularization of digital games has led scholars to explore their role and effects in the lives of individuals, particularly children (Aydoğdu-Karaaslan, 2015; Bülbül et al., 2018; Fullerton et al., 2014; Kaya & Karaca, 2023; Mustafaoğlu & Yasacı, 2018). Defined as the use of technological devices like computers, tablets, and phones for gaming across various platforms (Göldağ, 2018; Jones et al., 2014; Marsh et al., 2016; Özhan, 2011), digital games have been shown to positively influence children's development. Enhancements in areas such as visual attention skills, visual intelligence (Küçük & Çakır, 2020; Gentile et al., 2011; Green & Bavelier, 2002), spatial visualization, communication, calculation, empathy, computer literacy (Anderson et al., 2012), cognitive development (Hazar & Hazar, 2017; Irmak & Erdoğan, 2016; Kestane, 2019; Yalçın & Bertiz, 2019), time management, decision-making, problem-solving skills (Mustafaoğlu & Yasacı, 2018), and hand-eye coordination (Bilgin, 2015) have been reported.

Conversely, there are concerns about the negative effects of digital games. Experts warn that while well-designed games can be beneficial, poorly designed ones might adversely impact children's mental, physical, and developmental health (Aydoğdu Karaaslan, 2015; Fullerton et al., 2014; Lautamo & Heikkila, 2011; Lieberman et al.,

2009). A crucial aspect to consider is the duration and content of engagement with digital games, as excessive use can lead to addiction and social or emotional problems (Bülbül et al., 2018; Lemmens et al., 2009). Children with digital game addiction may exhibit symptoms like attention deficit, aggression, depression, musculoskeletal disorders, visual impairments, headaches, sleep problems, epilepsy, obesity, skeletal and circulatory system disorders, decreased social behaviors, and academic achievement (Dursun & Çapan-Eraslan, 2018; Gentile, 2009; Gentile et al., 2012; Hazar et al., 2017; Mustafaoğlu & Yasacı, 2018; Karademir-Coşkun and Filiz, 2019; Talan & Kalınkara, 2020). Furthermore, addiction can impede the acquisition of social skills, as noted by Kestane (2019), who highlighted the risk of social isolation and loneliness. Unfortunately, excessive engagement in digital games can deprive children of valuable experiences like peer interaction and outdoor play (Hayırcı & Sarı, 2020; Hazar et al., 2017). This growing concern about the impact of digital game addiction on the social skills and peer interactions of children aligns with the principles of Bronfenbrenner's ecological systems theory, emphasizing the influence of both mothers' and fathers' education levels. This theory emphasizes the interconnectedness of a child's environment and its profound influence on their development. As we consider the risks associated with excessive digital gaming, it becomes essential to examine how these activities fit within the diverse ecosystems that shape a child's growth and learning.

Bronfenbrenner's (1979) ecological systems theory is based on the principle of mutual interaction, considering the child as a part of this system and explaining it as interconnected and interrelated ecosystems. In the microsystem within the ecological systems model, individuals directly interact with and establish connections with their environments. Therefore, it is asserted that there is ongoing interaction between the ecological system and the child, and peer relationships are one dimension of this interaction, in addition to the child's interactions with other elements. The microsystem encompasses the child's family, peers, school or work environment (Bronfenbrenner, 1979). In this context, it can be said that the child's acquisition of many social skills and friendships plays a significant role in their development (Lautamo & Heikkila, 2011). Peer relationships, which are one of the fundamental components of social life, play an important role in a child's development (Levine & Munsch, 2014). The foundation of peer relationships is laid in play environments during early childhood. Play can be defined as activities that have existed throughout human history and take on different forms at different stages of a person's life (L'abate, 2009). According to Levine and Munsch (2014), playing with peers in childhood provides numerous opportunities for cognitive, physical, and linguistic development and also offers many opportunities for social and emotional development (Cohen & Mendez, 2009; Lautamo & Heikkila, 2011; Tuğrul, 2015). Additionally, positive interactions established during play with peers can help children acquire necessary social skills for their future and reduce some social problems (Coplan et al., 2006), while negative peer relationships can increase problem behaviors (Hodges et al. 1997; Schwartz et al., 2000). To allow children to experience positive or negative peer relationships and develop positive peer relationships, opportunities need to be created. Interactive peer play environments play a significant role in this regard, especially in the early childhood period. In this context, Elkind (2007) emphasizes that children who engage in play from an early age are more likely to become individuals dedicated to lifelong learning, capable of solving problems

and understanding them. Furthermore, Erikson (1959), who places great importance on self-development, argues that positive social experiences acquired through self-development will lead to emotionally healthy individuals in their later lives. This is because during play, a child's social needs are met, allowing them to progress through developmental stages in a healthy manner (Tuğrul, 2015). Therefore, it can be said that interactive play environments play a crucial role in enabling children to become successful, individuals with positive self-concepts, and healthy individuals in their future lives.

Today, instead of engaging in peer play, children are increasingly turning to digital games due to urbanization and the rapid advancement of technology. In recent years, there has been a significant increase in the prevalence of digital game use among young children, raising concerns about its potential impact on their social development and peer interactions (Chaudron et al., 2018; Domoff et al., 2019). The advent of the COVID-19 pandemic has further accelerated this trend, as children have spent more time indoors and have had limited opportunities for face-to-face social interactions, leading to increased reliance on digital media for entertainment and socialization (Nagata et al., 2022; Lemish, 2021). While digital games can offer educational benefits and enhance certain cognitive skills (Granic et al., 2014), excessive use has been associated with negative outcomes such as social withdrawal, decreased physical activity, and the development of addictive behaviors (Kuss & Griffiths, 2017; Paulus et al., 2018).

Despite the growing body of research on digital game addiction in adolescents and adults, there is a paucity of studies focusing on early childhood—a critical period for social and emotional development (Hinkley et al., 2018; Njoroge et al., 2013). Early childhood is a formative stage where children acquire foundational social skills through interactive play with peers (Bo Stjerne & Parker, 2021). Excessive engagement with digital games during this period may interfere with children's opportunities to engage in essential peer play experiences, potentially impacting their social competence and peer relationships (Gottschalk, 2019; Madigan et al., 2020).

Furthermore, parental education levels play a crucial role in shaping children's media use behaviors and can influence the extent to which children are exposed to and engage with digital games (Lauricella et al., 2015; Wu et al., 2017). Parents with higher education levels may be more aware of the potential risks associated with excessive digital game use and may implement strategies to moderate their children's screen time (Nikken & Opree, 2018). Conversely, lower parental education levels have been linked to less monitoring of children's media use and higher rates of digital game addiction among children (Nikken & Jansz, 2006). However, there is a lack of research examining how parental education levels may moderate the relationship between children's digital game addiction tendencies and their peer play behaviors in early childhood. This gap in the literature underscores the need for studies that explore the intersection of digital game addiction, peer interactions, and parental influence during early childhood. Understanding these dynamics is particularly important in the current digital era, where children's media environments are rapidly evolving (Livingstone et al., 2017). By investigating how digital game addiction tendencies relate to peer play behaviors and considering the role of parental education levels, this study aims to contribute valuable

insights that can inform interventions and guide parents, educators, and policymakers in supporting children's healthy development."

In line with this goal, the research questions for this study are as follows:

- Is there a relationship between children's digital game addiction tendencies and peer play behaviors in early childhood?
- Is there a relationship between the sub-dimensions of children's digital game addiction tendencies and the sub-dimensions of their peer play behaviors in early childhood?
- Is there a significant difference between the sub-dimensions of digital game addiction tendencies and the sub-dimensions of peer play behaviors in children in early childhood based on parental education level?

In this study, the relationship between the digital game addiction tendencies of children in early childhood and their interactive peer play behaviors was examined, taking into account parental education levels.

Method

Research Design

This study employs a correlational research design to examine the relationship between children's digital game addiction tendencies and their peer play behaviors, considering the influence of parental education levels. A correlational design is appropriate for this research because it allows for the investigation of the extent to which two or more variables are related without manipulating any variables (Creswell, 2014; Fraenkel et al., 2012). This design is commonly used in educational research to identify patterns and relationships among variables in natural settings (Gall et al., 2007).

Study Sample

The population of the research consists of children in preschool institutions affiliated with the Afyonkarahisar Provincial Directorate of National Education - Türkiye. The sample of the study was determined using the convenient sampling method, which is one of the non-random sampling methods, for the 2022-2023 academic year. The convenient sampling method aims to reach the group that provides the closest, most appropriate, and easiest access to the required sample for the research (Büyüköztürk et al., 2011; Cohen & Manion, 1998). Accordingly, 405 preschool children attending nine preschool education institutions affiliated with the National Education Directorate in Afyonkarahisar city center for the 2022-2023 academic year were included in the research through convenient sampling. The participants' ages ranged from 58 to 70 months, with a mean age of 64 months.

Table 1

Demographic Information of Children and Parents Included in the Study

Characteristics	N	%
Child Gender		
Boy	197	48.6
Girl	208	51.4
Mother's age		
29 years and below	123	30.5
30-39 years	238	58.8
40 years and above	44	10.9
Father's age		
29 years and below	37	9.1
30-39 years	280	69.1
40 years and above	88	21.7
Mother's Education		
Primary or Middle School	127	31.4
High School	135	33.3
University	143	35.3
Father's Education		
Primary or Middle School	69	17
High School	159	39.3
University	177	43.7
Child's birth order		
First child	185	45.7
Middle child or one of the middles	116	28.6
Last child	104	25.7
Number of children in the family		
1 child	78	19.3
More than 1 child	327	80.7
Child's previous attendance to preschool education		
Attended	121	29.9
Not attended	284	70.1

Table 1 presents a detailed demographic breakdown of the study's participants. The gender distribution of the children involved in the study is fairly balanced, with boys comprising 48.6% (n=197) and girls 51.4% (n=208). Regarding parental age, mothers were predominantly in the 30-39 age bracket, accounting for 58.8% (n=238) of the sample, while the majority of fathers fell into the same age category, representing 69.1% (n=280). In terms of educational attainment, a slightly higher percentage of

fathers (43.7%, n=177) than mothers (35.3%, n=143) had received university education. Mothers with primary or middle school education constituted 31.4% (n=127) of the sample, whereas this educational level was reported for 17% (n=69) of fathers. The distribution of children according to birth order revealed that 45.7% (n=185) were first-borns, 28.6% (n=116) were middle children, and 25.7% (n=104) were the youngest in their family. In terms of family size, the majority of families had more than one child (80.7%, n=327). Lastly, previous attendance to preschool education was reported for 29.9% (n=121) of the children, while a significant majority (70.1%, n=284) had not attended preschool education.

Data Collection Instruments

As instruments for data collection, the study utilized the "General Information Form," which contains personal details of preschool children, and two specialized scales. The "Digital Game Addiction Tendency Scale," developed by Budak and Işıkoğlu (2022), and the "Penn Interactive Peer Play Scale (Parent Form)," developed by Ahmetoğlu et al. (2016), were employed. Both scales are parent-reported measures.

General Information Form: This form, devised by the researcher, includes questions determining the child's gender, parents' age and educational status, birth order of the child, and whether the child has attended preschool education. The inclusion of parental education levels helps to understand how education may influence parenting styles, supervision, and management of children's digital game use.

Digital Game Addiction Tendency Scale: To measure the levels of children's tendencies towards digital game addiction, the study used the "Digital Game Addiction Tendency Scale," developed and validated for reliability by Budak and Işıkoğlu (2022). The scale, consisting of 20 items rated on a 5-point scale (5: Always, 4: Often, 3: Sometimes, 2: Rarely, 1: Never), allows for a minimum score of 20 and a maximum of 100. It's important to note that there are no negatively scored items. Higher total scores indicate an increased tendency towards digital game addiction. The scale can be analyzed either by evaluating each item individually or by considering the total score. It includes four subscales: disconnection from life (7 items), conflict (5 items), continuous Play (5 items), and reflection in life (3 items). The subscales measure, respectively, social withdrawal during game play, reactions to being prevented from playing, the tendency to spend prolonged periods in digital gaming, and the probable symptomatic behaviors and life impacts resulting from gaming. The Cronbach's Alpha coefficients for the subscales are as follows: disconnection from life = .88, conflict = .90, continuous play = .82, and reflection in life = .70. The overall reliability coefficient of the scale is .93, indicating its reliability. The Digital Game Addiction Tendency Scale showed high internal consistency in this study (α = .91), confirming the scale's reliability for assessing digital game addiction tendencies in young children. The subscales exhibited strong reliability, with Cronbach's Alpha values of .86 for disconnection from life, .88 for conflict, .83 for continuous play, and .72 for reflection in life, indicating robust measurement across the various dimensions of digital game addiction.

***Penn Interactive Peer Play Scale (PIPPS) - Parent Form*:** This scale, originally developed by Fantuzzo, Mendez, and Tighe (1998) and adapted to Turkish by

Ahmetoğlu, Acar, and Aral (2016), is used to determine the play behaviors of preschool children aged 60-72 months during free play with their peers. The Penn Interactive Peer Play Scale consists of 28 items and encompasses three subscales: play interaction, play disruption, and play disconnection. The play interaction subscale highlights positive aspects such as comforting other children, helping, displaying creative behaviors in play, and encouraging others to join in (e.g., sharing toys with others). Play disruption defines aggressive and antisocial behaviors that disrupt ongoing peer interaction (e.g., ruining others' games), while play disconnection represents non-participation and withdrawn behaviors in peer play (e.g., refusing to join when invited). Scores are expected to be inversely related between the play interaction and the other two subscales (play disruption and play disconnection). Each item on the scale is rated on a four-point Likert scale. The internal reliability coefficients for the Turkish adaptation are play interaction (α=.72), play disruption (α=.75), and play disconnection (α=.68). For the study sample, the Penn Interactive Peer Play Scale (Parent Form) demonstrated satisfactory internal consistency, making it a suitable tool for measuring peer play behaviors in early childhood. The subscales also demonstrated acceptable reliability, with Cronbach's Alpha values of .74 for play interaction, .77 for play disruption, and .68 for play disconnection, suggesting reliable measurement across different dimensions of peer play behaviors.

Data Collection Process

In this study, examining the relationship between digital game addiction tendencies and peer play behaviors among early childhood children and the variable of parental educational status, initial efforts were focused on determining the study group. Necessary permissions were obtained from the Afyonkarahisar Directorate of National Education to identify the study group. Prior to data collection, parents were informed about the study's objectives, data collection tools, and privacy policies. A parental consent form was also utilized to ensure ethical compliance. The measurement tools, which were parent reported, were completed by the parents of the 405 children from nine preschool centers included in the sample group. During this process, meetings were initially held with the parents of the children involved in the study, where they were asked to assess their children's digital game addiction tendencies and peer play behaviors. Information about the scales was provided to the parents during these meetings. The measurement tools were distributed to the interested parents and collected by the researchers at the end of the meeting. This process facilitated the efficient gathering of data necessary for the study within the designated time frame.

Data Analysis

The analysis of the data derived from the "Digital Game Addiction Tendency Scale" and the "Penn Interactive Peer Play Scale (Parent Form)" commenced with an evaluation of the distribution of scores. This preliminary assessment utilized the Kolmogorov-Smirnov (K-S) Test, a robust method for determining the conformity of data distribution to normality. The results of this test indicated that the p-values were below the threshold of .05 (Büyüköztürk, 2007), thus confirming a deviation from a normal distribution.

In light of the non-normal distribution of the data, the Spearman Correlation Coefficient was judiciously selected as the most appropriate statistical tool for examining the relationships between the scores on the Digital Game Addiction Tendency Scale and the Penn Interactive Peer Play Scale (Parent Form). This non-parametric measure was employed due to its suitability for analyzing ordinal data or data not adhering to a normal distribution, providing a robust evaluation of the monotonic relationships between the variables under study.

Furthermore, to analyze the impact of the variable of parental educational status on the aforementioned scales, the Kruskal Wallis H Test was utilized. This non-parametric test, optimal for comparing more than two independent groups, was instrumental in discerning any statistically significant differences in scores across varying levels of parental education. The implementation of these rigorous statistical methodologies underscores the comprehensive and meticulous approach adopted in the analysis phase of this research, ensuring the validity and reliability of the findings.

Results

The findings related to the influence of maternal education levels on the tendencies toward digital game addiction and the sub-dimensions of peer play behaviors among early childhood children are presented in Tables 2 and 3.

Table 2

Kruskal Wallis H Analysis of the Relationship between Digital Game Addiction Tendencies and Sub-Dimensions of Peer Play Behaviors in Early Childhood, In Relation to Mothers' Education Levels.

Scales	Sub-dimensions	Mother's Education	N	Mean Rank	Kruskal-Wallis H		
					χ^2	P	Sig.
Digital Game Addiction Tendency Scale	Disconnection from life	Primary or Middle School	127	218.484	4.990	0.082	
		High School	135	186.411			
		University	143	204.909			
	Conflict	Primary or Middle School	127	227.961	8.451	0.015	1-2
		High School	135	191.889			1-3
		University	143	191.322			
	Continuous Play	Primary or Middle School	127	228.965	10.393	0.006	1-2
		High School	135	199.141			1-3
		University	143	183.584			
	Reflection in life	Primary or Middle School	127	198.559	0.290	0.865	

		High School	135	203.981			
		University	143	206.017			
	Play interaction	Primary or Middle School	127	182.461			
					5.722	0.057	
		High School	135	212.307			
		University	143	212.455			
Penn Interactive Peer Play Scale (PIPPS) - Parent Form	Play disruption	Primary or Middle School	127	224.220			
					6.302	0.043	1-2 1-3
		High School	135	190.519			
		University	143	195.937			
	Play disconnection	Primary or Middle School	127	221.547			
					4.905	0.086	
		High School	135	191.093			
		University	143	197.769			

Upon examination of Table 2, it is evident that no significant relationship was found between the mothers' education levels and the sub-dimensions of the Digital Game Addiction Tendency Scale, namely disconnection from life ($\chi^2 = 4.990$, $p = .082$, $p > .05$) and reflection in life ($\chi^2 = 0.290$, $p = .865$, $p > .05$). However, significant statistical differences were identified in the conflict ($\chi^2 = 8.451$, $p = .015$, $p < .05$) and continuous play ($\chi^2 = 10.393$, $p = .006$, $p < .05$) sub-dimensions based on the mother's education level. Further pairwise comparisons to ascertain where these significant differences lay revealed that lower maternal education levels were significantly associated with higher scores in the conflict and continuous play sub-dimensions.

Regarding the sub-dimensions of the Penn Interactive Peer Play Scale, no significant relationship was observed between the mothers' education levels and the play interaction ($\chi^2 = 5.722$, $p = .057$, $p > .05$) and play disconnection ($\chi^2 = 4.905$, $p = .086$, $p > .05$) sub-dimensions. However, a significant statistical difference was noted in the play disruption sub-dimension ($\chi^2 = 6.302$, $p = .043$, $p < .05$) relative to the mothers' education level. Subsequent pairwise comparisons indicated a significant difference favoring children of mothers with lower education levels in the play disruption sub-dimension scores.

This finding suggests that maternal education levels are associated with certain behaviors in children, particularly in the realms of digital game addiction and peer play. Specifically, lower maternal educational levels are linked with increased tendencies in children towards conflict and continuous play in digital game addiction, and more disruptive behaviors in peer interactions. This highlights the influence of maternal educational background on specific child behavioral outcomes, underscoring the need for attention to parental education in understanding and addressing children's digital engagement and social behaviors.

Table 3

Kruskal Wallis H Analysis of the Relationship between Digital Game Addiction Tendencies and Sub-Dimensions of Peer Play Behaviors in Early Childhood, in Relation to Fathers' Education Levels

Scales	Sub-dimensions	Father's Education	N	Mean Rank	Kruskal-Wallis H		
					X^2	P	Sig.
Digital Game Addiction Tendency Scale	Disconnection from life	Primary or Middle School	69	206.580	1.276	0.528	
		High School	159	209.626			
		University	177	195.653			
	Conflict	Primary or Middle School	69	212.783	8.404	0.015	2-3
		High School	159	219.792			
		University	177	184.102			
	Continuous Play	Primary or Middle School	69	222.812	13.207	0.001	1-3 2-3
		High School	159	221.016			
		University	177	179.093			
	Reflection in life	Primary or Middle School	69	213.543	2.335	0.311	
		High School	159	209.453			
		University	177	193.093			
Penn Interactive Peer Play Scale (PIPPS) - Parent Form	Play interaction	Primary or Middle School	69	187.609	2.322	0.313	
		High School	159	199.862			
		University	177	211.819			
	Play disruption	Primary or Middle School	69	217.761	6.724	0.035	1-3 2-3
		High School	159	215.516			
		University	177	186.003			
	Play disconnection	Primary or Middle	69	220.355	1.882	0.390	

	School		
	High School	159	198.079
	University	177	200.655

Upon reviewing Table 3, it is discernible that no significant relationship exists between fathers' educational levels and the sub-dimensions of the Digital Game Addiction Tendency Scale, specifically disconnection from life ($\chi^2 = 1.276$, $p = .528$, $p > .05$) and reflection in life ($\chi^2 = 2.335$, $p = .311$, $p > .05$). However, significant statistical differences were identified in the conflict ($\chi^2 = 8.404$, $p = .015$, $p < .05$) and continuous play ($\chi^2 = 13.207$, $p = .001$, $p < .05$) sub-dimensions in relation to paternal education level. Further pairwise comparisons to determine the nature of these differences revealed that children of fathers with lower educational levels exhibited significantly higher scores in the conflict and continuous Play sub-dimensions.

In terms of the Penn Interactive Peer Play Scale sub-dimensions, no significant relationship was observed between fathers' education levels and play interaction ($\chi^2 = 2.322$, $p = .313$, $p > .05$) or play disconnection ($\chi^2 = 1.882$, $p = .390$, $p > .05$). However, a notable statistical difference was found in the play disruption sub-dimension ($\chi^2 = 6.724$, $p = .035$, $p < .05$) based on paternal education level. Subsequent pairwise comparisons indicated a significant difference favoring children of fathers with lower education levels in the play disruption sub-dimension scores.

This finding implies that paternal educational levels have a significant impact on certain aspects of children's behaviors related to digital game addiction and peer interaction. Specifically, children of fathers with lower educational levels are more likely to exhibit higher tendencies towards conflict and continuous play in the realm of digital game addiction, as well as increased disruptive behaviors in peer interactions. This suggests a potential link between paternal education and specific behavioral patterns in children, highlighting the importance of considering parental educational backgrounds in understanding children's digital and social behaviors.

The findings regarding the relationship between the sub-dimensions of digital game addiction tendencies and peer play behaviors among early childhood children are presented in Table 4.

Table 4

Spearman Correlation Analysis of the Scores on the Sub-Dimensions of the Digital Game Addiction Scale and the Penn Interactive Peer Play Scale - Parent Form among the Study Group Included in the Research

Digital Game Addiction Tendency Scale	Penn Interactive Peer Play Scale (PIPPS) - Parent Form	N	r	p
Disconnection from life	Play interaction	405	-.119	.016*
Conflict		405	-.099	.047*
Continuous play		405	-.059	.237
Reflection in life		405	-.032	.518
Disconnection from life	Play disruption	405	.215	.000**
Conflict		405	.222	.000**
Continuous play		405	.164	.001**
Reflection in life		405	.180	.000**
Disconnection from life	Play disconnection	405	.263	.000**
Conflict		405	.191	.000**
Continuous play		405	.162	.001**
Reflection in life		405	.115	.021*

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

In a sample of 405 participants, the Spearman Correlation Analysis revealed diverse relationships between the sub-dimensions of the Digital Game Addiction Tendency Scale and the Penn Interactive Peer Play Scale (PIPPS) - Parent Form. Notably, negative correlations were found between disconnection from life and play interaction ($r = -.119$, $p = .016$) and conflict and play interaction ($r = -.099$, $p = .047$), suggesting that higher disconnection or conflict due to digital game addiction is associated with less positive peer interaction. The correlations for continuous play and reflection in life with play interaction were negative but not statistically significant. Conversely, all sub-dimensions of the Digital Game Addiction Scale showed positive, statistically significant correlations with play disruption and play disconnection, with disconnection from life ($r = .263$, $p = .000$) and conflict ($r = .191$, $p = .000$) showing particularly strong associations. These positive correlations indicate that higher digital game addiction tendencies are linked with more disruptive and disconnected peer play behaviors. The significance levels, denoted by asterisks, highlight the varying degrees of these relationships, underscoring the nuanced interplay between digital game addiction tendencies and peer play behaviors in early childhood. This finding implies that digital game addiction in early childhood is intricately linked with various aspects of peer play behaviors. Higher tendencies towards digital game addiction, particularly in dimensions like disconnection from life and conflict, are associated with more negative peer interactions and an increase in disruptive and disconnected behaviors. This highlights the complex and significant impact of digital game engagement on the social development and interaction skills of children in their early years.

Discussion

Games, acknowledged as a vital component of culture since the dawn of human history, hold particular significance during early childhood. Children in this phase can spend most of their time playing (Schwartzman, 2012), with play environments enabling them to overcome a myriad of emotions and relax, thus underscoring the therapeutic aspect of play. However, contemporary trends have shifted children's play environments and materials, increasingly favoring digital games over traditional play (Biricik & Atik, 2021). Technological advancements and the digital era have inevitably altered the nature of play, compounded by factors such as urbanization, parental safety concerns, and pandemics, leading children to play through screens and virtual platforms (Biricik & Atik, 2021). A critical point of concern is the introduction of digital games at younger ages, unpredictable content, increased screen time, and the emerging concept of addiction. Mustafaoğlu and Yasacı (2018) argue that digital game addiction in individuals can lead to undesirable outcomes such as behavioral and health problems. Therefore, it is imperative for parents to understand the contributions of peer play environments to their children's healthy development, provide such opportunities, and exercise control over digital game content and duration. Contemporary education systems also demand the cultivation of 21st-century skills in individuals, emphasizing the need for interactive play environments to acquire skills like communication, collaboration, and social and intercultural competencies. This study aimed to investigate the relationship between digital game addiction tendencies and peer play behaviors in early childhood, exploring the reasons behind the associations between their sub-dimensions.

The study initially established significant negative correlations between the sub-dimensions of disconnection from life and conflict in the Digital Game Addiction Tendency Scale and the play interaction sub-dimension in the Penn Interactive Peer Play Scale Parent Form. The disconnection from life sub-dimension indicates behaviors where children detach from social life and postpone or delay biological needs during digital gameplay. Conflict refers to negative behaviors and reactions when children are not allowed to play digital games. Play interaction highlights children's strengths in comforting and assisting others during play. The study found that as children's digital game addiction tendencies in disconnection from life and conflict increased, their play interaction scores decreased. The significance of peer relationships in children's developmental domains is highlighted, given that children initially bond with their parents and later expand their network to include peers. Digital games can negatively affect children's peer interaction during play, as evidenced by the reduction in play interaction scores and the increase in disconnection from life and conflict scores with increased digital gameplay. Current trends suggest a decline in physical play and outdoor play habits (Aarsand, 2011), with a shift towards digital games, limiting children's socialization and interaction with peers in favor of virtual gaming environments. It has been noted that the increasing number of gamers leading to more game development, with children playing with electronic analogs of traditional play materials in virtual worlds (Elkind, 2007; Frost et al., 2012). Concerns about screen-based play environments isolating children from real life, increasing obesity due to inactivity, and exposing them to physical and psychological issues have been raised (Aarsand, 2011). The findings of this research corroborate these concerns, indicating a

decrease in play interaction scores and an increase in disconnection from life and conflict scores with higher digital game addiction tendencies. Budak (2020) also noted a decrease in social competence and the emergence of social behavioral problems with increased digital game addiction. Hazar et al. (2016) observed that digital games individualize children, detaching them from family and society. Griffiths (2010) highlighted that children addicted to digital games experience an increased desire to play, leading to conflicts with parents when restricted. This study's findings align with these observations, indicating a decrease in play interaction and an increase in conflict scores, reflecting the adverse effects of digital game addiction on peer play behaviors.

The findings of this research highlight that the tendencies toward continuous play" and reflection in life" in digital game addiction do not have a direct effect on the children's interactions with their peers in play settings. This result suggests that the impact of digital games on children's social skills might be limited and can be explained by several factors within the context of early childhood education. Firstly, there's a distinct difference between digital games and peer-interactive play; the former focuses on individual skills and screen engagement, while the latter enhances communication and social abilities (Vygotsky, 1978). While digital games require individual skill and concentration, peer play facilitates the development of a child's communicative and social skills. Children, inherently social beings (Bronfenbrenner, 1979), do not entirely replace their need for social interaction through digital games, and this need can be fulfilled outside digital gameplay. Furthermore, there is a distinction in the development of cognitive and emotional skills between digital and peer play. Digital games often cater to cognitive skills like problem-solving and decision-making, whereas peer interactive play nurtures empathy, cooperation, and social skills (Piaget, 1962). This indicates that skills developed through individual games do not directly correlate with those developed in peer interactive settings. Lastly, due to the structural nature of digital games, their focus on individual achievement and progression offers a somewhat independent experience from peer interactions. While this may suggest a diminishing effect on peer interactions (Ferguson, 2015; Gentile et al., 2011), it does not completely inhibit them, hence the lack of a direct correlation in the scales. These findings underscore the complexity and importance of individual and environmental factors in the examination of digital game addiction and peer interactions. Each child’s individual characteristics and their environmental context play a significant role in the dynamics of these interactions. Considering these varied factors and potential interplays is critical for researchers evaluating the impact of digital games on children (Przybylski & Weinstein, 2017).

In the study, positive significant correlations were found between the sub-dimensions of disconnection from life, conflict, continuous play, and reflection in life in the Digital Game Addiction Tendency Scale and the play disruption and play disconnection sub-dimensions in the Penn Interactive Peer Play Scale Parent Form. Continuous play signifies that children spend more and longer durations playing digital games daily, and reflection in life shows that children imitate characters from the games and express a desire to purchase related items. Play disruption in peer play behaviors indicates aggressive and antisocial behaviors disrupting ongoing peer interactions, and play disconnection represents non-participation and introverted behavior. The research findings indicate that as the scores in disconnection from life, conflict, continuous play,

and reflection in life increase due to digital game addiction tendencies, the scores in play disruption and play disconnection also rise. Hence, it can be said that increased digital game addiction tendencies negatively impact peer play behaviors. Given the nature of digital games, children play individually, distancing themselves from social play environments, thus adversely affecting their social-emotional gains from peer play settings. Literature review indicates that children now prefer playing digital games indoors instead of traditional street games (Balcı & Ahi, 2017; Koçyiğit & Başara-Baydilek, 2015; Tuğrul, 2015). Studies also show that as children's scores in digital game addiction tendencies increase, their inclination towards social play decreases (Baysan, 2022; Gözüm & Kandır, 2020), and parents believe that digital gameplay negatively impacts children's social relationships (Mustafaoğlu & Yasacı, 2018) and academic performance (Cerniglia et al., 2020). Aggressive and hostile behaviors have been observed in children with digital game addiction tendencies (Allahverdipour et al., 2010; Avcı & Er, 2019), along with a tendency to identify with and become attached to game characters, which can lead to fatal consequences (Horzum, 2011), and discordance with the social environment (Gholamitooranposhti et al., 2012). Our study aligns with these findings, suggesting that children with digital game addiction tendencies develop negative peer play behaviors, particularly in the sub-dimensions of play disruption and play disconnection. Especially in contemporary times, when children are provided with peer play environments, they often struggle to decide what to play, create, or find games. Even when together, they prefer playing digital games, indicating an inclination towards digital game addiction, reduced interest in different play materials and environments, and difficulties in initiating and sustaining play. Our study's findings corroborate these observations.

Our findings indicate that parental education levels significantly influence children's behaviors related to digital game addiction and peer interactions. Specifically, children of parents with lower educational levels exhibited higher tendencies towards digital game addiction and more problematic peer interactions. This aligns with the literature suggesting that parental education levels are crucial in shaping children's digital engagement and social development (Bardak, 2023). Higher education levels in parents often correlate with better awareness and strategies for managing children's digital game use, thereby fostering healthier play behaviors and social skills (Mustafaoğlu & Yasacı, 2018). Research indicates that parents with higher educational attainment tend to provide more structured environments and engage in more effective monitoring of their children's activities, which helps in reducing the risks associated with digital game addiction (Işıkoğlu-Erdoğan et al., 2019). In contrast, lower educational levels in parents can be associated with less awareness and fewer resources to manage and mitigate the negative impacts of digital game usage (Bağçeli-Kahraman & Başal, 2011).

Additionally, our findings contribute to the existing body of research by highlighting the importance of parental education in understanding and mitigating the negative effects of digital game addiction on children. Previous studies have shown that parental involvement and the quality of parent-child interactions are critical in shaping children's behavioral outcomes. For instance, the quality and quantity of play interactions between parents and children significantly impact children's social and emotional development (Case-Smith & Kuhaneck, 2008; Fogle & Mendez, 2006).

Parents with higher education levels often engage more effectively in these interactions, providing richer and more diverse play experiences that promote better social and cognitive skills in children (Wood et al., 2002).

Conclusion and Suggestions

This study reveals that there is no direct relationship between the continuous play" and reflection in life" dimensions of digital game addiction tendency and children's interactions in peer play. According to the research results, intensive use of digital games has not created the anticipated negative impact on children's social skills and peer interactions. This situation is supported by literature findings that digital games and peer play develop different skill sets, and children's social needs can also be met through activities outside digital gameplay. Our study's results expand our understanding of the impact of digital game use on children's peer relationships and social development, adding a new perspective to research in this field. Furthermore, the significant influence of parental education levels on children's digital game addiction tendencies and peer play behaviors highlights the critical role of parental involvement in managing children's digital engagement.

Given these findings, it is essential to provide practical implications and recommendations for parents, educators, and policymakers. Parents should be educated on the importance of monitoring and regulating their children's digital game use, ensuring that screen time is balanced with opportunities for peer interaction and outdoor play. Parent training programs can offer strategies to create structured and supportive environments that promote healthy play behaviors. Educators should integrate play-based learning into the curriculum, emphasizing activities that enhance social and communication skills. Schools can also support parents by providing resources and guidance on managing children's digital game use. Policymakers should develop and implement policies that support these efforts, such as establishing guidelines on screen time and funding initiatives that encourage play-based learning and parent education.

This study, while providing valuable insights into the relationship between digital game addiction and peer interaction in early childhood, has certain limitations. Firstly, the cross-sectional nature of the research design limits the ability to establish causation. Longitudinal studies are recommended for future research to better understand the temporal dynamics of this relationship. Additionally, the sample was geographically and culturally specific, which may affect the generalizability of the findings. Future research should consider diverse populations to enhance the applicability of the results. Lastly, the reliance on parent-reported measures might introduce bias; incorporating direct observations or children's perspectives could provide a more holistic understanding. Future research should explore these areas to provide a more comprehensive understanding of the impact of digital game addiction on children's social development. In conclusion, addressing these factors can better support children's overall development in the digital age, paving the way for healthier and more balanced growth.

Statement of Responsibility

Nezahat Hamiden Karaca: Conceptualization, methodology, validation, formal analysis, writing original draft. Neriman Aral: Writing-review & editing, supervision, resources. Ümit Ünsal Kaya: Writing-review, translation, proofreading.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article. All authors have contributed to the work and have approved the final manuscript. There are no financial, personal, or professional relationships that could be perceived to influence the work reported in this paper.

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Exploring EFL Students' AI Literacy in Academic Writing: Insights into Familiarity, Knowledge and Ethical Perceptions

İngilizceyi Yabancı Dil Olarak Öğrenen Öğrencilerin Akademik Yazımda Yapay Zekâ Okuryazarlığını Keşfetmek: Aşinalık, Bilgi ve Etik Algılar Üzerine İçgörüler

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ABSTRACT: As artificial intelligence (AI) increasingly influences education, understanding learners' experiences, engagement and literacy of these tools is critical. This study explores AI literacy among Turkish English as a Foreign Language students regarding their familiarity, knowledge, and ethical perceptions of AI technologies in academic writing. Using a descriptive exploratory approach, the study surveyed 427 students from two Turkish universities. Findings reveal a moderate level of AI familiarity and usage among participants, with a significant reliance on AI tools for translation and grammar proofreading. Despite recognizing AI's potential to enhance academic writing, students exhibited limited technical proficiency and understanding of AI's underlying mechanisms, highlighting a need for targeted and structured AI education for EFL writing. Moreover, ethical perceptions emerged as a critical dimension of AI literacy: while students acknowledged the utility of AI in improving academic writing, the majority expressed concerns about plagiarism and academic integrity, emphasizing the importance of transparent and responsible AI use. The findings contribute to the ongoing discourse on AI integration in EFL education, offering insights for policymakers, educators, and researchers to better prepare students for an AI-driven academic environment.

Keywords: Artificial intelligence literacy, EFL, academic writing, generative artificial intelligence, Türkiye.

ÖZ: Yapay zekanın (YZ) eğitim üzerindeki etkisi giderek artarken, öğrenenlerin bu araçlarla ilgili deneyimlerini, etkileşimlerini ve okuryazarlık seviyelerini anlamak büyük önem taşımaktadır. Bu çalışma, Türk EFL (İngilizceyi Yabancı Dil Olarak Öğrenen) öğrencilerinin akademik yazımda YZ teknolojilerine yönelik aşinalıkları, bilgileri ve etik algıları açısından YZ okuryazarlığını keşfetmeyi amaçlamaktadır. Betimleyici-keşfedici yaklaşım kullanarak, çalışma iki Türk üniversitesinden 427 öğrenci üzerinde bir anket gerçekleştirmiştir. Bulgular, katılımcılar arasında YZ'ye yönelik orta düzeyde bir aşinalık ve kullanım olduğunu, çeviri ve dilbilgisi düzeltmeleri için YZ araçlarına önemli bir ölçüde bağımlılık olduğunu ortaya koymaktadır. Öğrenciler, YZ'nin akademik yazımı geliştirme potansiyelini kabul etmelerine rağmen, YZ'nin temel mekanizmalarına dair sınırlı teknik beceriler ve anlayış sergilemiş, bu da EFL yazımı için hedefli ve yapılandırılmış bir YZ eğitimi ihtiyacını ortaya koymuştur. Dahası, etik algılar YZ okuryazarlığının kritik bir boyutu olarak ortaya çıkmıştır: öğrenciler akademik yazımı geliştirmede YZ'nin faydasını kabul ederken, çoğunluk intihal ve akademik dürüstlükle ilgili endişelerini dile getirmiş, şeffaf ve sorumlu YZ kullanımının önemini vurgulamıştır. Bulgular, EFL eğitiminde YZ entegrasyonu konusunda süregelen tartışmalara katkıda bulunmakta, politika yapıcılar, eğitimciler ve araştırmacılar için öğrencileri YZ odaklı bir akademik ortamda daha iyi hazırlamak adına önemli içgörüler sunmaktadır.

Anahtar kelimeler: Yapay zekâ okuryazarlığı, yabancı dil olarak İngilizce, akademik yazım, üretken yapay zekâ, Türkiye.

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In recent years, the development of artificial intelligence (AI), particularly Generative AI (GenAI), has radically impacted education (Bahroun et al., 2023). This change and transformation of AI in education is predicted to continue in the future (Becker et al., 2018). With the emergence of the Transformers infrastructure and Large Language Models (LLMs) and their intensive use by users (i.e. 1.5 billion visits per month for ChatGPT) (Bianchi, 2023), there have been significant developments, especially AI-based text generation. Similarly, research reported that the substantial capabilities and features of AI tools have profound implications for English as a Foreign Language (EFL) learning and teaching (Jiang, 2022; Layali & Al-Shlowiy, 2020). AI tools can support academic writing in areas such as text generation, grammar and spelling checking, text editing and brainstorming about writing processes (Conde et al., 2024; Kong et al., 2024; Roe et al., 2023). The proliferation of such technologies in EFL writing creates the need to explore how such a phenomenon is first understood. Understanding students' perceptions, knowledge levels and ethical perspectives on integrating AI technologies into EFL and academic writing processes is imperative for making policy on this issue (Chan & Hu, 2023; Jiang, 2022). By exploring EFL students' AI engagement and literacy—encompassing their awareness, knowledge and ethical perspectives—we can establish a solid foundation for developing informed policies and teaching strategies. This study not only guides the thoughtful implementation of AI tools in educational contexts but also promises to empower students to use these technologies ethically and effectively in their EFL writing, thereby enhancing the quality of education.

It has been proposed that AI literacy and AI citizenship is a way of defining competencies for students needed to succeed in everyday life and work with AI (Hossain, 2024; Stolpe & Hallström, 2024). To date, research on AI in EFL and academic writing has emerged (Jiang, 2022; Kong et al., 2024; Roe et al., 2023). Nevertheless, to our knowledge, studies concentrating on AI literacy in the EFL writing or academic writing context tend to be comparatively scarce. Accordingly, this study attempts to explore tertiary-level Turkish EFL students' AI literacy regarding their familiarity, knowledge and ethical understanding of AI technologies in academic writing contexts. The following specific objectives helped guide the study in exploring the various aspects of AI literacy among the participating EFL students in 2 public universities in Türkiye.

- To explore the level of familiarity, recognition and usage experience of AI technologies and applications among EFL students in Turkish universities.
- To understand how Turkish students use AI, specifically GenAI, in their academic writing.
- To investigate EFL students' perceptions regarding the ethical issues of using AI in academia, particularly in academic writing, concerning academic integrity.

To achieve these research objectives, the following research questions (RQs) were addressed:

RQ1: What is the level of AI familiarity and literacy of Turkish EFL students?

RQ2: To what extent and for what purposes do Turkish EFL students use AI tools in their academic pursuits?

RQ3: In the context of academic integrity, what are Turkish EFL students' ethical viewpoints on AI integration in academic writing?

Literature Review

AI Literacy

With the rapid integration of AI tools into our daily lives, the concept of AI literacy has come to the fore. According to UNESCO (2022), AI needs to be steered for the common good by equipping all citizens with skills, knowledge, understanding and value orientation, which can be called AI literacy. Hossain (2023) defined AI literacy simply as "the ability to identify, understand, develop ideas and critically evaluate AI technologies, their applications, and ethical implications'' (p.1). Building on Hossain's (2023) definition, in this study, we define AI literacy as students' familiarity, knowledge and ethical perceptions of AI. The familiarity domain refers to the degree of familiarity of students with AI in general and in EFL education, while the knowledge domain focuses on how often and to what extent students use AI tools in their daily lives and at school. The ethical perceptions dimension aims to measure the level of students' perceptions of the ethical aspects of using such tools in accordance with the principles of academic integrity when using AI tools at school. Collectively, these three dimensions reveal students' AI literacy levels.

Generative AI Application in Education

We are living in a time where AI is increasingly becoming an integral part of our daily lives, our workplaces and our public services, including education (Hossain, 2024). The application of AI in education, known as AIEd, has been a focus of academic research for over three decades (Luckin et al., 2016). This field explores learning in diverse contexts, be it traditional classrooms or professional settings, to support both formal education and continuous learning initiatives (Luckin et al., 2016). With the proliferation of AI tools, AIEd was estimated to grow by 43% from 2018 to 2022 (Becker et al., 2018), whereas the Horizon Report 2019 (Alexander et al., 2019) predicts even greater impacts. Furthermore, Limna et al. (2022) noted that educational institutions have been infiltrated by AI through the rapid advancement and adoption of GenAI tools.

AI has been widely embraced in higher education institutions in a variety of forms and formats. The World Economic Forum stressed the importance of integrating AI into education through traditional and innovative methods in order to shape tomorrow's workforce (Milberg, 2024). AI's machine learning models (MLMs) capabilities enable the creation of personalised curriculum and content, which results in greater student engagement, retention and overall learning effectiveness (Ge & Hu, 2020). Similarly, UNESCO's Global Education Monitoring Report 2023 highlights many new AI tools can prove invaluable in providing personalised support for students, particularly those with disabilities or living in remote areas. Further, the use of AI tools and platforms helped streamline administrative processes as well, such as the review and grading of assignments (Ge & Hu, 2020; UNESCO, 2023). Similarly, Hollands and Breazeal (2024) assert that the explosion of AI applications in our everyday lives makes it imperative for teachers and students to become AI literate. The authors concluded that learning about AI technologies increased students' (and perhaps teachers') optimism

about how AI tools can benefit society and contribute to shaping its future. As outlined by Hossain et al. (2024), teachers should teach their students how to use AI technology ethically and legally in order to prepare them to be AI-ready.

Nevertheless, the integration of AI into education faces various challenges and ethical dilemmas (Tahiru, 2021), including false information and privacy, AI hallucinations, deepfakes, academic integrity, plagiarism and copyright issues (Hossain et al., 2024; Udell, 2024). Further, Su et al. (2023) identified a set of challenges to AI literacy including (1) lack of teachers' AI knowledge, skills and confidence (2) lack of curriculum design, and (3) lack of teaching guidelines. UNESCO (2022) stated that policymakers in the education sector must comprehend unique ethical issues associated with using AI in education. Consequently, UNESCO published its 'Recommendation on the Ethics of Artificial Intelligence' and a guide for policymakers on AI and education in 2021 (UNESCO, 2023). In addition, to address the disruptions caused by AI technologies, UNESCO published its first guidance for GenAI in education and research in September 2023. The European Union also adopted the draft "EU AI Act" in 2023, as proposed by the EU Commission in April 2021, to ensure better conditions for the development and usage of AI in EU states (European Parliament, 2024).

It is worth mentioning that as of August 2024, 70 states (Bangladesh has developed a 'National Strategy for Artificial Intelligence' in 2020 which isn't in the OECD list), both developed and developing, have already published their national AI policies and strategies (OECD.AI, 2021 & 2024). As a result of these national policies and strategies, AI benefits are guaranteed, and rules and frameworks are established for the safe and ethical use of AI while protecting citizens' rights and privacy. The government of Türkiye published the country's National Artificial Intelligence Strategy for 2021-2025 in August 2021 within the framework of the "Digital Türkiye" vision and Türkiye's "National Technology Move" (Özdemir, 2021, p. 6).

Essentially, Türkiye's National AI Strategy includes 6 main strategies: (i) training AI employment opportunities in the field, (ii) supporting research, entrepreneurship, and innovation, (iii) improving access to quality data and technical infrastructure, (iv) accelerating socioeconomic adjustment, (v) strengthening international cooperation, and (vi) accelerating structural and workforce transformations. By 2025, Türkiye plans, among others, to increase AI's share of Gross Domestic Product (GDP) to 5%, create 50,000 new jobs in the sector, and increase the number of AI postgraduate students by 10,000 (Digital Transformation Office, 2021). A major objective of the strategy is to place Türkiye among the top 20 countries in international AI rankings (Moss, 2021). To achieve these state ambitions, according to Digital Transformation Office (2021), Türkiye should increase universities' academic and technical capacity in AI and related disciplines and the quota of students who will enroll in undergraduate and postgraduate degree programs. The researchers believe that Turkish schools and universities should also focus on developing and integrating AI literacy into their curricula and teachers need necessary training and professional development opportunities for a vertical and horizontal contribution to the Turkish National Artificial Intelligence Strategy. According to the UNESCO report (2023), the most effective way to build AI competencies in schools, technical and vocational institutions, and higher education institutions is to mainstream them into national curricula.

AI Tools and Application in EFL Learning and Academic Writing

As AI tools evolve, their influence on teaching and learning is becoming more evident including in EFL settings. Moreover, AI tools based on LLMs offer significant opportunities to improve students' writing process thanks to their substantial capacity to generate text. ChatGPT, for example, excels in understanding and producing language, making it valuable for dialogue and text generation. As part of EFL education, OpenAI's ChatGPT provides students with personalised feedback and writing support, helping them to improve their expression abilities. Additionally, other AI tools, such as speech recognition and text-to-speech technology, expand opportunities for English learning and writing enhancement (Wu, 2024). Students at five South African universities were found in a study by Bosch and Uzuegbunam (2023) to prefer other AI-powered tools like translation and referencing tools over ChatGPT. The study found that 46.5% of respondents used online writing assistants like Quillbot to improve their writing style, while 80.5% used Grammarly or similar tools to help them write in appropriate English. Only 37.3% of respondents had used ChatGPT to answer an essay question. Students acknowledged that AI-powered tools could lead to plagiarism or affect their learning. However, they also stated that they did not use these tools in problematic ways. Amirjalili et al. (2024) study focused on authorship and voice in academic writing using ChatGPT. Their study reported that despite potential benefits, limitations exist in ChatGPT's current ability to generate academic text, emphasising the need for ongoing improvement.

Recently, AI-powered writing assistants have garnered significant interest as a novel method to improve students' academic writing prowess (Zhao et al., 2024). Shofiah and Putera (2024) stated that in academic writing, AI technology has surfaced as a cutting-edge solution capable of improving both the effectiveness and caliber of students' writing. Based on interviews with 30 participants, Zhao and colleagues (2024) investigated how Chinese international students in higher education utilise Wordtune, an AI-powered writing assistant. Regardless of English proficiency, students found the rewriting options helpful, particularly for formal language. They expressed a desire for improved functionality to better align with academic writing standards. This study sheds light on international students' use of digital tools in writing.

Syahnaz and Fithriani (2023) explored how EFL students perceive QuillBot usage in an academic writing course. Their qualitative case study involving 20 English education majors reveals positive responses towards Quillbot, highlighting its benefits in improving writing quality and enhancing attitudes toward writing. In another study, Kurniati and Fithriani (2022) examined post-graduate students' perceptions of Quillbot as a digital tool for English academic writing. The study underscores the significant role of AI-powered technologies like Quillbot in fostering high-quality writing in academic contexts.

In another study, Al Mahmud (2023) stated that AI-powered writing tools like Wordtune and Grammarly are increasingly used in L2 (EFL) writing. The study found that Saudi students using Wordtune showed better performance than those in the control group. Quantitative results showed improved writing and higher scores in the final exam for the Wordtune users. Qualitative findings indicated modest improvements in lexical and syntactic aspects, with enhancements in nouns, adjectives, verbs and sentence

structures. The tool had a similar effect on writing quality for both male and female participants.

Malik et al. (2023) found that students had a positive view of AI-powered writing tools, acknowledging their benefits in grammar checks, plagiarism detection, and essay outlines. While AI improved writing skills and academic integrity, some students were concerned about its potential impact on creativity and critical thinking. In this context, Shibani et al (2024) study reported that AI tools contribute to critical thinking skills by helping students brainstorm before and after the writing process. A study by Song and Song (2023) reported that the quantitative analysis showed significant improvements in writing skills and motivation with AI-assisted instruction. The experimental group demonstrates enhanced proficiency in organisation, coherence, grammar, and vocabulary. Qualitative findings revealed mixed views on AI's role, emphasising the need for ongoing development for sustainability.

Tran (2023) demonstrated that teachers and students have positive attitudes towards AI usage in academic writing. This study provides valuable insights for educators and students, especially those preparing for standardised English tests, improving cohesion, coherence, vocabulary, grammar, and accuracy. Another finding from Nazari et al. (2021) indicated that AI-driven writing tools might effectively encourage learning behaviour and foster technology acceptance among non-native postgraduate students in English academic writing through formative feedback and assessment. By providing students with fast and high-quality feedback on their writing processes, Darvishi et al. (2022) and Lee (2023) assert that such tools can serve as responsive peers independent of time and space. All these pedagogical outcomes support the notion that integrating AI tools into EFL learning and academic writing processes has a positive effect, and integration is therefore inevitable (Dong, 2023; Kong et al., 2024; Shibani et al., 2024; Tran, 2024).

However, debates persist concerning AI tools' effectiveness in EFL and academic writing contexts. To explore this, a study was carried out by Sumakul et al. (2022) to understand the perceptions of eight (8) EFL students in an Indonesian university who used an AI app in their writing class. Results indicated positive student perceptions, highlighting enjoyment and helpfulness in writing tasks. The study also emphasised the importance of considering various factors when integrating AI into writing classes. Gayed et al. (2022) explored the increasing use of English as a Lingua Franca, highlighting the need for tools to aid EFL learners in achieving fluency. "AI KAKU," an AI-based web application, was developed to assist EFL learners in overcoming cognitive barriers when writing in English. Initial findings from an experiment suggest its potential as a valuable resource for learners needing structured writing assistance beyond traditional word processors. Ginting et al. (2023) mentioned students prefer using AI for their final assignments despite its scarcity. Their positive outlook on AI's role in writing enhances the quality of their work, emphasising its benefits in project completion. Thus, integrating AI writing tools can be beneficial for improving EFL students' academic writing. Most importantly, if used ethically, AI tools can be seen as an important aid in the development of students' identity as writers.

The research emphasised a balanced AI integration approach to preserve human ingenuity in language learning and academic writing. Integrating AI tools like ChatGPT, Grammarly, QuillBot and Wordtune aids EFL students in overcoming

writing challenges, yet further research is needed to fully understand its impact in language classrooms (Amirjalili et al., 2024; Malik et al., 2023; Syahnaz & Fithriani, 2023). It is imperative, however, to establish students' AI literacy before developing policies and educational interventions, and this study attempted to fill this research gap by studying Turkish EFL students' AI literacy.

Methodology

This study adopted a descriptive approach (Creswell, 2014) to investigate AI literacy among Turkish university students. Descriptive quantitative research is particularly suited for capturing participants' rich, detailed perspectives on emerging topics like AI literacy.

Data Collection Procedure and Tools

Based on the objectives of the study and relevant literature, we developed an AI literacy survey questionnaire comprising four distinct sections: Demographic Information, AI Familiarity, AI Applications, and AI Ethical Concerns, as detailed in Table 1.

Table 1

Components of AI Literacy with Details Breakdown

AI Components	Details Breakdown
Familiarity	AI Awareness, recognition and usage experience
Knowledge & Application	Conceptual and technical AI knowledge and understanding
Ethical perceptions	AI impact on academic integrity

After assembling a pool of survey items and drafting the initial version of the survey, feedback was sought from co-authors, resulting in minor revisions that improved the content before piloting. To further ensure clarity and accuracy, the survey underwent evaluation through the think-aloud method. This approach allowed for an in-depth exploration of participants' understanding of the survey items and assessed whether the survey effectively captured the intended information. Three students participated in these think-aloud sessions, each lasting approximately 15-20 minutes. During the sessions, the students were asked to verbalise their thoughts while completing the survey, offering real-time insights into their comprehension of the questions. The sessions were recorded and thoroughly reviewed to identify any areas of confusion or misunderstanding. The think-aloud protocols confirmed that the survey items were generally well understood, though a few minor adjustments were made based on the feedback to enhance clarity and ensure the questions were as straightforward as possible. Following these refinements, the survey was piloted with a larger sample of 50 students. The initial results from the pilot indicated strong reliability of the survey scale, with a Cronbach's alpha of 0.85, demonstrating high internal consistency.

Various question formats, including checkboxes, Likert scales, multiple-choice and statement-type questions, were employed to capture nuanced responses from

participants. Purposive sampling targeted a diverse cohort of respondents enrolled in various programs across multiple academic institutions. The survey was delivered using a Google Forms link and distributed through the authors' academic networks to various institutions in the participating country from December 2023 to February 2024.

Participants and Setting

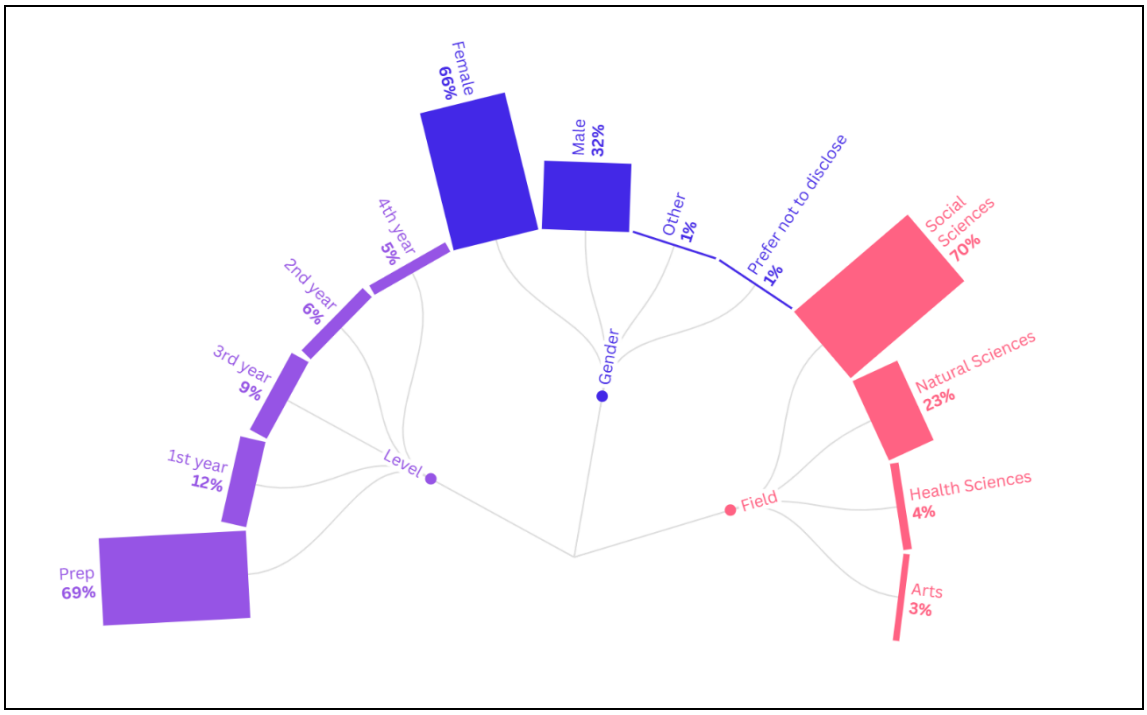
This research was conducted at two well-established and prestigious public universities in Türkiye, both founded in 1992. The first university has a broad educational network with 10 campuses, 18 faculties, and 13 vocational schools, offering a diverse range of academic programs to approximately 50, 000 students. The second university, with a more centralised campus structure, serves approximately 50,000 students through its 13 faculties and 12 vocational schools. Both universities provide extensive opportunities for students, including international exchange programs, scholarships, rich library resources, and a variety of social activities. These universities were selected using a combination of convenience sampling and typical site sampling. This approach provided ease of access while also representing the broader landscape of Turkish higher education at both regional and national levels.

At the first university, the survey was conducted under the guidance of one of the researchers. A QR code was generated for the survey link uploaded to Google Forms. Students scanned the QR code using their smartphones, allowing them to access and complete the survey under the supervision and guidance of the researcher. At the second university, the survey was administered through the researchers' network. Faculty members were informed about the survey and its application, and they facilitated the distribution of the survey link to students, who then completed it under the supervision of these faculty members.

A total of 427 students participated in the study, with ages ranging from 18 to 50 years old (see Figure 1). Participants were selected using a combination of convenience and random selection methods, based on their availability and willingness to participate. The majority of participants were between 18 and 20 years old, with 19 being the most common age (n = 142). A smaller number of participants were aged 21 or older, with only two participants aged 50. In terms of academic standing, most participants were in the English Preparatory level (n = 294), with fewer students in their 1st (n = 50), 2nd (n = 26), 3rd (n = 37), and 4th years (n = 20) of study. Participants represented a wide range of academic majors, with the most common being International Relations (n = 71), Economics (n = 66), Business Administration (n = 60), and Molecular Biology and Genetics (n = 54). Gender distribution indicated a majority of female participants (n = 283), followed by male participants (n = 138), with a small number identifying as "Other" (n = 1) or choosing not to disclose their gender (n = 5).

Figure 1

Percentages of Participants' Genders, University Levels, and Fields



Data Analysis

The collected data was initially processed through a data cleaning phase to ensure accuracy and reliability. Then, the data was analyzed using descriptive statistics using the Jamovi software. To enhance the interpretability, the results were further visualized with the online data visualization tool, Flourish.

Ethical Concerns

This study received approval from the Research Ethics Committee at Balıkesir University. Ethical guidelines were rigorously followed, ensuring the anonymity and confidentiality of participants, who all provided informed consent. Participation was entirely voluntary, and surveys were conducted in a manner that did not disrupt the educational process, with prior permission obtained from course instructors.

Findings

The findings of this study are organized in alignment with the research questions. Each section of findings will delve into the specific aspects of the research questions.

AI Familiarity and Literacy of Turkish EFL Students

We initially asked participants to indicate their overall familiarity with AI technologies and applications on a five-point scale. Upon analysing the reported responses, we found that Turkish students, on average, have a moderate level of familiarity with AI technologies and applications (M = 2.64), with a marginal difference in familiarity between males (M = 2.78) and females (M = 2.57) participants. Similarly, we also asked the participants about their ability to recognize if a software or digital tool utilises AI technology. The average score (M = 2.70) aligns with their self-reported overall familiarity score (M = 2.64).

Secondly, we wanted to explore where students heard about AI tools to uncover which sources can play an important role in students' interaction with AI technologies and whether they have taken any education.

Figure 2

Sources of AI Awareness and Participation

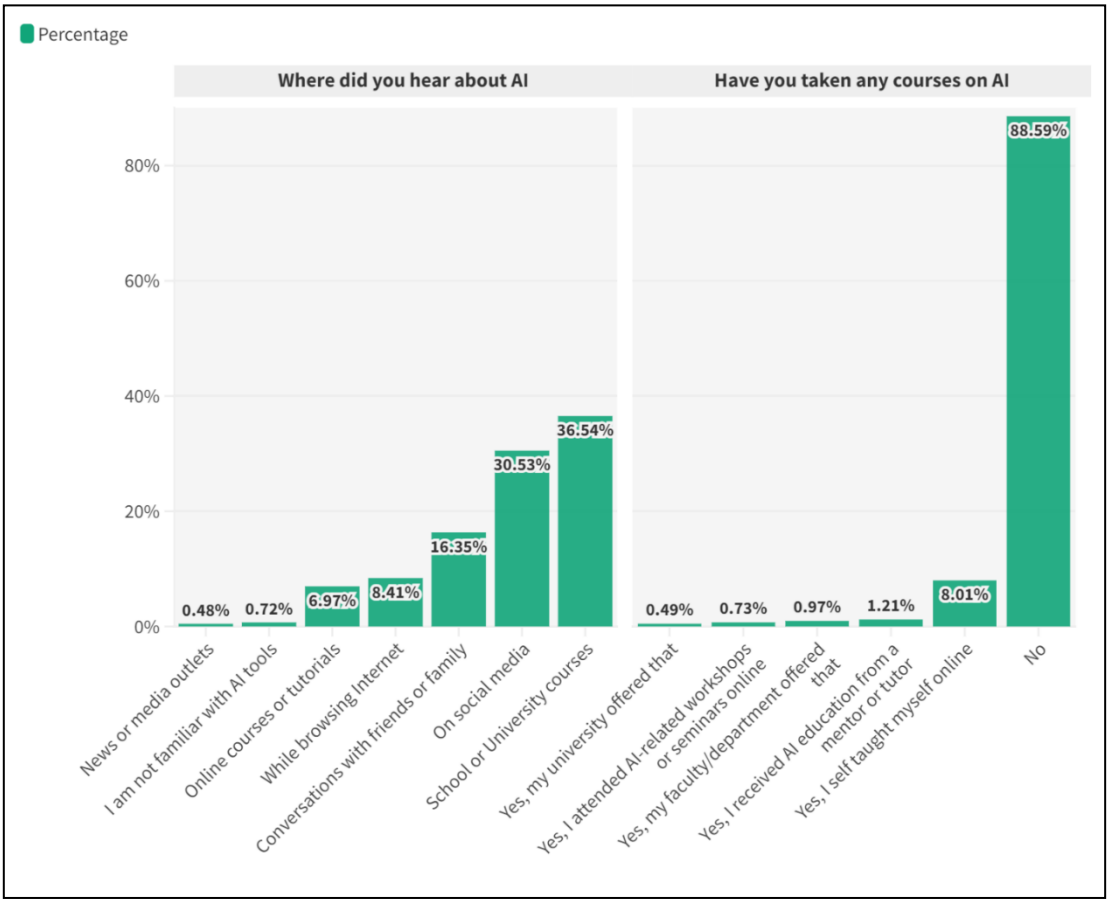
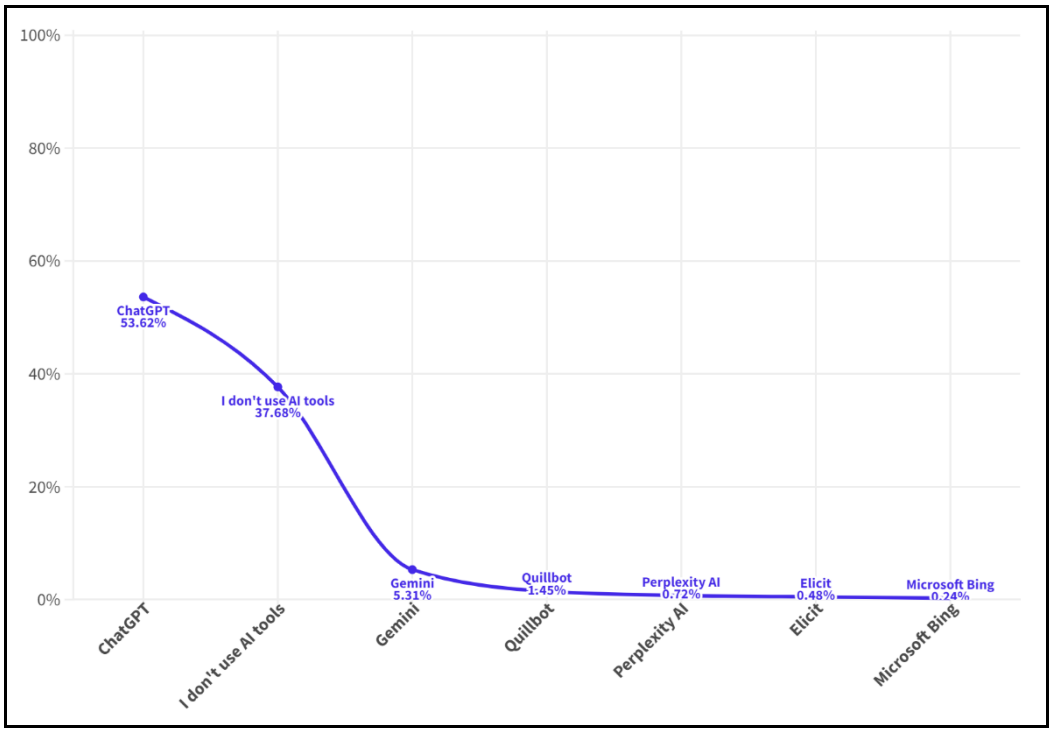


Figure 2 shows that "School or University courses" stands out as the most common source of information with 36.5%, followed by "Social media" with a percentage of 30.5%. The total share of these two sources exceeds 67%, emphasising the importance of formal education and digital platforms in students' familiarisation with AI technologies. On the other hand, "Conversations with friends or family" has a share of 16.35%, indicating that interpersonal communication also plays a role in this familiarisation. In terms of education, 88.59% of participants reported that they had not taken any courses or received formal education about AI-related topics. Only around 8% of participants familiarised themselves with AI technologies with their own efforts. Interestingly, very few participants (n = 6) reported that they received education on AI from their university or department, which is a significant finding.

Next, we shifted the focus to academic writing and first asked the participants which AI-based text generation tools they use most.

Figure 3

Preferred AI Text-generation Tools



More than half of the participants (53.62%) reported using ChatGPT for text generation purposes, followed by Gemini (5.31%). Notably, almost 38% of participants (n = 156) reported that they do not use any AI tools for text generation purposes. It can be seen that ChatGPT remains the leading AI tool among participants who use AI tools for text generation purposes.

We continued to explore students' use of AI tools in academic writing by uncovering their purposes and frequency of use. In order to explore their interaction with AI tools, we requested them to rate their level of engagement using a five-point scale, ranging from never to always. We then computed the percentages of engagement frequency for each purpose, as well as an overall percentage for each purpose. In Figure 4, the bars illustrate the students' level of engagement for specific purposes, while the line represents the overall percentage for each purpose.

Figure 4

Purpose and Frequency of Using AI Tools for Academic Writing

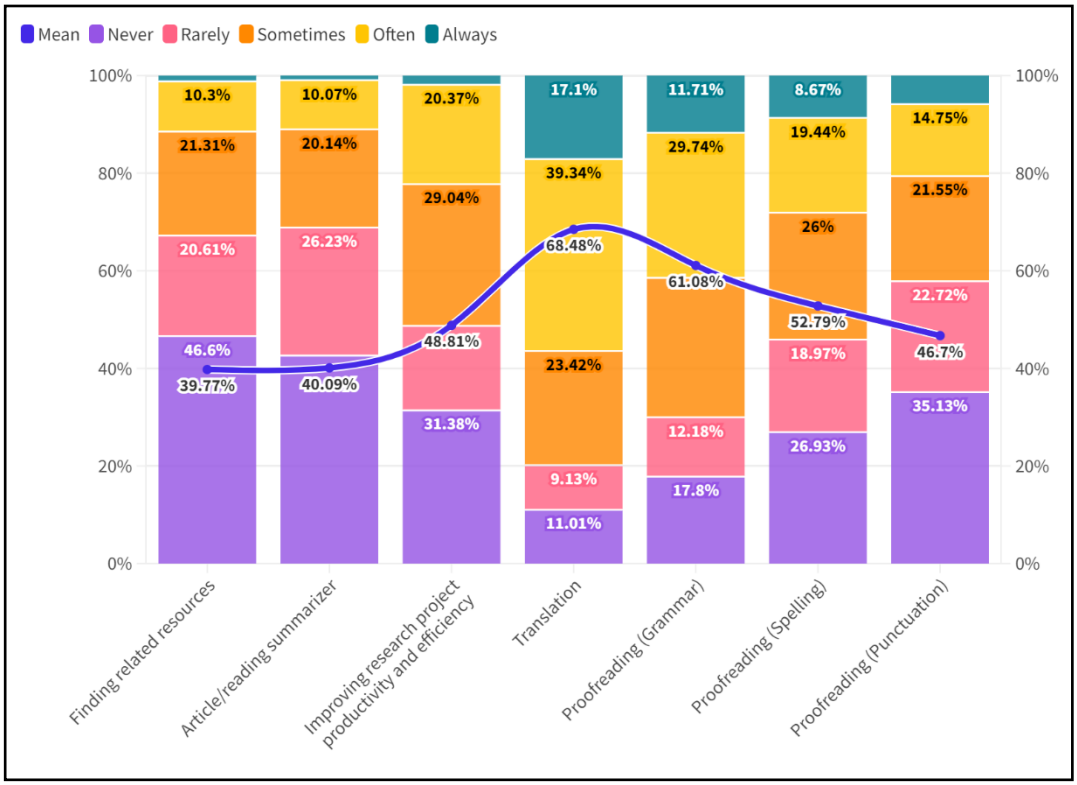


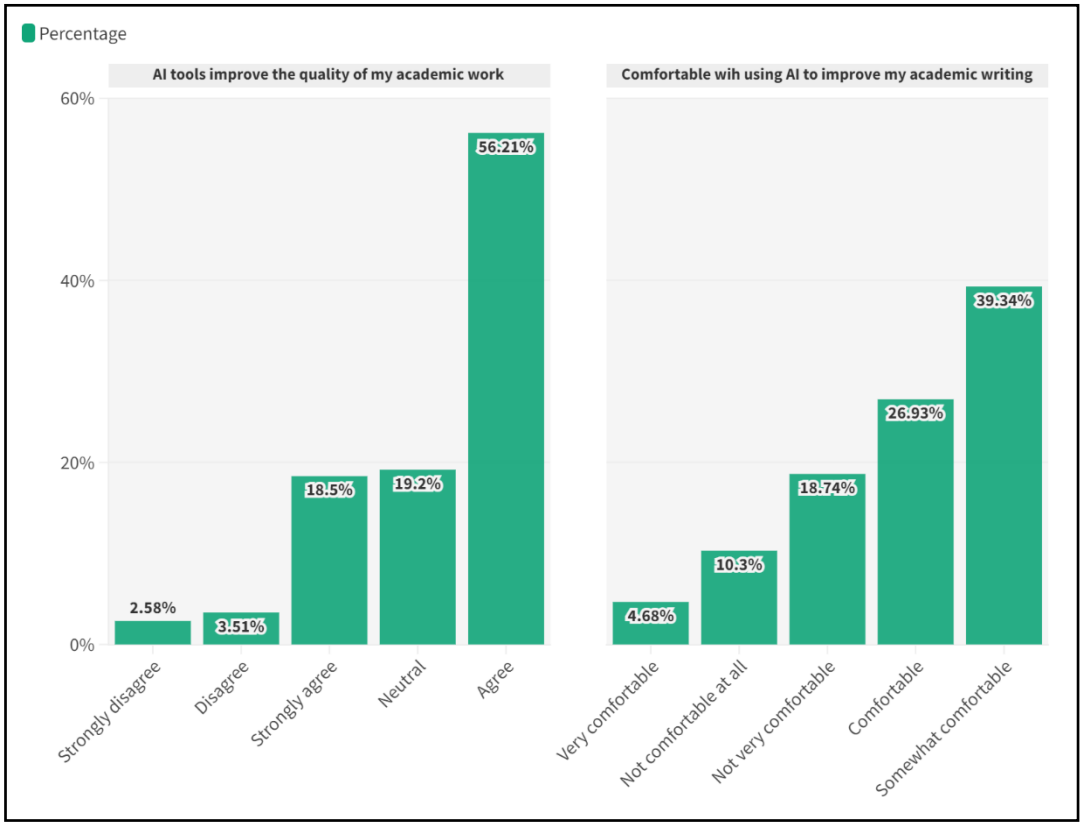
Figure 4 clearly shows that translation emerges as the most prevalent area of AI use among students, with a mean usage of 68.48%, and this is closely followed by grammar proofreading (61.08%), which suggests that students strongly rely on AI tools for translation and grammar proofreading purposes. Spelling checks (52.79%) and improving research productivity and efficiency (48.81%) show moderate levels of usage. On the other hand, more specific tasks such as punctuation checks (46.7%), article/text summarization (40.09%), and finding related resources (39.77%) exhibit relatively lower AI usage.

The Use of AI Tools by Turkish EFL Students in Academic Writing

In this research question, we started by surveying students to elicit their perceptions regarding the relationship between AI tools and academic writing. We posed two initial questions. Firstly, we inquired about their belief in the potential of AI tools to enhance the quality of their academic writing by asking, “Do you believe using AI tools in academic writing can enhance the quality of your academic work?”. Secondly, we asked to what extent they feel comfortable in utilizing AI to improve the coherence and flow of their academic writing with the following question: “How comfortable are you with the use of AI to improve the coherence and flow of your academic writing?”. Figure 5 below presents the findings related to these two questions.

Figure 5

Perceptions of AI Tools in Enhancing Academic Work and Comfort Level in Using AI for Academic Writing



According to Figure 5, the majority of the participants agreed that AI tools improve the quality of their academic work. As data shows, 56.21% (n = 240) of the participants agreed with this statement, while 18.5% (n = 79) strongly agreed. These results show that the total positive perception reached 74.71%. The rate of neutral respondents was 19.2% (n = 82). The proportion of those who expressed a negative opinion was very low, with only 3.51% (n = 15) disagreeing and 2.58% (n = 11) strongly disagreeing. On the other hand, students' perceptions of using AI to improve the coherence and fluency of academic writing showed a more diverse distribution. The highest rate was observed in the "Somewhat comfortable" option with 39.34% (n = 168). This was followed by "Comfortable" with 26.93% (n = 115) and "Very comfortable" with 4.68% (n = 20). In total, 70.95% of the participants expressed some degree of comfort with using AI. However, 18.74% (n = 80) responded "Not very comfortable" and 10.3% (n = 44) responded, "Not at all comfortable". These data suggest that students recognize the potential benefits of AI tools in academic writing but may still have some reservations about using them.

In the following questions, our goal was to delve into the scope of students' understanding of AI, ranging from surface-level knowledge to more technical comprehension with two specific questions. The first question was "How would you rate your proficiency in the technical aspects of AI tools used in academic writing?" while the second one was "How would you rate your understanding of the MLMs that underlie AI text generation tools used in academic writing?"

Figure 6

Perceived Proficiency in Technical Aspects of AI Tools and their Understanding of MLM for Academic Writing

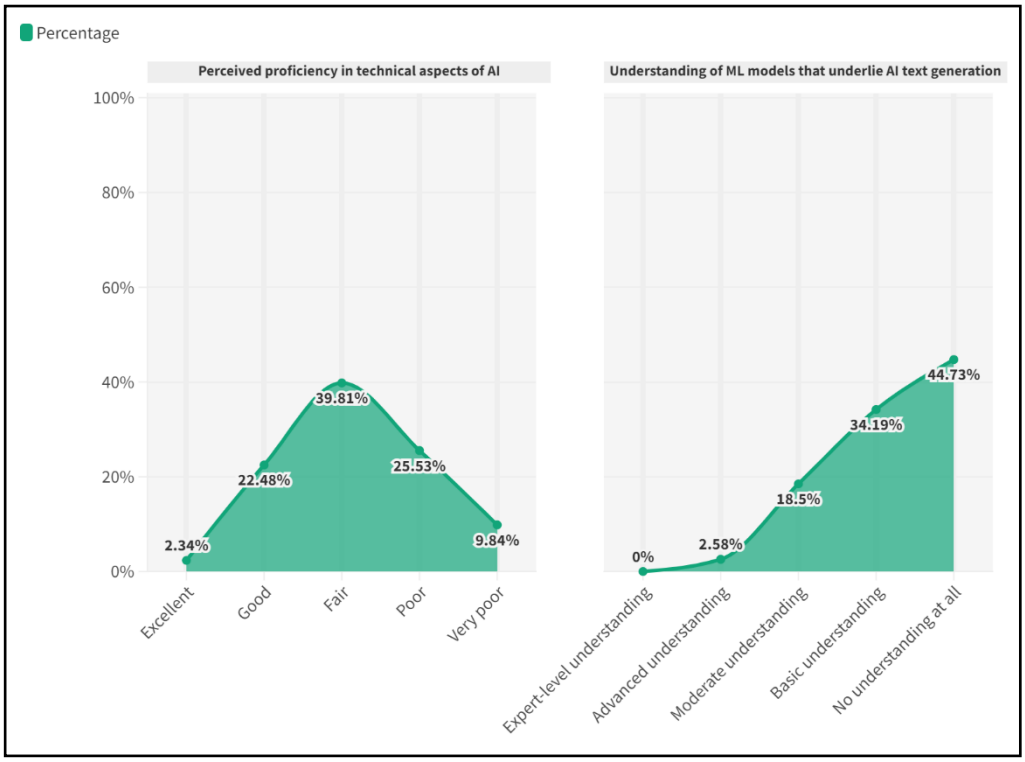


Figure 6 shows that the majority of the participants (39.81%, n = 170) see themselves as moderately competent. This was followed by the categories of "poor" (25.53%, n = 109) and "good" (22.48%, n = 96). A few participants rated themselves as "very poor" (9.84%, n = 42) or "excellent" (2.34%, n = 10). This distribution shows that students have various levels of competence in the technical aspects of AI tools, but the majority have a perception of moderate or lower competence. Figure 5 also shows students' level of understanding of MLMs underlying AI text generation. The majority of the participants (44.73%, n = 191) indicated that they had "no understanding at all" of these models. This was followed by "basic understanding" (34.19%, n = 146) and "moderate understanding" (18.5%, n = 79). Very few participants reported "advanced understanding" (2.58%, n = 11) and there were no participants in the "expert understanding" category. These results suggest that students face significant difficulties in understanding the technical mechanisms underlying AI text generation tools.

Lastly, in this domain, we aimed to explore whether students can customise or adapt AI tools for their special academic writing purposes such as adhering to an academic writing style or adjusting discipline-specific terminology, etc. In this respect, we asked them about their perceived proficiency in customising AI tools for academic writing purposes.

Figure 7

Students Perceived Proficiency in Customising AI Tools for Academic Writing Purposes

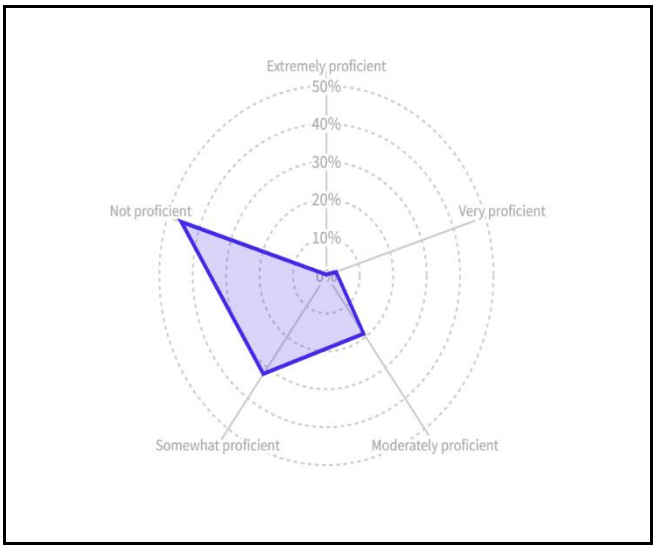


Figure 7 indicates that a substantial portion of the participants lacks proficiency in customising AI tools for academic writing purposes. Specifically, 45.67% (n = 195) of respondents reported being "Not proficient" in customising AI tools for academic writing. This category represents the largest segment of the surveyed population. The second-largest group, comprising 32.08% (n = 137) of respondents, identified themselves as "Somewhat proficient." This suggests that while these students have some ability to customise AI tools, their skills may be limited or inconsistent. "Moderately proficient" students accounted for 18.97% (n = 81) of the sample, indicating a smaller but significant group with a more advanced level of competency in adapting AI tools for academic writing tasks. Only a small fraction of students reported high levels of proficiency. "Very proficient" students made up 3.04% (n = 13) of the respondents, while those considering themselves "Extremely proficient" represented a mere 0.23% (n = 1) of the sample. These findings suggest a significant skills gap in AI tool customization for academic writing purposes among the surveyed student population. The data reveals that the majority of students (77.75%) fall into the lower two categories of proficiency, indicating a potential area for skill development in the context of AI literacy and its application to academic writing.

Turkish EFL Students' Ethical Viewpoints on AI Integration in Academic Writing

In this research question, we aimed to explore students' ethical perceptions regarding the use of AI for academic writing purposes, with a special focus on academic integrity. Our initial question was, "How concerned are you about issues related to plagiarism when using AI for academic writing?".

Figure 8

Students' Perceptions Related to Plagiarism About Using AI for Academic Writing Purposes

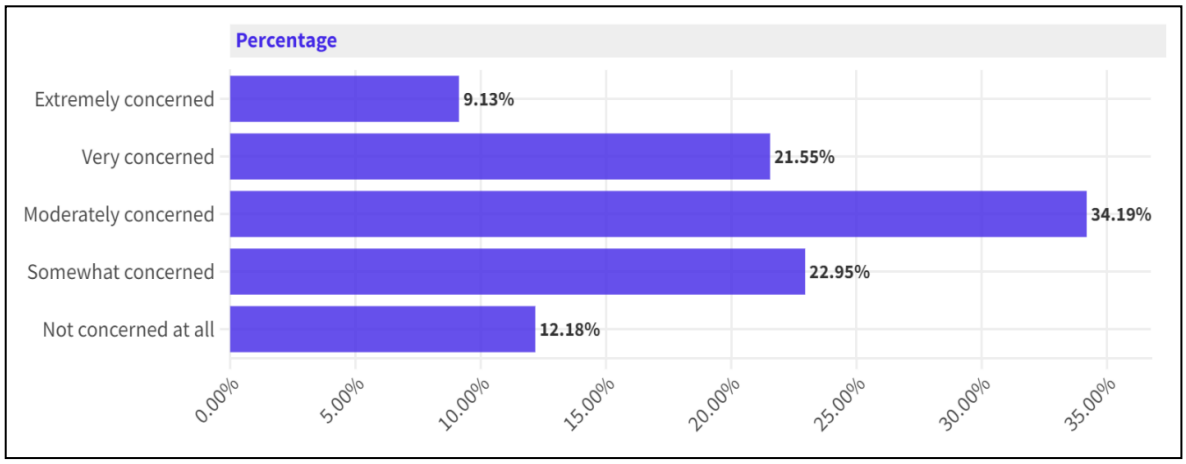


Figure 8 shows students' levels of concern regarding plagiarism issues when using AI for academic writing. It can be observed that participants reported varying degrees of concern. The majority of students (34.19%, n = 146) reported being moderately concerned about plagiarism issues related to AI use in academic writing. This was followed by 22.95% (n = 98) of students who were somewhat concerned and 21.55% (n = 92) who were very concerned. A smaller proportion of students (12.18%, n = 52) indicated no concern at all, while 9.13% (n = 39) expressed extreme concern about potential plagiarism when using AI for academic purposes. The distribution of responses suggests that the majority of students (87.82%) have some level of concern about plagiarism issues associated with AI use in academic writing, with only a small percentage expressing no concern.

Lastly, we measured the ethical perceptions of students regarding using AI in academic writing through their agreement levels to certain statements illustrated in Figure 9.

Figure 9

Students' Ethical Perceptions About Using AI in Academic Writing

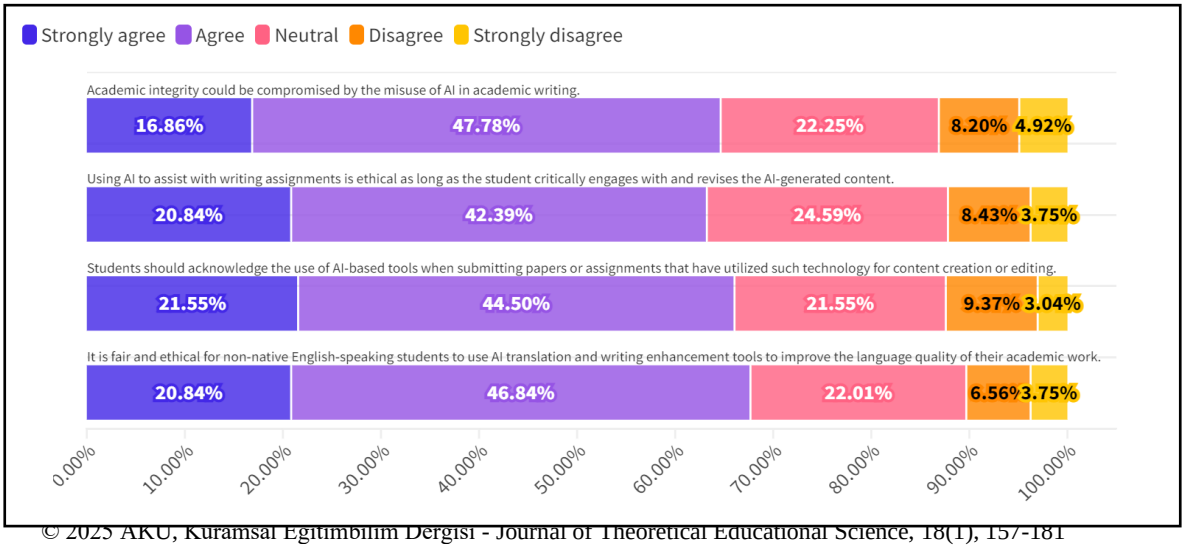


Figure 9 shows students' agreement levels with the statements regarding ethical perceptions of AI use in academic writing, revealing varying levels of agreement across different ethical perceptions. For the statement "Academic integrity could be compromised by the misuse of AI in academic writing," a majority of students expressed agreement (47.78%; n = 204 agree, 16.86%; n = 72 strongly agree), while 22.25% (n = 95) remained neutral, and a minority disagreed (8.20%; n = 35 disagree, 4.92%; n = 21 strongly disagree). Regarding the ethical use of AI in writing assignments in a supervised way, 63.23% of students agreed (42.39%; n = 181 agree, 20.84%; n = 89 strongly agree) that it is ethical when students critically engage with and revise AI-generated content. Neutral responses accounted for 24.59% (n = 105), while 12.18% disagreed (8.43%; n = 36 disagree, 3.75%; n = 16 strongly disagree). The statement on acknowledging AI use in submitted work showed 66.05% agreement (44.50%; n = 190 agree, 21.55%; n = 92 strongly agree), with 21.55% (n = 92) neutral responses, and 12.41% in disagreement (9.37%; n = 40 disagree, 3.04%; n = 13 strongly disagree). Lastly, 67.68% of students agreed (46.84%; n = 200 agree, 20.84%; n = 89 strongly agree) that it is fair and ethical for non-native English speakers to use AI for translation and writing enhancement. Neutral responses comprised 22.01% (n = 94), while 10.31% disagreed (6.56%; n = 28 disagree, 3.75%; n = 16 strongly disagree). These findings indicate generally positive ethical perceptions of AI use in academic writing among students, particularly when used thoughtfully and transparently.

Discussion

This study aims to investigate EFL students' AI literacy in Turkish higher education contexts, particularly in the context of academic writing, and their familiarity, knowledge, and ethical perceptions. The findings offer both pedagogical and theoretical insights into the ongoing discourse on AI integration in EFL writing.

The study reveals that Turkish university students possess a moderate level of familiarity with AI technologies. Moreover, students demonstrate a moderate ability to recognize AI-driven tools, indicating that while AI has become increasingly present in diverse fields and settings, participants' comprehensive understanding and practical use of these tools in EFL writing remain limited. Despite the widespread availability of AI tools, a significant majority (88.59%) reported not having taken any formal AI-related courses, indicating a potential gap in structured AI education. While school or university courses are the main source of information for learning about AI, the low percentage of students receiving formal education on AI indicates a lack of structured learning opportunities, echoing concerns that Luckin et al. (2016) and Limna et al. (2022) raised regarding the inconsistent integration of AI topics in educational settings. The findings align with broader trends found in recent studies, where familiarity with AI varies significantly depending on contextual factors such as educational exposure and social media influences (Alexander et al., 2019; Chen et al., 2020; UNESCO, 2023).

The results indicate that ChatGPT is the most widely used AI tool for EFL writing, with 53.62% of students relying on it, while the next most popular tool, Gemini, is used by only 5.31% of respondents. This heavy reliance on a single AI tool like ChatGPT, which is designed for general usage rather than specifically targeting EFL writing, has significant implications for students' learning experiences and outcomes. While ChatGPT's accessibility and user-friendly interface may make it a

convenient choice, overreliance on one tool can lead to a limited approach to language learning. Students may miss out on the diverse functionalities offered by other AI tools, such as those focused on different aspects of writing, editing, or critical thinking enhancement. To ensure a more comprehensive learning experience, it is important to encourage the use of a variety of AI tools, each offering unique strengths in different areas of writing and language development. This diversification can help students build a broader set of skills, making them more versatile and adaptive in their language proficiency. Additionally, educators should guide students in critically assessing the feedback from these tools, promoting independent thinking and the ability to refine their work beyond what a single AI tool suggests.

The finding that AI tools are predominantly used for translation and grammar proofreading in academic contexts aligns with Bosch and Uzuegbunam's (2023) observations on the prevalent use of AI for language-related tasks. This finding suggests that students tend to use AI to translate from their native language to English, rather than using it to support their writing. Further studies should investigate how the use of AI tools for translation impacts foreign language writing skills. Moreover, this finding suggests that students must be educated and supported in using AI to enhance and improve their writing by receiving feedback, editing, and correcting, rather than just translating from their native language to English.

Participants' use of AI tools to enhance the quality of academic writing aligns with the positive perceptions reported in other studies (Gayed et al., 2022; Jiang, 2022; Shofiah & Putera, 2024). AI tools are valuable not only for editing and grammar checks but also for providing insights into various stages of the writing process, such as identifying and generating topics, brainstorming ideas (Conde et al., 2024; Kong et al., 2024; Roe et al., 2023), and checking the coherence, cohesiveness, and relevance of content. However, despite these advantages, participants primarily utilised AI for technical aspects of writing, such as translating, editing, and grammar checking. Moreover, a significant portion of students (38%) reported not using any AI tools for text generation at all, suggesting a divide in attitudes and practices regarding AI's role in academic writing. This indicates that while many embrace AI for improving technical elements of writing, a considerable number of students are either hesitant or uncertain about relying on AI for more complex aspects. This hesitation could be attributed to their lack of structured education on the use of AI. It appears that students used AI based on their perceived needs and skills rather than maximising its functionality or fully benefiting from its potential in EFL writing, all while considering ethical issues.

The study also explores students' self-reported proficiency in the technical aspects of AI tools and their understanding of machine learning models. The majority of students perceive themselves as having only moderate or lower proficiency in these areas, consistent with previous research indicating that students often struggle with the technical complexities of AI (Shofiah & Putera, 2024; Song & Song, 2023). This lack of advanced understanding, combined with difficulties in customising AI tools for specific academic purposes, highlights a significant area for targeted education for the utilisation of AI. The findings underscore the need for targeted educational interventions to enhance technical proficiency and address learners' concerns and potential anxieties about using AI tools.

The study also examines students' ethical perceptions related to AI use in academic writing, revealing a critical aspect of AI literacy. Although students acknowledge the potential benefits of AI, their ethical concerns about academic integrity and the authenticity of AI-generated content reflect broader debates about responsible AI use in education (Nazari et al., 2021; Sumakul et al., 2022; Tahiru, 2021). The majority of students (87.82%) expressed some level of concern about plagiarism when using AI, with 34.19% being moderately concerned. This concern is reflected in the ethical perceptions surrounding the use of AI, where most students agreed that improper use could compromise academic integrity (64.64% agreeing or strongly agreeing). There was also strong support (63.23%) for the ethical use of AI when students critically engage with and revise AI-generated content. A significant majority (66.05%) believed it is necessary to acknowledge AI use in submitted work, indicating a preference for transparency. Additionally, 67.68% agreed that it is fair and ethical for non-native English (EFL) speakers to use AI for translation and writing enhancement, suggesting a recognition of AI's potential to level the playing field in academic writing.

Conclusion

The study offers pedagogical and theoretical implications regarding the integration of AI tools in foreign language education. The moderate familiarity and utilisation of AI tools among Turkish EFL students indicate the necessity for a more structured and comprehensive integration of AI education in university curricula. To address this, universities should provide adequate support and resources to help students navigate the complexities of AI tools. This could involve the development of formal courses, training programs, workshops, and support services aimed at enhancing students' familiarity and technical proficiency with AI technologies. An interdisciplinary approach, combining technical AI knowledge with practical applications in targeted foreign language courses such as reading, writing, listening, speaking, grammar, and vocabulary, would be particularly beneficial. Such an approach would not only equip students with the necessary skills to utilise AI tools effectively but also foster a deeper understanding of the ethical and practical implications of AI use in diverse academic contexts.

The moderate familiarity and utility of AI tools among students may be linked to the familiarity of educators with these technologies (Kong et al., 2024; Sperling et al., 2024; Tran, 2023). The novelty and rapidly evolving nature of AI technology could contribute to this gap, as educators may also struggle to keep pace with advancements and incorporate them effectively into their teaching practices. To address this, future research should explore foreign language educators' perceptions, proficiency and professional development needs concerning AI integration. Understanding foreign language educators' views and needs can provide valuable insights into the barriers they face and the support they require to effectively integrate AI. While poor or inadequate use of AI tools can create a competitive disadvantage for students, overdependence on these tools may affect students' cognitive, emotional and social development negatively. Educators are pivotal in determining the extent and effectiveness of AI integration in education. Therefore, targeted professional development programs should be offered to educators to ensure the effective integration of AI. These programs should equip them

with the knowledge and tools necessary to guide students in the responsible and effective use of AI in academic writing.

Future research should explore whether learners experience anxiety about using AI tools due to a lack of self-efficacy, concerns about plagiarism or perceived threats to cognitive development, as suggested by Lee (2023) and Shibani et al. (2024). In the current landscape of AI integration in Türkiye, there is still a lack of clear guidelines for students and teachers concerning the ethical and effective use of AI. Some teachers may forbid the use of AI without a guiding principle, while some learners may refrain from using it due to fears of facing consequences or negatively impacting their cognitive skills. To explore and mitigate these concerns and prevent potential anxieties, ongoing research on targeted education and clear AI usage policies is essential. Otherwise, the moderate, ineffective, and inefficient use of AI by some learners may create a competitive disadvantage and potentially lead to societal inequalities in the future.

Further research is also needed to explore the long-term impacts of AI integration in EFL academic writing and to develop best practices for its implementation. Studies should investigate the effectiveness of different educational interventions in enhancing AI literacy and technical proficiency in promoting various foreign language skills. While this study focused specifically on writing skills, further research can explore the familiarity and use of AI for other language skills. This broader perspective could provide a more comprehensive understanding of how AI can support language learning and the development of critical skills in EFL students. By addressing these issues, educators, researchers, and policymakers can better prepare students for the evolving landscape of AI-driven academic environments.

At the time of data collection, AI technologies had been widely available for a year, and students' utilisation and skills in using these tools were still limited. The findings indicate that integrating AI into language education and academic writing may not be as straightforward or rapid as anticipated. There is a clear need for targeted education for both teachers and students to ensure they can effectively and ethically utilise AI tools. The study emphasises the necessity of global and contextualised guidelines to support the appropriate use of AI in academic settings. With proper education and policies in place, AI could significantly contribute to the development of academic writing skills. However, without these measures, AI risks being used superficially or unethically. Overlooking, banning or avoiding AI is nearly impossible due to its increasing capabilities, accuracy, and speed. Therefore, there is an urgent need to reform curriculum and educational policies to adapt to the evolving role of AI in education.

Limitations

This study acknowledges several limitations that may have impacted the findings. First, the research was conducted within a specific demographic of Turkish EFL students, which may limit the generalizability of the results to other contexts or populations. Second, the study primarily relied on self-reported data through surveys, which may be subject to response biases or inaccuracies in participants' self-assessments of their AI literacy and ethical perceptions. Additionally, the study focused on participants' experiences with ChatGPT, which may not fully capture the broader range of AI applications in academic writing.

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Statement of Responsibility

The authors accept full responsibility for the article content. Author contributions are as follow: Introduction: ÖÇ and ZH; Literature: ZH; Methodology: ZH, GH; Data Collection: GH; Data Analysis: ÖÇ; Data Visualization and Reporting: ÖÇ; Discussion and Conclusion: GH and ZH; Review of the Paper: ZH, ÖÇ and GH.

Conflicts of Interest

No potential conflict of interest was reported by the authors.

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Scale of Time Traps Teachers Fall into: A Validity and Reliability Study

Öğretmenlerin Düştüğü Zaman Tuzakları Ölçeği: Geçerlik ve Güvenirlik Çalışması

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ABSTRACT: The aim of this study is to develop a valid and reliable scale to measure the time traps teachers fall into during the teaching-learning process. The sample consists of 234 final-year students continuing their education at the Faculty of Education in the first implementation and 233 pedagogical formation students in the second implementation. Expert opinion was sought for content and face validity of the scale, and exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were applied for construct validity. For reliability analysis, Cronbach's Alpha internal consistency, Spearman-Brown, and Guttmann split-half coefficients were calculated, and corrected item-total correlations were used for item analysis. In the first implementation, six items with low factor loadings were removed from the 50-item scale as a result of EFA. It was determined that the remaining items had sufficient factor loadings, were unidimensional, and explained 39.3% of the variance. After EFA, the Cronbach's Alpha internal consistency coefficient was found to be .96, Spearman-Brown and Guttmann split-half coefficients were calculated as .91, and the corrected item-total correlations ranged from .34 to .75. Following CFA, 21 items remained in the scale, and the fit indices for the unidimensional structure were within the recommended limits. After CFA, the Cronbach's Alpha internal consistency coefficient was found to be .91, Spearman-Brown and Guttmann split-half coefficients were calculated as .85, and the corrected item-total correlations ranged from .37 to .73.

Keywords: Teacher, time trap, scale development, validity, reliability.

ÖZ: Bu araştırmanın amacı, öğrenme-öğretme sürecinde öğretmenlerin düştüğü zaman tuzaklarını ölçmeye yönelik geçerli ve güvenilir bir ölçek geliştirmektir. Örneklem, birinci uygulamada eğitim fakültesinde öğrenimine devam eden 234 son sınıf öğrencisi ve ikinci uygulamada 233 pedagojik formasyon öğrencisinden oluşmaktadır. Ölçeğin kapsam ve görünüş geçerliği için uzman görüşüne başvurulmuş, yapı geçerliği için açımlayıcı faktör analizi (AFA) ve doğrulayıcı faktör analizi (DFA) uygulanmıştır. Güvenirlik analizi için Cronbach Alfa iç tutarlık, Spearman Brown, Gutmann split-half katsayısı hesaplanmış ve madde analizi için düzeltilmiş madde toplam korelasyonlarından yararlanılmıştır. İlk uygulamada 50 maddeden oluşan ölçekten, AFA sonucunda faktör yükü düşük olan altı madde çıkarılmıştır. Kalan maddelerin yeterli faktör yüküne sahip, tek boyutlu bir yapıda olduğu ve açıklanan varyansın %39.3 olduğu belirlenmiştir. AFA sonrası Cronbach Alfa iç tutarlık katsayısı .96, Spearman-Brown ve Guttman split-half katsayıları .91 olarak hesaplanmış, düzeltilmiş madde toplam korelasyonlarının .34 ile .75 arasında değiştiği ortaya çıkmıştır. DFA sonucunda, ölçekte 21 madde kalmış ve tek boyutlu yapıya ilişkin uyum indekslerinin önerilen sınırlar içerisinde kaldığı belirlenmiştir. DFA sonrası Cronbach Alfa iç tutarlık katsayısı .91, Spearman-Brown ve Guttman split-half katsayıları .85 olarak hesaplanmış, düzeltilmiş madde toplam korelasyonlarının .37 ile .73 arasında değiştiği ortaya çıkmıştır.

Anahtar kelimeler: Öğretmen, zaman tuzağı, ölçek geliştirme, geçerlik, güvenirlik.

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In today's world, while our needs are rapidly increasing, our resources are rapidly decreasing. Among these diminishing resources, time stands out. Time is an ever-progressing and unstoppable resource which everyone has equally (Eğilmez & Uçar, 2023). It is the duration within which an activity occurs, will occur, or is occurring (Turkish Language Institution Dictionaries). Time is a limited and continuously depleting resource. It is up to individuals to use time effectively or waste it. The first step to using time efficiently is for humans, who can control many areas in nature and social life, to be able to control themselves (İğdeler, 2001). Although it varies according to the tasks each individual undertakes, with the rapidly increasing need for professional and educational knowledge and skills, individuals today are expected to use time effectively and efficiently to be successful. Each person uses their time according to their own goals (Alay & Koçak, 2003). Individuals who manage their time well can allocate more time to their personal activities and can achieve their goals effectively and efficiently in both their personal lives and professional careers (Kocabaş & Erdem, 2003).

The effective and efficient use of time is related to time management. Time management is defined by Mackenzie and Nickerson (2009) not as an external imposition, but as self-discipline on the way to achieving goals. Similarly, according to Güçlü (2001), time management is essentially self-management; it is about controlling the events we experience and managing events by guiding oneself. According to Kocabaş and Erdem (2003), it is the process of applying management functions such as planning, organizing, and controlling to one's activities in order to achieve goals effectively and efficiently in both personal and professional life. According to Taş (2004), two things are important in time management. The first is to prioritize what is urgent. This expresses expectations and directs people to pursue priorities. The second is to prioritize what is important. This expresses goals and ensures that life is conducted in accordance with these goals. According to Dunke, Heckmann, Nickel, and Saldanha-da-Gama (2018), the main components of the future are time and uncertainty. Time refers to the amount of the future to be considered, while uncertainty explains the degree and type of information available about future developments. Failing to address these two aspects appropriately leads to what we call a time trap. A time trap refers to situations where the importance of time is recognized but not adequately processed.

Time traps are factors which prevent individuals from using their time effectively and efficiently, rendering much of their time unproductive and wasted. According to İğdeler (2001), many time traps originate from within ourselves, but there are also numerous time traps that come from external sources. The most significant threat posed by time traps is failure. Time traps slowly deplete those who fall into them; they turn habits and exceptions into rules. According to Mackenzie, some of the time traps which hinder goal achievement include inadequate planning, excessive involvement, personal disorganization, lack of self-discipline, inability to say no, procrastination, leaving tasks unfinished, socializing, and poor communication (Mackenzie & Nickerson, 2009). Falling into a time trap is a significant barrier, especially in achieving goals. In such cases, individuals need to avoid time traps and develop skills for managing time more effectively to reach their objectives. Like other professions, teachers need to develop their time management skills to avoid time traps and manage their time effectively. This is crucial because maximizing students' learning

potential in the learning-teaching process is a complex and dynamic process. There are a number of time traps which teachers can fall into during this process. These traps can hinder teachers from using their time efficiently and affect student success. To avoid these traps, it is important for teachers to set priorities and prevent unnecessary time losses.

A review of the relevant literature reveals that studies on developing scales related to time traps are limited. For example, in a study conducted by Tortumlu and Uzun (2023), the validity and reliability of the Modern Era Time Traps Scale were examined to determine the extent to which university students are affected by 21st-century time traps. In a research conducted by Enterieva and Sezgin (2020), two separate scales were developed to validly and reliably measure teaching time traps in middle schools and the effectiveness of teaching time. Buldum (2023) developed a survey to determine classroom teachers' views on time usage and time traps. Yenilmez (2010) developed a survey to identify primary school teachers' views on time usage, time traps, and effective time management. As it can be seen, there are existing studies on developing scales/surveys to identify time traps for teachers and university students. However, there are no scale development studies aimed at identifying the time traps teachers fall into during the learning-teaching process from the perspective of teacher candidates taking the teaching practice course. The teaching practice course is an important component of the preparation process for teaching profession. These courses help teacher candidates gain classroom experience and transform their theoretical knowledge into practical application. Developing a scale to identify time traps which teachers fall into, whether knowingly or unknowingly, during the practice phase is crucial for raising awareness about time traps among future teachers. Therefore, this study aims to develop a valid and reliable scale to measure the time traps teachers fall into during the learning-teaching process.

Method

Research Model

According to Güler, Teker, and İlhan (2019), studies aimed at developing, adapting, or revising measurement tools are considered quantitative descriptive research. Since this research aims to develop a valid and reliable scale to measure the time traps teachers fall into during the learning-teaching process, it can be characterized as a quantitative descriptive study.

Participants

This research was conducted during the spring semester of the 2023-2024 academic year at the Faculty of Education of a state university. Criterion sampling, a type of purposive sampling, was used to determine the participants. In accordance with the aim of the study, the sample was selected from final-year students of the faculty of education and pedagogical formation students. Additionally, since the goal was to identify the time traps teachers fall into during the teaching-learning process from the perspective of teacher candidates, the criterion for participation was being enrolled in the Teaching Practice I course.

Data for the scale development process were collected in two stages. For EFA, data were collected from 234 final-year students studying in the Turkish, English, Secondary Education Mathematics, Primary Education Mathematics, Science, Geography, and Social Studies departments at the Faculty of Education. For CFA, data were collected from 233 pedagogical formation students studying in the Mathematics, Accounting, Child Development, Physical Education, Philosophy, Sociology, Religious Culture and Ethics, and Engineering departments.

Scale Development Process

In the scale development process, a literature review on the topic was first conducted, and a pool of items consisting of 60 items in a five-point Likert scale (always = 5, often = 4, sometimes = 3, rarely = 2, never = 1) was created. The item pool was reviewed for face and content validity by four experts (two in education sciences, one in field education, and one in measurement and evaluation) and two teachers. Based on their feedback and suggestions, similar items which the experts agreed on were combined, items not considered time traps were removed, and the content of some items was revised. For example, the items "Talking constantly about personal/health issues in class," "Frequently telling life stories in class," and "Talking for a long time about a topic that is suddenly opened/current events in the lesson" were combined into "Talking about non-lesson topics (personal issues, life stories, current events, etc.) during the lesson". The item "Evaluating exam papers in class" was changed to "Grading exam papers in class." The item "Allowing distractions to be present in the classroom environment" was not considered a time trap by experts and was removed from the scale. After similar revisions based on the experts' feedback, the application of the 50-item pilot form was carried out. Using the data obtained from the initial application, EFA was performed to assess the scale's construct validity, followed by reliability and item analysis. Based on the data from the second application of the remaining items after EFA, CFA was conducted, followed by further reliability and item analyses.

Data Analysis

Before proceeding with the data analysis, the data sets for EFA and CFA were first examined for sample size adequacy, univariate and multivariate outliers, and univariate and multivariate normality.

Kline (2011) suggests that a typical sample size in factor analysis studies should be approximately 200 individuals. Tabachnick and Fidell (2001) also stated that a sample size of 150 is adequate. Accordingly, it was concluded that the sample sizes for both datasets are appropriate for conducting validity and reliability studies. Univariate outliers were determined by examining Z-scores, and observations outside the ±4 range, as recommended by Stevens (2009), were considered outliers. Based on this, no univariate outliers were found in the EFA (between -2.40036 and +3.00852) and CFA (between -2.40036 and +3.54733) datasets. For multivariate outliers, Aybek's (2021) web tool, which operates with R software and was developed to prepare data for factor analysis, was used. In the dataset for EFA, 15 observations and in the dataset for CFA, 33 observations were identified as multivariate outliers. After removing these participants, 219 and 200 observations remained in the EFA and CFA datasets, respectively. The assumptions of univariate and multivariate normality for both datasets were assessed using the cleaned datasets provided by Aybek's (2021) web tool. For

univariate normality, the skewness and kurtosis coefficients of the total scores were calculated. The multivariate normality test was assessed using Henze-Zirkler's multivariate normality test results from Aybek's (2021) web tool. The results of the univariate and multivariate normality tests are presented in Table 1.

Table 1

The Results of the Univariate and Multivariate Normality Tests

	Skewness		Kurtosis		Henze-Zirkler
	Statistic	Std. Error	Statistic	Std. Error	
AFA dataset	.547	.164	.057	.327	HZ=1.568407, p=.000
DFA dataset	.765	.172	.012	.342	HZ=1.560953, p=.000

According to Table 1, the fact that the skewness and kurtosis coefficients of both datasets fall within the range of ±1 is considered as an indication that the univariate normality assumption is met (Çokluk, Şekercioğlu, & Büyüköztürk, 2012). However, the significance of the Henze-Zirkler test results indicates that the data do not meet the multivariate normality assumption. To determine the factor structures of the test, EFA was conducted using the "JASP 0.18.3" software. Since the data did not meet the multivariate normality assumption, Principal Axis Factoring (Costello & Osborne, 2005) was used in the EFA.

To determine whether the factor structure obtained from the EFA was confirmed as a model, CFA was performed using the "JASP 0.18.3" program. Since the dataset for CFA did not meet the multivariate normality assumption, the Robust Maximum Likelihood estimation method (Şimşek, 2007) was employed. To test the reliability of the scale after both EFA and CFA, Cronbach's Alpha internal consistency, Spearman Brown and Guttmann split-half coefficents were calculated. Additionally, corrected item-total correlations were examined to assess item discriminability and to identify whether any item did not serve the purpose of the scale.

Ethical Procedures

This study was deemed ethically appropriate by the Ethics Committee of Social and Human Sciences at Dicle University in accordance with the Higher Education Institutions Directive on Scientific Research and Publication Ethics (Date: 01.05.2024, Reference No: E-14679147-663.05-698178).

Results

Exploratory Factor Analysis (EFA)

EFA was conducted to determine the factor structures of the scale. To assess whether the data set was suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's Test of Sphericity were examined. The KMO value was found to be .93, and the chi-square value from Bartlett's test was significant [$\chi^2(1225)=6367.654$, p=.000]. According to Büyüköztürk (2011), a KMO value higher than .60 and a significant Bartlett's Test indicate that the data are suitable for factor

analysis. Based on these findings, it was concluded that the data were suitable for factor analysis.

In EFA, factors with an eigenvalue of 1 or greater are considered significant factors (Büyüköztürk, 2011). The EFA conducted using Principal Axis Factoring revealed that there were 10 factors with eigenvalues above 1. When determining the number of significant factors in EFA, Lord (1980) stated that unidimensionality can be identified if the first factor has a high eigenvalue and explains a large portion of the variance, while the second factor shows a noticeable drop in these values, and the eigenvalues of the second and subsequent factors are similar to each other (Çokluk et al., 2012). When examining the analysis results obtained without any rotation, it was observed that the first factor contributed 35.2% to the total variance, and the second factor contributed 5.0%, with a ratio of approximately 7 between them. The contributions of the third and other factors to the total variance were 3.0%, 2.7%, 2.0%, 1.8%, 1.5%, 1.4%, 1.3%, and 1.1%, respectively. It was observed that the first component significantly contributed to the variance, while this contribution decreased from the second component onwards, and the contributions of the remaining factors were low and similar to each other. Based on this, it was concluded that the scale is unidimensional.

When limited to a single factor and evaluated for whether the factor loadings meet the acceptance criteria, it was ensured that the factor loadings were at least .30 (Büyüköztürk, 2011; Çokluk et al., 2012; Seçer, 2013). It was observed that the factor loadings for items 3, 4, 5, 6, 7, and 11 were below .30. Therefore, these six items were removed from the scale as they were below value. The factor loadings of the scale in its final state are provided in Table 2.

Table 2

The Factor Loadings of the Scale in its Final State

Item no	Factor loading	Item no	Factor loading	Item no	Factor loading	Item no	Factor loading
1.	.45	18.	.34	29.	.60	40.	.75
2.	.48	19.	.69	30.	.71	41.	.68
8.	.63	20.	.64	31.	.64	42.	.73
9.	.48	21.	.53	32.	.45	43.	.67
10.	.57	22.	.64	33.	.61	44.	.73
12.	.43	23.	.71	34.	.64	45.	.55
13.	.57	24.	.62	35.	.57	46.	.75
14.	.57	25.	.63	36.	.63	47.	.76
15.	.67	26.	.71	37.	.63	48.	.71
16.	.68	27.	.67	38.	.74	49.	.60
17.	.68	28.	.51	39.	.63	50.	.64
Total variance explained: 39.3%							

Table 2 shows that the factor loadings of the scale in its final state range between .34 and .76. Additionally, it was noted that the explained variance was 39.3%. According to Büyüköztürk (2011), for single-factor scales, an explained variance of 30% or more is considered sufficient.

Reliability and Item Analysis

The Cronbach's Alpha internal consistency, Spearman Brown and Guttmann split-half coefficents calculated for reliability, along with the results of the item analysis, are presented in Table 3.

Table 3

Reliability and Item Analysis Results

Item no	Corrected item-total correlation	Item no	Corrected item-total correlation	Item no	Corrected item-total correlation	Item no	Corrected item-total correlation
1.	.44	18.	.34	29.	.59	40.	.73
2.	.47	19.	.68	30.	.70	41.	.67
8.	.62	20.	.63	31.	.63	42.	.71
9.	.47	21.	.53	32.	.44	43.	.65
10.	.57	22.	.63	33.	.60	44.	.71
12.	.43	23.	.69	34.	.63	45.	.53
13.	.57	24.	.60	35.	.55	46.	.73
14.	.56	25.	.62	36.	.62	47.	.75
15.	.66	26.	.69	37.	.62	48.	.69
16.	.67	27.	.65	38.	.72	49.	.58
17.	.67	28.	.51	39.	.62	50.	.63
Cronbach's Alpha internal consistency coefficient: .96							
Spearman Brown ve Guttmann split-half coefficent: .91							

After EFA, the Cronbach's Alpha internal consistency coefficient was found to be .96, and the Spearman-Brown and Guttman split-half coefficients were calculated as .91. On the other hand, the corrected item-total correlations ranged between .34 and .75. In general, scales with reliability coefficients of .70 and above are considered reliable (Büyüköztürk, 2011; Urbina, 2004). Furthermore, items with item-total correlations of .30 or higher are considered to have good discriminative power (Büyüköztürk, 2011). Accordingly, it can be stated that the scale has high reliability and discriminative power after EFA.

Confirmatory Factor Analysis (CFA)

Following EFA, the one-factor structure of the scale consisting of 44 items was tested using CFA to determine if it could be validated as a model. According to Seçer (2015), the factor loadings in CFA should be at least .30, and according to Kline (2011), error variances should be less than .90. As a result of the CFA, items 1, 2, 3, 5, 8, 9, 10,

and 12 were removed from the scale because their factor loadings were below .30 and the error variances of items 6, 22, 23, 25, and 26 were above .90. The remaining items had factor loadings ranging from .30 to .74 and error variances ranging from .24 to .80.

Several fit indices are used to assess the adequacy of the model tested in CFA. There are differing opinions among researchers regarding the criteria for evaluating fit indices (Weston & Gore, 2006). The fit indices examined in this study and their corresponding threshold values are presented in Table 4.

Table 4

Fit Indices Examined in the Study and Their Threshold Values

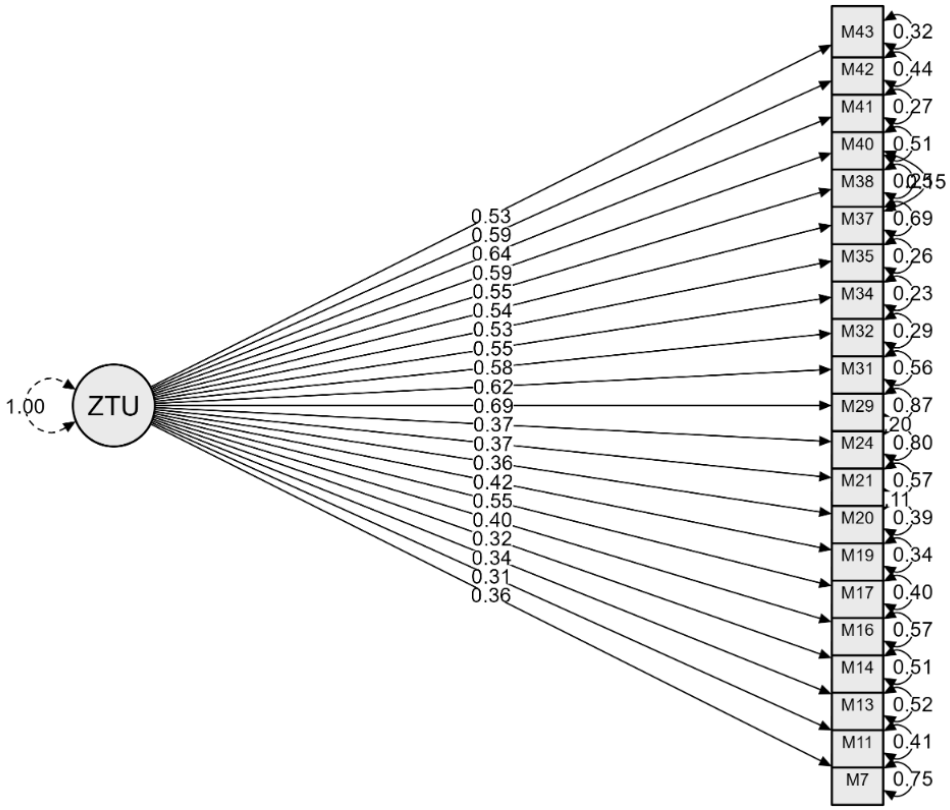
Fit indices	χ^2/ sd[a]	RMSEA[b]	SRMR[c]	CFI[c]	NNFI[c]
Fit criteria	<3	<.10	<.10	>.90	>.90

([a]Marsh & Hocevar, 1985; [b]Meyers vd., 2006; [c]Pituch & Stevens, 2016; cited in Gezen & İlhan, 2023)

The fit indices of the tested model in CFA were outside the acceptable range based on the threshold values shown in Table 4. According to Kline (2011), if the CFA results show poor fit indices, modification suggestions in the output files may need to be considered. Therefore, modification suggestions among items within the same dimension after the analysis were reviewed. Items recommended for linking with multiple theoretically similar items (4, 15, 18, 27, 28, 30, 33, 36, 39, 44) were removed from the test. Additionally, modifications were made among items that were also theoretically similar (37 with 40, 24 with 29, 20 with 21).

Figure 1

Measurement Model of the Scale



After removing items and making the modifications, the measurement model shown in Figure 1 was obtained. It is observed that the factor loadings for the remaining 21 items range between .31 and .69, and the error variances range between .23 and .87. Therefore, it can be stated that there are no problems related to factor loadings and error variances. The fit indices for the model presented in Figure 1 are provided in Table 5.

Table 5

Fit Indices for the Model

Fit indices	χ^2	sd	χ^2/ sd	RMSEA	SRMR	CFI	NNFI
Fit criteria	328.496	186	1.77	.062	.054	.91	.90

As shown in Table 5, the fit indices for the model remain within the threshold values provided in Table 1.

Reliability and Item Analysis

The Cronbach's Alpha internal consistency, Spearman Brown and Guttmann split-half coefficents calculated for reliability, along with the results of the item analysis, are presented in Table 6.

Table 6

Reliability and Item Analysis Results

Item no	Corrected item-total correlation	Item no	Corrected item-total correlation	Item no	Corrected item-total correlation
7.	.37	20.	.49	35.	.65
11.	.43	21.	.46	37.	.52
13.	.43	24.	.39	38.	.70
14.	.41	29.	.59	40.	.62
16.	.47	31.	.61	41.	.73
17.	.63	32.	.69	42.	.64
19.	.58	34.	.69	43.	.64
Cronbach's Alpha internal consistency coefficient: .91					
Spearman Brown ve Guttmann split-half coefficent: .85					

After CFA, the Cronbach's Alpha ınternal consistency coefficient was found to be .91, and the Spearman-Brown and Guttman split-half coefficients were calculated as .85. On the other hand, the corrected item-total correlations ranged from .37 to .73. Based on these results, it can be concluded that the scale is reliable and has high discriminative power.

Discussion and Conclusion

An effective education process depends on the ability of teachers and students to manage their time efficiently. Time management is a critical skill that directly affects both teachers' professional performance and students' learning experiences. In this context, the time traps that teachers may encounter during the teaching and learning process can hinder both their own and their students' efficient use of time. Considering that education is a process and that the effectiveness of this process largely depends on effective time management, identifying and avoiding the time traps that teachers fall into is crucial for improving the quality of education and enabling both teachers and students to use their time more effectively. This study aims to develop a valid and reliable scale to identify the time traps that teachers fall into during the teaching-learning process from the perspective of teacher candidates who have taken the Teaching Practice I course. The Teaching Practice course is a key component of the preparation process for the teaching profession. These courses help teacher candidates gain classroom experience and transform their theoretical knowledge into practical applications. Developing a scale to identify the time traps that teachers knowingly or unknowingly fall into during practice is essential for raising awareness among teacher candidates, who will become the teachers of the future, about time traps.

In the study, data obtained from the first implementation were used, and EFA was applied to examine the construct validity of the scale. Subsequently, reliability and item analyses were conducted. As a result of the EFA, six items with low factor loadings were removed from the scale. It was determined that the remaining items had sufficient factor loadings, formed a unidimensional structure, and explained sufficient variance for a unidimensional scale. After the EFA, reliability and item analysis revealed that the scale was reliable and had high discriminative power. Using the data obtained from the second implementation based on the remaining items after the EFA, CFA was conducted, followed by reliability and item analyses. The CFA results indicated that the fit indices for the 21 items and the unidimensional structure were within the recommended limits. Post-CFA reliability and item analyses also demonstrated that the scale was reliable and had high discriminative power.

Based on the findings from the analyses conducted to examine the psychometric properties of the Time Traps in Teaching-Learning Process Scale, it was concluded that the scale provides valid and reliable measurements. In future studies, the validity and reliability of the scale can be tested on different groups. In this study, EFA and CFA were applied to the data to test the validity of the scale. To provide additional evidence for the validity of the scale, future research can include studies on criterion validity, cross-validation, convergent validity, and discriminant validity.

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Statement of Responsibility

All authors contributed to the study. The first author was involved in conceptualization, literature review, design, data collection, writing, review, editing and supervision. The second author contributed to literature review, design, data collection, methodology, analysis, writing, review, editing, and supervision.

Conflicts of Interest

The authors have no relevant financial or non-financial interests to disclose.

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APPENDIX: Time Traps Teachers Fall into During the Teaching-Learning Process Scale

Items		Never	Rarely	Sometimes	Often	Always
1.	Talking about non-lesson topics (personal issues, life stories, current events, etc.) during the lesson					
2.	Leaving the classroom during the lesson to attend to personal matters					
3.	Spending too much time on routine tasks (filling out the class book, etc.) during the lesson					
4.	Experiencing discipline problems during the lesson					
5.	Spending too much time assessing students' readiness					
6.	Coming to class unprepared and teaching the lesson haphazardly					
7.	Attempting to relate the topic to previous topics/other lessons, causing the topic to drift					
8.	Coming to class unprepared and struggling to write questions/give examples; searching for ready-made questions/examples					
9.	Solving too many questions/giving too many examples/repeating too much on the same topic					
10.	Failing to obtain/check educational technologies, materials, etc. before the lesson					
11.	Giving inappropriate feedback/corrections that don't align with the lesson's purpose or student level					
12.	Using too much reinforcement during the lesson					
13.	Using concepts that are not appropriate for the student's level during the lesson					
14.	Getting caught up in unnecessary details of the topic/activities					
15.	Spending too much time on activities unrelated to the lesson					
16.	Continuing to explain a topic that students have already understood					
17.	Spending too much time summarizing the topic during the lesson					
18.	Not pre-determining assessment criteria for homework and trying to establish them while evaluating homework during the lesson					
19.	Spending too much time checking students' homework during the lesson					
20.	Having to repeatedly explain to students without giving written instructions for activities during the lesson					
21.	Preparing exam questions/answer keys during the lesson					

EK: Öğretme-Öğrenme Sürecinde Öğretmenlerin Düştüğü Zaman Tuzakları Ölçeği

	Maddeler	**Hiçbir zaman**	**Nadiren**	**Bazen**	**Çoğunlukla**	**Her zaman**
1.	Derste ders dışı konulardan (kişisel sorunlar, hayat hikâyesi, güncel olaylar vb.) bahsetme					
2.	Ders sırasında özel işlerini yapmak için sınıftan ayrılma					
3.	Derste rutin işlere (sınıf defteri doldurma vb.) uzun zaman ayırma					
4.	Derste disiplin sorunu yaşama					
5.	Öğrencilerin hazır bulunuşluklarını tespit etmede gereğinden fazla zaman harcama					
6.	Derse hazırlıksız gelip dersi gelişi güzel anlatma					
7.	Derste işleyeceği konuyu daha önceki konularla/diğer derslerle ilişkilendirmeye çalışırken konunun dağılmasına yol açma					
8.	Derse hazırlıksız gelip soru yazmada/örnek vermede güçlük çekme/ hazır soru, örnek bulma arayışına girme					
9.	Aynı konuda gereğinden fazla soru çözme/örnek verme/tekrar etme					
10.	Derste kullanılması planlanan eğitim teknolojilerinin, araç-gereçlerin vb. dersten önce temin/kontrol edilmemesi					
11.	Dersin amacına, öğrenci seviyesine vb. uygun olmayan dönüt-düzeltme yapma					
12.	Derste gereğinden fazla pekiştireç kullanma					
13.	Derste öğrenci düzeyine uygun olmayan kavramlar kullanma					
14.	Konunun/etkinliklerin gereksiz ayrıntılarına takılma					
15.	Ders ile ilgili olmayan etkinliklere fazla zaman ayırma					
16.	Derste öğrencilerin anladığı konuyu anlatmaya devam etme					
17.	Derste konuyu özetlemek için gereğinden fazla zaman harcama					
18.	Ödevlerin değerlendirme ölçütlerini önceden belirlemeyip derste ödevleri değerlendirirken belirlemeye çalışma					
19.	Derste öğrencilerin ödevlerini kontrol ederken gereğinden fazla zaman harcama					
20.	Derste yapılacak etkinliklerde yazılı yönerge vermeden öğrencilere defalarca açıklama yapmak durumunda kalma					
21.	Derste sınav sorularını/cevap anahtarını hazırlama					