akef

İmtiyaz Sahibi
Prof. Dr. Cem ZORLU
Necmettin Erbakan Üniversitesi Rektörü

Baş Editör/ Editor in Chief
Prof. Dr. Ertuğrul USTA (Necmettin Erbakan Üniversitesi)

Editörler/ Editors
Prof. Dr. Tuğba Öztürk (Ankara Üniversitesi)
Doç. Dr. Aslıhan Istanbullu (Ortadoğu Teknik Üniversitesi)
Doç. Dr. Gül Özüdoğru (Ahi Evran Üniversitesi)
Doç. Dr. Burcu Durmaz (Süleyman Demirel Üniversitesi)
Doç. Dr. İlker Dere (Tekirdağ Namık Kemal Üniversitesi)
Prof. Dr. Gökhan Kayılı (Selçuk Üniversitesi)
Prof. Dr. Murat Ateş (Necmettin Erbakan Üniversitesi)
Dr. Öğr. Üyesi Melek Alemdar (Necmettin Erbakan Üniversitesi)

Dil Editörü/Language Editor
Öğr. Gör. Dr. Handan Atun (Yıldırım Beyazıt Üniversitesi)
Arş. Gör. Merve Nur İnce (Necmettin Erbakan Üniversitesi)

Yayına Hazırlık ve Mizanpaj/Puplishing Preparation & Layout Editor
Arş. Gör. Merve Temel (Necmettin Erbakan Üniversitesi)

Yayın ve Danışma Kurulu/Editorial and Advisory Board

İçindekiler | Contents

The Role of Metacognitive Strategies Training in Foreign Language Learning: A Meta-Analysis Study

Emine SUR[1] iD

[1] MEB, Konya, Türkiye

Article Info	ABSTRACT
	Although learning a new language and acquiring a native language require the use of similar skills, the processes of learning a first and a second language are quite different from each other. Planning, monitoring and evaluation, which constitute the three processes of meta-cognitive strategies, ensure that the learner is active throughout the learning process. Using metacognitive strategies in foreign language education positively affects students' acquisition of language skills. While studies have examined the impact of metacognitive strategy training on foreign language learning, no comprehensive analysis currently exists to assess its overall effectiveness across these studies. In this study, research articles investigating the effect of metacognitive strategies training on students' foreign language learning in Turkey and across the world were compiled using meta-analysis method. The results of the analysis showed that metacognition strategies training had a strong effect on students' foreign language learning. As a result of the subgroup analysis, no significant difference was found between the effect sizes by language skills and study group. Within the scope of the research, it was suggested that students should be given training in metacognitive strategies while teaching a foreign language, that future studies should be conducted to examine the effects of metacognitive strategies training on speaking skills, and that future studies should include primary, secondary and high school students as samples.

Yabancı Dil Eğitiminde Üstbilişsel Stratejileri Eğitiminin Rolü: Bir Meta-analiz Çalışması

ÖZET

Yeni bir dil öğrenilirken ana dil ile benzer beceriler kazanılsa da birinci ve ikinci dilin öğrenilme süreçleri birbirinden oldukça farklıdır. Birey ilk dili ailesinden ve yakın çevresinden doğal bir süreçte edinirken ikinci dili kendi iradesi ve çabasıyla öğrenir. Meta-bilişsel stratejilerin üç sürecini oluşturan planlama, izleme ve değerlendirme öğrenenin süreç boyunca aktif olmasını sağlamaktadır. Yabancı dil eğitiminde üst biliş stratejilerini kullanmak öğrencilerin dil becerilerini kazanmasını olumlu yönde etkilemektedir. Alanyazında üst biliş stratejileri eğitiminin öğrencilerin yabancı dili öğrenmesindeki etkisini inceleyen bir dizi araştırma yapılmıştır ancak tüm bu araştırmaları kapsayan ve strateji eğitiminin öğrencilerin yabancı dil öğrenimine etkisinin ne düzeyde olduğunu tespit eden bir çalışmaya rastlanamamıştır. Bu araştırmada Türkiye'de ve dünyada üst biliş stratejileri eğitiminin öğrencilerin yabancı dil öğrenmesine etkisini inceleyen çalışmalar meta-analiz yöntemiyle bir araya getirilmiştir. Yapılan analiz sonucunda üst biliş stratejileri eğitiminin öğrencilerin yabancı dil öğrenmesinde geniş düzeyde etkiye sahip olduğu görülmüştür. Yapılan alt grup analizleri sonucunda, dil becerilerine ve çalışma grubuna göre etki büyüklükleri arasında anlamlı farklılık tespit edilememiştir. Araştırma kapsamında yabancı dil eğitiminde meta bilişsel stratejilerin kullanılması, gelecekte meta biliş stratejileri eğitiminin konuşma becerileri üzerindeki etkisini inceleyen çalışmalar yapılması, gelecekte örneklem olarak ilkokul, ortaokul ve lise öğrencilerini içeren çalışmaların yapılması önerisinde bulunulmuştur.

*Corresponding Author: Emine SUR, Ministry of Education , Turkiye, eminesur30@gmail.com

INTRODUCTION

Improving language skills has become a necessity rather than an option in order to keep up with the complex conditions imposed by time and to benefit from ıntercultural interaction (Ateş, 2023; Deniz & Çekici, 2023). Learning a foreign language refers to the process in which an individual makes sense of and internalizes another language after they acquire their mother tongue. Although similar skills are acquired while learning a new language, learning processes of the first and second languages differ from each other. An individual learns a second language after they start speaking and absorb information; in other words, is conscious while learning the second language (Suryantari, 2018). Being conscious in this process provides the opportunity to direct thoughts and produce solutions when faced with problems. Metacognition strategies, which allow individuals to be aware of the thinking process, are among the skills that should be possessed in a successful foreign language education (Alamri, 2019). According to Paris et al. (1983), metacognition skills constitute one of the important reasons for the differences among students' achievement levels while learning a language (Chon & Shin, 2019)

The concept of metacognition, first used by Flavell (1979), refers to being aware of and controlling one's own cognitive process, in other words, thinking about their thoughts. According to Flavell (1979), this process occurs in two stages: (1) metacognitive knowledge, and (2) metacognitive control. While metacognitive knowledge includes the knowledge that an individual has about metacognition,metacognitive control includes the organizing and directing the individual's thinking process. An individual with metacognitive skills has awareness of their thoughts, can direct and organize thoughts in line with a specific purpose. Combining metacognitive knowledge and metacognitive control process has led to the emergence of concept of metacognitive strategies. Metacognitive strategies are related to how a person thinks and learns (Ashman & Conway, 1993 as cited in Batang, 2015). These strategies are considered as high-level executive skills that utilize knowledge about cognitive processes and constitute an attempt to organize one's own learning through planning, monitoring and evaluation (Zhang & Seepho, 2013).

Metacognitive strategies are highly effective in helping individuals to be successful throughout their education and to acquire new skills. As Devin (1993) states, a successful student has sufficient knowledge about the nature of the cognitive task and metacognitive knowledge about which strategy to use to achieve cognitive goals (Karbalaei, 2011). O'Malley (1985) emphasizes the importance of strategy use by stating that students without metacognitive strategies essentially do not have the opportunity to review their progress, achievements and future situations (Coşkun, 2010). Students who lack the use of metacognitive strategies are not aware of their success or failure because they cannot plan their learning processes.

Metacognitive strategies enable the student to focus, plan, obtain resources, organize, coordinate, and evaluate the construction of L2 knowledge in language learning (Oxford, 2011 as cited in Osuji, 2017). According to Wenden (1998), learners with metacognitive abilities have the following advantages over those who are not aware of the role of metacognition in learning another language they are more strategic learners, their rate of progress in learning is higher, as well as the quality and speed of their cognitive engagement, they are confident in their ability to learn, they do not hesitate to seek help from peers, teachers or parents when necessary, they provide accurate assessments of why they are successful students, they reflect clearly on what went wrong when failure occurs during an activity, their tactics match the learning task and adjustments are made to reflect changing circumstances, they perceive themselves as continuous learners, metacognition enhances and enriches the learning experience, applying metacognitive strategies such as self-awareness and self-monitoring is to develop independent learners who can control their own learning and learn lifelong learning (Papaleontiou-Louca, 2008). 11. Metacognition enables self-monitoring, which is a step-by-step

evaluation process in the learning process. 12. Metacognition develops higher learning and problem solving skills (Damanik, 2019).

Individuals employing metacognitive strategies while learning language skills are aware of the learning process, encounter fewer problems than others, and can produce more effective solutions to the problems they encounter. Students who are less successful in learning a language sometimes use less strategies than others and do not know exactly which strategy to use where and how (Zhang & Guo, 2019). Studies show that better readers also have more metacognitive strategy knowledge and they are better strategy users (Batang, 2015). There are a number of studies showing that using metacognitive strategies improves individuals' reading (Çubukçu, 2008; Dabarera, Renandya, & Zhang, 2014), listening (Dousti & Abolfathiasl, 2013; Selamat & Sidhu, 2012;), writing (Pitenoee et al., 2017), and vocabulary acquisition (Damanik, 2019; Mahdavi, 2014;) skills. Although there are different studies examining the role of metacognitive strategies in students' language learning skills, no study in the literature that combines these studies and reaches a generalizable conclusion was found. This study determines to what extent metacognitive strategies are effective in students' foreign language learning. The problem statement and sub-problems of the research were as follows:

Research questions: To what extent does metacognitive strategies training in second language learning play a role in students' acquisition of language skills?

1. Does the effect of metacognitive strategies training in foreign language learning differ significantly by language skills?

2. Does the effect of metacognitive strategies training in foreign language learning differ significantly by study groups?

METHOD

Many studies have examined the effect of metacognitive strategies training on students' language learning skills. This study aimed to determine the effect level of metacognitive strategy training on students' acquisition of language skills, and the sources obtained as a result of the literature review were compiled using the meta-analysis method. Meta-analysis is the grouping of similar studies on a subject, theme or field of study under certain criteria and interpreting the quantitative findings of these studies by combining them (Dinçer, 2014).

Table 1 shows the descriptive statistical values of the studies included in the meta-analysis.

Table 1.

The Descriptive Statistical Values of the Studies Included in the Meta-Analysis

		Frequency (f)	Percent (%)
	2000-2010	3	14.28%
Publication Year	2010-2015	11	52.38%
	2016-2020	7	33.33%
Publication Type	Thesis	1	4.76%
	Article	20	95.23%
	Primary school	1	4.76%
Educational Level	Middle school	2	9.52%
	Secondary School	-	-
	University	18	85.71%

	1-3 weeks	1	4.76%
	3-5 weeks	6	28.57%
Implementation Period	6-8 weeks	6	28.57%
	8-10 weeks	2	9.52%
	More than10 weeks	5	23.80%
	Unspecified	1	4.76%
	Reading	11	52.38%
	Listening	7	33.33%
Language Skill	Speaking	-	-
	Writing	2	9.52%
	Vocabulary	1	4.76%

As seen in Table 1, studies examining the effect of metacognitive strategies education on language learning skills were mostly conducted between 2010 and 2015. The least studies were carried out between 2000 and 2010. A significant part of these studies were performed with university students (85%). The duration of the studies varied between 3–5 (28%) and 6–8 weeks (28%). The shortest implementation period was 1–3 weeks (4%) and the longest was more than 10 weeks (23%). The implementation period was not specified in 4% of the studies. It was found that most of these studies (52%) aimed to improve reading skills, and no study aimed to improve speaking (0%) skills using metacognitive strategies.

Research Instruments and Processes

A five-step process was followed to conduct a comprehensive review of the studies examining the effect of metacognitive strategies training in second language learning. First, in the first review, it was seen that the first study on metacognition strategies training was published in 2009. Google Scholar, CoHE, National Thesis Centre (YÖK), ERIC, Proquest, WOS databases were searched to find studies published in peer-reviewed journals between 2009 and 2020. In the review process, the words "metacognition", "metacognition strategies training", "metacognition strategies training and reading", "metacognition strategies and speaking", "metacognition strategies and writing", "metacognition strategies and listening" and their Turkish equivalence were used as keywords. At the end of the research, 160 studies were reached. In order to include these studies in the meta-analysis, they were checked in term of these criteria: (a) whether they included metacognitive strategy training in second language learning, and b) whether they used sample size, arithmetic mean, standard deviation, and t or p values in their analyses. The reason for determining these criteria is the necessity of having these data in order to conduct meta-analysis (Sur, 2022). Studies meeting these criteria were recorded in the coding key. The total sample size of the studies included in the meta-analysis consisted of 1,415 participants. The review showed that 25 studies met the criteria for inclusion in the meta-analysis and 32 data from 25 studies were included in the analysis. Some studies had to take two or more data from each study. Since Pei and Suwanthep (2019) worked with more than one group, 2 data from their study, 3 data from the study of Mehrdad, Ahghar, and Ahghar (2012), and because Nguyen and Trinh (2011) and Takallou (2011) provided different metacognition strategy training to the groups, more than one data from their studies were included in the meta-analysis. However, four studies were found to cause publication bias during the analysis process, therefore, five data from these studies had to be excluded from the analysis. A total of 27 data obtained from 21 studies were used in the meta-analysis to determine the role of metacognitive strategies training in students' language learning skills.

Data Analysis

Code lists were created in order to ensure the reliability of the study. These lists included the name of the study, sample sizes, arithmetic mean and standard deviation values, type of the study, and

the language skill that was aimed to be developed. While creating code lists, a second researcher was consulted and two different charts were prepared. Three studies that led to disagreement between the researchers were re-examined and recorded in the coding key when they reached a consensus.

The publication bias of this meta-analysis study was examined using a funnel scatter plot, Orwin's Safe N calculation, and Egger's regression test. The funnel scatter plot showing the publication bias of the studies examining the effect of metacognitive strategies training on students' language learning is shown in Figure 1:

Figure 1.

Funnel Scatter Plot of the Effect of Metacognitive Strategies Training on Students' Foreign Language Learning Skills
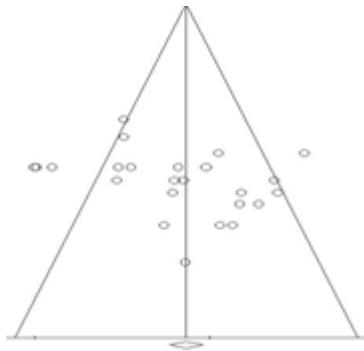
When there is no publication bias, studies are symmetrically distributed on both sides of the overall effect size vertical line, whereas if there is publication bias, the distribution is concentrated on one side of the line. In addition, it is possible to argue that there is a potential publication bias if the studies are concentrated in the lower corner of the triangle (Borenstein et al., 2009). In this study, the overall effect size is distributed symmetrically on both sides of the vertical line.

Table 2.

Results of Publication Bias Analysis

Bias Status	
z value for the reviewed studies	17,702
p-value for the reviewed studies	0.00
Alpha	0.05
Direction	2
z value for Alpha	1.95
The number of reviewed studies	27
FSN	2176
Tau	0.22
z Value for Tau	1.66
p value (tailed)	0.04
p value (tailed)	0.09
Standard error	2.24

95% lower limit (1-tailed)	-1.34
95% upper limit (1-tailed)	7.91
t value	1.46
sd	25
p value (tailed)	0.07
p value (tailed)	0.15

Orwin's Safe N calculation is used to calculate the number of studies that may be missing in meta- analysis (Borenstein et al., 2009). As a result of the analysis, the number of studies required to eliminate significance was calculated as 2,176. It was impossible to reach 2,176 studies examining the effect of metacognition strategies in foreign language education in order to eliminate significance (*p* > .05). The funnel plot and Orwin's Safe N calculation showed no publication bias in the study. In addition, the result of Egger's test was not significant (*p* > .05), which also confirmed that there was no publication bias in the meta-analysis.

In the analysis of the data, first, it should be decided which standard scores will be converted from the values obtained from the studies. The values collected from the difference-based studies are used by transforming them into one of the Cohen's d, Hedges' g and Glass Δ effect size values (Borenstein et al., 2009). Among these values, the Cohen's d formula is more appropriate for studies with a sample size of larger than 20 (Lipsey & Wilson, 2001 as cited in Çırak et. al., 2018). The sample size of 21 studies analyzed in this study was more than 20. Therefore, the values collected from the studies were converted into Cohen's d value and then used. The effect size was calculated using Cohen's d coefficient, the standardized mean difference method. According to this method, -.15 ≤ effect size (g or d) < .15 is insignificant, .15 ≤ effect size (g or d) < .40 is small, .40 ≤ effect size (g or d) < .75 is moderate, .75 ≤ effect size (g or d) < 1.10 is large, 1.10 ≤ effect size (g or d) < 1.45 is very large, and 1.45 ≤ effect size (g or d) is excellent (Dinçer, 2014: 33).

Table 3.

Heterogeneity of the Studies Included in the Meta-Analysis

Model	*n*	Mean Effect Size	*z*	Standard error	For Effect size 95% Confidence Interval Lower Upper Limit Limit	*Q*	sd	I2	*p*
Stable	27	0.86	17.43	0.05	0.76-0.96	119.5	26	78.2	0.00

A heterogeneity test was conducted to calculate the overall effect and to select the model that would be used. The *Q* value and *p* value were 240.504 and 0.00, respectively. Since the *Q* value was 40.11 in the χ2 critical value range table for 26 degrees of freedom (df) and 95% significance level, it was concluded that the studies were heterogeneous. In the I2 analysis, the fact that the values are 25% and around, 50% and around and 75% and around indicate a low-, a medium-, and a high-level of heterogeneity, respectively. The I2 value, which was determined as 78% in the current study, indicates a high level of heterogeneity (Cooper et al., 2009). Since the effect sizes were distributed heterogeneously, the random effects model was used as the analysis model, and the overall effect size was calculated as 0.90 within the limits of 0.69 and 0.96 (the overall effect size was calculated as 0.90 –within the limits of 0.76 and 0.96 based on the fixed-effect model).

FINDINGS

The forest plot showing the effect of metacognition strategies training on students' language learning skills is presented in Figure 2 and the findings regarding the effect size values are presented in Table 4:

Figure 2.

Forest Plot of the Effect of Metacognitive Strategies Training on Students'
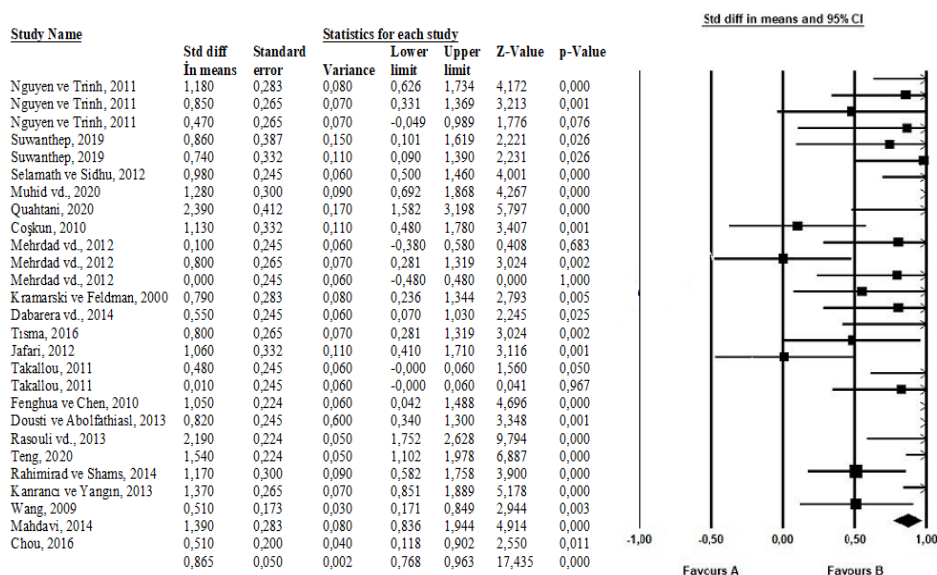
Table 4.

The Effect of Metacognitive Strategies Training on Students' Language Learning Skills

	S	n	ES_{mean}	p	z	S_{error}	ES_{lower}	ES_{upper}
Gender	27	1,415	0.90	0.00	8.41	0.10	0.69	1.11

Looking at Table 4 and the forest plot, it is seen that the effect size value of metacognition strategies training on students' acquiring language skills is (0.90) with a standard error of (0.10). When the calculated effect value is evaluated together with the forest plot, metacognition strategy training has a large effect on students' acquiring language skills.

Within the scope of the research, groups were compared to determine the source of heterogeneity. The extent to which the students were affected by metacognitive strategy training by language skills (listening, reading, speaking, writing and vocabulary teaching) and the study group was examined using Analogue ANOVA analysis. The results are present in Table 5:

Table 5.

Subgroup Analysis Results According to Random Effects Model

	Variable	N	Effect Size	St. Deviation	95% confidence interval Lower Limit	Upper Limit	sd	.05 Confidence Level χ	Q_S	p
	Reading	16	0.659	0.066	0.530-0.788					
	Listening	8	1.060	0.090	0.883-1.237		3	10.16	7.102	0.6
Language	Writing	2	1.295	0.158	0.985-1.605					

Skill	Vocabulary	1	1.390	0.283	0.836-1.944				
Study Group	Primary school	1	0,550	0,245	0,070-1,030	2	8.68	2.38	0.3
	Middle school	2	1.089	0.290	0.520-1.657				
	Secondary School	-	-	-	-				
	University	24	-0.910	0.119	0.677-1.143				

Table 5 shows that the effect sizes by language skills were 0.659 for reading, 1.060 for listening, 1.295 for writing, and 1.390 for vocabulary. However, the variance between studies by language skills was not statistically significant ($p > .05$). The effect sizes were determined as 0.550 for primary school, 1.089 for secondary school, and 0.910 for university by the study groups. The variance between studies by the study groups was not statistically significant ($p > .05$).

CONCLUSION and DISCUSSION

This study investigated the effect of metacognition strategies on students' acquiring language skills in foreign language education using the meta-analysis method. The result of the analysis carried out with 27 data obtained from 21 studies showed that metacognitive strategies training had a large effect on students' language learning skills. In addition, the strategy training given in the language education process has a positive effect on students' strategy use and learning. Individuals who learn metacognitive strategies and begin to use them effectively gain significant advantages over those who cannot use these strategies while learning a new language.

As Vandergrift states, students with high metacognitive awareness find the best ways to apply and reinforce what they have learned and perform much better than others in processing and retaining new information (Ghapanchi & Taheryan, 2012). A person may have sufficient knowledge of vocabulary and grammar; however, if they cannot use them appropriately at the right time and place, they cannot gain from what they have learned. It is the metacognitive knowledge that enables learners to adapt what they have learned to new situations. According to Oxford and Crookall (1988), the use of appropriate strategies improves students' independence, self-direction and learner autonomy, which are crucial for students to sustain their lifelong learning efforts. This allows them to be responsible for their own learning (Nguyen & Trinh, 2011: 16). Planning, monitoring and evaluation, which constitute the three processes of meta-cognitive strategies, prevent the learning process from occurring spontaneously and ensure that the learner is active throughout the process. The use of strategies in learning a new language allows one to set goals, identify difficulties in learning reading, listening, speaking and writing skills, assess the extent to which skills have been learned, select appropriate methods, check their suitability and modify these methods when necessary, and correct mistakes. Individuals who take responsibility for their own learning can manage the learning process, process and store the information they have learned through repetition and practice.

One who is able to use the metacognition strategy makes connections between their previous knowledge and new knowledge while learning a second language and repeats the information until they learn it. Repetition is the most effective way of learning knowledge and making it permanent. Combining new knowledge with previously acquired knowledge and synthesizing it helps learners understand and make sense of it. When learning a new language, comprehension and interpretation activities ensure that information is retrieved from long memory when necessary. Metacognitive strategies play an important role not only in making sense of the knowledge but also in monitoring the

learner's own learning. A student who has a strategy can plan and organize the learning process while learning a new language, monitor whether the processes are running regularly, change the applications that do not yield results when necessary, and keep their mind awake while performing these processes (Cemiloğlu & Ogur, 2016). In this case, it is seen that the use of strategy is an important factor in overcoming the difficulties that students may encounter in the foreign language learning process and in facilitating the learning process.

Within the scope of this study, it was examined whether the studies examining the effect of metacognitive strategies training on students' foreign language learning showed significant differences by language skills and research group. Accordingly, a homogeneity test was conducted to determine whether there was a significant difference between effect sizes by language skills, and it was found that the difference between groups was not significant ($QS = 7.10$, $p > .05$). Similarly, a homogeneity test was performed to determine whether there was a significant difference between the effect sizes by the study groups, and no significant difference was found ($QS = 2.38$, $p > .05$). Most of the studies ($f = 24$) examining the effect of metacognitive strategies training on students' ability to learn a foreign language were conducted with university students. The lack of studies examining the role of metacognition strategy training in high school students' foreign language learning and the low number of studies investigating the role of metacognition strategy training in primary and secondary school students' foreign language learning are important gaps in the literature.

SUGGESTIONS

1. Providing students with metacognitive strategies training while teaching them foreign language education is extremely necessary for the efficiency of the learning process.

2. The effects of metacognition strategies training on reading, listening and writing skills have been examined in the studies; however, no study addressing the effect of this training on speaking skills was found. In the future, studies examining the effect of metacognitive strategies training on speaking skills should be conducted.

3. Studies examining the effect of metacognitive strategies training on students' foreign language learning selected only university students for the study groups; therefore, future studies including primary, middle and high school students as samples should be conducted.

Ethical Statement

Ethics committee approval was not obtained because data from previously published studies were used in the study. Ethical principles and rules were followed throughout the study. The studies from which the data received within the scope of meta-analysis are shown in Appendix 1.

Conflict of Interest
There is no conflict of interest.

REFERENCES

Alamri, B. (2019). Exploring metacognitive strategies employed by esl writers: uses and awareness. *International Journal of English Linguistics*, 9(1), 159-168. doi:10.5539/ijel.v9n1p159

*Al Qahtani, A. (2020). Investigating metacognitive think-aloud strategy in improving saudi EFL learners' reading comprehension and attitudes. *English Language Teaching, 13*(9), 50-62.DOI: 10.5539/elt.v13n9p50

Ateş, M. (2023). Examining the use of methods and techniques used in teaching writing skills in writing activities in Turkish course books. *Ahmet Keleşoğlu Education Faculty Journal (AKEF) Journal, 5*(3), 1173-1182.

Batang, B. L. (2015). Metacognitive strategy awareness and reading comprehension of prospective pre-service secondary teachers. *Asia Pacific Journal of Multidisciplinary Research, 3*(4), 62-67.

Borenstein, M., Hedges, L. V., Higgins, J. P. T. & Rothstein, H. R. (2009). *Introduction to meta-analysis* John Wiley & Sons, Ltd.

Cemiloğlu, M. & Ogur, E. (2016). Cognition and metacognitive strategies in reading instruction. *International Journal of Human and Art Studies*, *1*(1), 46-53.

Chon, Y. V. & Shin, T. (2019). Profile of second language learners' metacognitive awareness and academic motivation for successful listening: A latent class analysis. *Learning and Individual Differences, 70*, 62-75. https://doi.org/10.1016/j.lindif.2019.01.007

*Chou, M. (2016). A task-based language teaching approach to developing metacognitive strategies for listening comprehension. *International Journal of Listening, 0*(0), 1-20. http://dx.doi.org/10.1080/10904018.2015.1098542

Cooper, H., Hedges, L. V., & Valentine, J. C. (2009). *The handbook of research synthesis and metaanalysis* (2nd edition). New York: Russell Sage Publication.

*Coşkun, A. (2010). The effect of metacognitive strategy training on the listening performance of beginner students. *Novitas-ROYAL (Research on Youth and Language), 4*(1), 35-50.

Çırak Kurt, S., Yıldırım, İ., & Cücük, E. (2018). The effects of blended learning on student achievement: A meta-analysis study. *Hacettepe University Journal of Education, 33*(3), 776-802. doi: 10.16986/HUJE.2017034685

*Çubukçu, F. (2008). How to enhance reading comprehension through metacognitive strategies. *The Journal of International Social Research, 1*(2), 83-93.

*Dabarera, C., Renandya, W. A. & Zhang, L. J. (2014). The impact of metacognitive scaffolding and monitoring on reading comprehension. *System, 42,*462-473.

Damanik, B. A. R. (2019). The effect of metacognitive strategy on the English learners' vocabulary mastery. *Southeast Asia Language Teaching and Learning (SALTeL) Journal, 2*(2), 45-55. DOI: http://dx.doi.org/10.35307/saltel.v2i2.31

Deniz, K. & Çekici, Y. E. (2023). List of current language functions based on needs analysis within the scope of teaching Turkish as a foreign language. *Necmettin Erbakan University Ahmet Keleşoğlu Faculty of Education Journal, 5*(2), 374-401.

Dinçer, S. (2014). *Introduction to meta-analysis.* Ankara: Ani Publishing

*Dousti, H. & Abolfathiasl, H. (2013). The effect of metacognitive listening strategy training on EFL

learners' listening sub-skills performance, *International Journal of Applied Linguistics & English Literature, 2* (4), 50-55.

*Habibian, M. (2015). The impact of training metacognitive strategies on reading comprehension among ESL learner's. *Journal of Education and Practice, 6*(28), 61-69.

Flavell, J. (1979). Metacognition and cognitive monitoring a new area of cognitive developmental ınquiry. *American Psychologist, 34*(10), 906-911. https://doi.org/10.1037/0003-066X.34.10.906

Ghapanchi, Z. & Taheryan, A. (2012). Roles of linguistic knowledge, metacognitive knowledge and metacognitive strategy use ın speaking and listening proficiency of ıranian EFL learners. *World Journal of Education, 2*(4), 64-75. DOI: 10.5430/wje.v2n4p64

*Jafari, D. & Ketabi, S. (2012). Metacognitive strategies and reading comprehension enhancement in Iranian ıntermediate EFL setting. *International Journal of Linguistics, 4*(3), 1-14. DOI: https://doi.org/10.5296/ijl.v4i3.1684

Karbalaei, A. (2011). Metacognition and reading comprehension. *İkala, Revista De Lenguaje Y Cultura, 16*(28), 5-14.

*Katrancı, M. & Yangın, B. (2013). Üstbiliş stratejileri öğretiminin dinlediğini anlama becerisine ve dinlemeye yönelik tutuma etkisi. *Adıyaman Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 6*(11), 733-771.

*Kramarski, B. & Feldman, Y. (2000). Internet in the classroom: effects on reading comprehension, motivation and metacognitive awareness. *Educational Media International, 37*(3), 149-155. DOI: 10.1080/09523980050184709

*Lv, F. & Chen, H. (2010). A study of metacognitive-strategies-based writing instruction for vocational college students. *English Language Teaching, 3*(3), 136-144.

*Mahdavi, M. (2014). Metacognitive strategy training and vocabulary learning in an "input -poor" environment. *International Journal of Multidisciplinary and Current Research, 2*, 389-398.

*Mehrdad, A. G., Ahghar, M. R. & Ahghar, M. (2012). The effect of teaching cognitive and metacognitive strategies on EFL students' reading comprehension across proficiency levels. *Procedia - Social and Behavioral Sciences, 46*, 3757 – 3763. https://doi.org/10.1016/j.sbspro.2012.06.142

*Muhid, A., Amalia, E. R., Hılalıyah, H., Budıana, N. & Wajdi, M. B. N. (2020). The effect of metacognitive strategies ımplementation on students' reading comprehension achievement. *International Journal of Instruction, 13*(2), 847-862. https://doi.org/10.29333/iji.2020.13257a

*Nguyen, T. M. T. & Trinh, L. Q. (2011). Learners' metacognitive strategy use and reading comprehension: Insights from a vietnamese context. *i-manager's Journal on English Language Teaching, 1*(1), 9-19.

Osuji, C. J. (2017). *Cognitive and metacognitive strategy use in first and second language reading comprehension* [Phd Thesis, Essex University]. Department of Language and Linguistics. https://repository.essex.ac.uk/19961/1/Chinedu

*Pei, T. & Suwanthep, J. (2019). Effects of web-based metacognitive listening on Chienese university EFL learners' listening comprehension and metacognitive awareness. *Indonesıan Journal of Applied Linguistics, 9*(2), 480-492. doi: 10.17509/ijal.v9i2.20246

*Pitenoee, M. R., Modaberi, A. & Ardestani, E. M. (2017). The effect of cognitive and metacognitive writing strategies on content of the Iranian intermediate EFL learners' writing. *Journal of*

Language Teaching and Research, 8(3), 594-600. DOI: http://dx.doi.org/10.17507/jltr.0803.19

*Rahimirad, M. & Shams, M. R. (2014). The effect of activating metacognitive strategies on the listening performance and metacognitive awareness of EFL students. *International Journal of Listening, 28*(3), 162-176. http://dx.doi.org/10.1080/10904018.2014.902315

*Rasouli, M., Mollakhan, K. & Karbalaei, A. (2013). The effect of metacognitive listening strategy training on listening comprehension in Iranian EFL context. *European Online Journal of Natural and Social Sciences, 2*(1), 115-128

*Selamath, S. & Sidhu, G. K. (2012). Enhancing listening comprehension: The role of metacognitive strategy instruction (MetSI). *Procedia - Social and Behavioral Sciences, 90*, 421-430.

Sur, E. (2022). Okuduğunu anlama becerisini etkileyen çeşitli değişkenler: bir meta analiz çalışması. *Milli Eğitim Dergisi, 51*(236), 3061-3080. https://doi.org/10.37669/milliegitim.941696

Suryantari, H. (2018). Children and adults in second-language learning. *Tell Journal, 6*(1), 30-38.

*Tabrizi, A. R. N. & Rajaee, M. (2016). The effect of metacognitive and cognitive writing strategies on Iranian elementary learners' writing achievement. *International Journal of Learning and Development, 6*(3), 216-229. doi:10.5296/ijld.v6i3.9935

*Takallou, F. (2011). The effect of metacognitive strategy instruction on EFL learners' reading comprehension performance and metacognitive awareness. *Asian EFL Journal, 13*(1), 272-300.

*Teng, F. (2019). The role of metacognitive knowledge and regulation in mediating university EFL learners' writing performance. *Innovation in Language Learning and Teaching, 14*(2), 1-15. DOI: 10.1080/17501229.2019.1615493

*Tišma, D. J. (2016). Improving listening comprehension skills relying on metacognitive strategies – focus on vocabulary and specific L2 instruction. *Zbornik Instituta za pedagoska istrazivanja, 48*(2), 2016-301.

*Wang, J., Spencer, K. & Xing, M. (2009). Metacognitive beliefs and strategies in learning Chinese as a foreign language. *System, 37,* 46–56.

Zhang, L., & Seepho, S. (2013). Metacognitive strategy use and academic reading achievement: Insights from a Chinese context. *Electronic Journal of Foreign Language Teaching, 10*(1), 54-69.

Zhang, X. & Guo, M. (2019). Metacognition and second language learning. *Advances in Social Science, Education and Humanities Research, 428*, 88-91. https://doi.org/10.1007/978-981-10-6325

Artificial Intelligence in Education: A Bibliometric Analysis

Seher KESER ATEŞ[1] (iD) **Fatih KALECİ[2]** (iD) **Ahmet ERDOĞAN[3]** (iD)

[1]PhD Candidate, Necmettin Erbakan University, Institute of Educational Sciences, Mathematics Education, Konya, Türkiye, seherkeser05@gmail.com
[2]Assist. Prof. Dr., Necmettin Erbakan University, Ereğli Faculty of Education, Mathematics Education, Konya, Türkiye, fkaleci@erbakan.edu.tr
[3]Prof. Dr., Necmettin Erbakan University, Ahmet Keleşoğlu Faculty of Education, Mathematics Education, Konya, Türkiye, aerdogan@erbakan.edu.tr

Article Info	ABSTRACT
	Artificial intelligence is a technological field that mimics human cognitive abilities. The rapid development of technology has accelerated the implementation of artificial intelligence in education. The aim of the study is to examine 4935 scientific researches on artificial intelligence in the field of education indexed in the Web of Science (WoS) database between 1981-2024 by bibliometric analysis method. The results of the analysis are given with VOSviewer program. The findings of the study showed that the most studies were conducted in 2023. Most of the studies on this subject are articles and papers. The most frequently published languages are English and Spanish. The results showed that Gwo-Jen Hwang, Melissa Bond and Olaf Zawacki-Richter are the top three most cited authors in the subject area. "Artificial intelligence" and "chatgpt" are frequently used keywords. Hong Kong University of Education and Carnegie Mellon University are the top two institutions with the most published researchers. Springer Nature, IEEE and Taylor & Francis are the top publishing journals respectively. Gwo-Jen Hwang is the most co-cited author. The USA has the highest frequency of cross-country linked publications. It is thought that this research will be a guide for researchers who want to study in the field and will increase their knowledge. The research topic has been analyzed in the WoS database, and it may be recommended to analyze it bibliometrically in other databases such as Scopus.

Eğitimde Yapay Zekâ: Bir Bibliyometrik Analiz

ÖZET

Yapay zekâ insan bilişsel yeteneklerini taklit eden teknolojik bir alandır. Teknolojinin hızlı gelişmesi, eğitimde yapay zekânın uygulamaya konulmasını hızlandırmıştır. Araştırmanın amacı, 1981-2024 yılları arasında Web of Science (WoS) veri tabanında indekslenen eğitim alanında yapay zekâ konusundaki 4935 bilimsel araştırmayı bibliyometrik analiz yöntemiyle incelemektir. Analiz sonuçları VOSviewer programı ile verilmiştir. Araştırmanın bulguları çalışmaların en fazla yapıldığı yılın 2023 olduğunu göstermiştir. Bu konu ile ilgili çalışmaların büyük kısmını makaleler ve bildiriler oluşturmaktadır. En sık yayın yapılan dillerin başında İngilizce ve İspanyolca gelmektedir. Araştırma sonuçları Gwo-Jen Hwang, Melissa Bond ve Olaf Zawacki-Richter yazarlarının konu alanında en çok atıf alan ilk üç yazar olduğunu göstermiştir. "Artificial intelligence" ve "chatGPT" sık kullanılan anahtar kelimelerdir. Hong Kong Eğitim Üniversitesi ve Carnegie Mellon Üniversitesi en çok yayın yapan araştırmacıların bulunduğu ilk iki kurumdur. Springer Nature, IEEE ve Taylor & Francis sırasıyla en çok yayın yapan dergilerdir. En fazla ortak atıf yapılan yazar Gwo-Jen Hwang'dır. ABD en yüksek frekansla ülkeler arası bağlantılı yayın sayısına sahip ülkedir. Bu araştırmanın alanla ilgili çalışma yapmak isteyen araştırmacılara rehber olacağı ve onların bilgi birikimlerini artıracağı düşünülmektedir. Araştırma konusu WoS veri tabanında incelenmiş olup, Scopus gibi diğer veri tabanlarında bibliyometrik açıdan analiz edilmesi önerilebilir.

*Corresponding Author: Fatih KALECİ, fkaleci@erbakan.edu.tr

INTRODUCTION

According to Minsky, one of the pioneers of artificial intelligence, artificial intelligence (AI) is defined as the fulfillment of tasks that require human intelligence by machines (Jiang et al., 2022). While the origins of artificial intelligence date back to the robot drawings of Al Jazari (1136-1206) (Coşkun & Gülleroğlu, 2021), its foundations are known to date back to the 1940s. One of the pioneering works in this field is thought to be the story Runaround, published by American science fiction writer Isaac Asunov, about a robot developed by engineers Gregory Powell and Mike Donovan (Haenlein & Kaplan, 2019). The concept of "artificial intelligence" was first expressed by John McCarthy in 1956 (Melak et al., 2024). Its modern expression dates back to Alan Turing. Known as the British mathematician and the father of artificial intelligence, Turing developed a code-breaking machine called The Bombe for England in order to solve the Enigma code used by the Germans during World War II. The Bombe was able to break the impossible code and made Turing more curious with its artificial intelligence. Turing published his paper "Computing Machinery and Intelligence" and developed the Turing test, which is used today (Coşkun & Gülleroğlu, 2021; Haenlein & Kaplan, 2019).

The concept of "artificial intelligence" was first expressed by John McCarthy in 1956 (Melak et al., 2024). Its modern expression dates back to Alan Turing. Known as the British mathematician and the father of artificial intelligence, Turing developed a code-breaking machine called The Bombe for England in order to solve the Enigma code used by the Germans during World War II. The Bombe was able to break the impossible code and made Turing more curious with its artificial intelligence. Turing published his paper "Computing Machinery and Intelligence" and developed the Turing test, which is used today (Coşkun & Gülleroğlu, 2021; Haenlein & Kaplan, 2019).

Artificial intelligence covers a wide range of human cognitive abilities such as problem solving, learning, reasoning, language processing. Artificial intelligence is a system based on the effort to simulate and improve human intelligence (Jiang et al., 2022). Research areas of AI include engineering, psychology, cognitive science, mathematics, computer science and many more. Artificial intelligence has application areas such as recognizing and processing given speech, analyzing digital images, pictures, videos, robotic surgery, simulation, health monitoring, health system analysis, diagnosis of neurological conditions, language processing, intelligent robots, autonomous vehicles, energy systems (Gondal, Khalid Masud, 2018). With the widespread use of artificial intelligence in areas such as advertisements, TV series/movies and social media, the concept of artificial intelligence has reached large masses and has become an intriguing topic (Saçan et al., 2022). The increasing integration of man-made machines and robots in our daily lives has increased the number of studies on artificial intelligence (Tellan, 2020).

Considering its increasing capabilities and widespread applications, artificial intelligence is expected to be integrated into almost every aspect of our daily lives in the future (Koçyiğit & Darı, 2023). Artificial intelligence, which has been around since the 1960s, has increased its integration with education with the development of intelligent tutoring systems (Bond et al., 2024).

Artificial Intelligence (AI) has the potential to overcome the challenges in today's education, innovate teaching and learning practices, and accelerate progress towards SDG 4. Artificial intelligence, which can develop different alternatives for an equitable, inclusive, quality education, brings risks and challenges along with rapid technological developments (UNESCO, 2024).

Pratama, Sampelolo & Lura (2023) found that 88% of the students strongly agreed that AI is helpful for learning according to the results of the survey they used in their study. According to the results of the research, artificial intelligence increased engagement with personalized learning

experiences and positively affected learning outcomes (Pratama et al., 2023). In the study conducted by Badi, Khan, and Alotaibi (2022), it was determined that instructors and students in higher education institutions had a positive attitude towards AI-supported personalized learning applications as a result of the analysis of 91 data sets (Al-Badi et al., 2022). Technological developments in education in recent years have been the subject of many studies in education as well as in different disciplines. Today, artificial intelligence applications significantly improve the quality of education in areas such as course content preparation, individual performance monitoring, and instructional model selection (Meço & Coştu, 2022). While the integration of AI into education systems offers significant advantages such as personalized learning, it has also brought challenges such as ethical concerns, privacy concerns, inequality issues and lack of technological literacy (Akyel & Tur, 2024). It is possible to see many studies in which different technologies are used in education.

The bibliometric analysis method, first used by Pritchard (1969), has gained widespread popularity in understanding the literature (Zhang et al., 2019). According to Pritchard, bibliometrics is the analysis of books and other communication tools with mathematical and statistical methods (Pritchard & Wittig, 1981).

The aim of this study is to examine 4935 scientific researches on artificial intelligence in the field of education indexed in the Web of Science (WoS) database between 1981-2024 by bibliometric analysis method and present them to the literature.

Identifying research topics in rapidly developing fields is a complex process for researchers. This research of the field of artificial intelligence in education will provide researchers with a comprehensive framework on the current state of the field, potential research topics and gaps in the literature. The number of artificial intelligence studies in education is increasing in our country and in the world over time. Through this research, researchers will be able to direct their work in a way that contributes to the needs and future development of the field.

Research Topic and Problems

The subject of the research is to analyze international scientific research on artificial intelligence in the field of education. The main problem of the research is to analyze the current status of international scientific publications on artificial intelligence in the field of education in bibliometric indicators. Based on this problem, sub-problems were determined as follows:

Studies on artificial intelligence in the field of education,

Studies on artificial intelligence in the field of education,

1. Growth and Spillover Trends

    a. How have their numbers and citation data statistics been over the years?

    b. What is their distribution according to the types of publications?

    c. What is their distribution according to the languages in which they were prepared?

    d. What are the journals that publish the most studies?

2. Content and Thematic Analysis

    a. How are the most cited authors and the number of studies?

    b. How is the social network analysis and usage intensity of common keywords?

    (What are the most frequently used keywords?)

c. What is the distribution of authors according to the institutions they work for?

3. Collaboration and Impact Analysis

a. What are the countries and collaborations in co-authorship analysis?

Literature Review

Bibliometric analysis is an effective tool that structures research areas, reveals interdisciplinary connections, identifies important authors and studies that identify gaps and current trends in the literature (Block & Fisch, 2020). The bibliometric analysis method, which has a wide range of applications, offers the opportunity to examine the scientific literature in depth with different analysis techniques and statistical approaches (Kaleci, 2023). Bibliometric studies provide researchers with the opportunity to access the information required before the research in the shortest time possible. Bibliometric studies provide researchers with the opportunity to access the information required before the research in the shortest time possible.

Many studies have been conducted in the literature on artificial intelligence in the field of education. There are studies examining the use of artificial intelligence tools in terms of academic and educational integrity (Bozkurt, 2024). When the related literature was examined, studies revealing the trends of studies on artificial intelligence in the field of educational sciences were observed (Güzey et al., 2023; Akdeniz & Özdinç, 2021; Tekin, 2023; Hwang & Tu, 2021; Zawacki-Richter et al., 2019). When the related literature was examined, studies on how artificial intelligence will contribute to education, how it will improve education, and what are the artificial intelligence applications used and can be used in education were seen (Arslan, 2020; Savaş, 2021; Meço & Coştu, 2022; Tekin, 2023; Aktay, 2022; Akdeniz & Özdinç, 2021; Chiu et al., 2023; Chiu, 2021; Chen et al., 2022; Lee et al., 2022; Chan, 2023; Wu & Yu, 2024). Cooper (2023) conducted a study on the use of artificial intelligence in science education and talked about the use of ChatGPT in education.

According to the research findings, there were concerns about the inadequacy of training on artificial intelligence and plagiarism (Sánchez Vera, 2023). Chaudhry et al. (2022) investigated the transparency requirements of AI in education for different stakeholders such as educators, educational technologists, and AI practitioners.

This study provides a detailed and comprehensive picture for researchers who want to work in the field of artificial intelligence in the field of education. It is thought that this research will guide researchers to identify different and current study topics for the related field. The examination of scientific studies on artificial intelligence in the field of education indexed in the WoS database has scientific necessity and importance in terms of determining the international effectiveness and change trends of the field.

It is thought that investigating international studies on artificial intelligence in the field of education with bibliometric analysis method will guide researchers who want to work on this subject and increase the knowledge of researchers.

Theoretical Framework

Artificial Intelligence

As a result of many years of efforts, artificial intelligence has become available in every field and has offered the opportunity to turn humanity's dreams into reality. Artificial intelligence adapts human characteristics such as decision-making, learning and generalization by using computers and software (Elmas, 2021). Robots that can recognize faces (SONY SDR-4X), driverless cars (Toyota Ruis, the first car on the road), robots with human emotions (robot developed by Professor Fumio Hara at the University of Tokyo), Infravoice System that makes life easier for the visually impaired (thanks to the headset developed at the Royal National Institute in the UK), unmanned aerial vehicles (UAV-drones), robots that can imitate human limbs (Meltant-a Avatar Robot that can imitate the human hand), quantum computers (computers that can solve complex, unsolvable problems in seconds) are some of these areas of use (Nabiyev, 2021). The rate of technological progress has far surpassed predicting the areas of use of artificial intelligence.

Artificial Intelligence in Education

Artificial intelligence, which was previously the subject of science fiction movies, is now integrated into many fields. Artificial intelligence has brought and continues to bring revolutionary innovations in areas such as discovery, learning and communication (Goralski & Tan, 2020). Artificial intelligence offers many advantages such as improving the quality of learning in students, creating student-centered learning paths, and providing students with timely feedback on their learning (Ouyang et al., 2023). In the context of education, artificial intelligence offers teachers opportunities such as preparing course content, facilitating performance and written assessments.

Artificial intelligence such as chatbots and virtual tutors tools increase the effectiveness of cognitive learning mechanisms, enabling students to personalize learning processes. Thanks to these tools, students' knowledge acquisition, problem solving and comprehension skills are analyzed in real time learning difficulties are identified (Elshansky, 2021). In line with the data obtained, alternative learning that will enable students to achieve their learning goals environments are created and learning strategies are developed. As a natural consequence of these developments, artificial intelligence in education has become a rapidly growing and developing research area.

METHOD

In this study on artificial intelligence in the field of education, a descriptive research model based on the quantitative research design approach was applied. Descriptive research describes the current characteristics of an event, phenomenon or situation (Büyüköztürk et al., 2018). Bibliometric analysis method and scientific field mapping method were applied in the study. In the study, bibliometric analysis of scientific publications was carried out by searching the keywords "Artificial Intelligent" or "AI" based on "subject" in the WoS database.

The bibliometric analysis method provides the types of documents on the subject, the sources that contribute most to the subject, the most used keywords related to the subject, the most cited authors, and more (Harnal et al., 2024).

Research Design

In this research on artificial intelligence in the field of education, descriptive research model based on quantitative research design approach, bibliometric analysis method and scientific field mapping technique were used.

Data Collection Tools

Web of Science (WoS) is one of the most frequently used databases in the world and researchers from more and more countries are involved in the use of this database in academic articles (Zhu & Liu, 2020). In this study, Web of Science (WoS) database was preferred as a data source. WoS contains different types of documents such as full-text articles, proceedings, reviews, book chapters. WoS is an important data collection tool that provides a comprehensive coverage of scientific studies. VOSviewer program was used to create and visualize bibliometric maps. The detailed and practical interpretation of the graphical representation of large bibliometric maps and the fact that it is free of charge have made the VOSviewer program preferable (Van Eck & Waltman, 2010). The studies to be included in the bibliometric analysis were added to the Zotero source data management application. The difficulties in finding, editing and citing sources in academic studies have made it appropriate to use the free Zotero application, which provides practicality in these areas (Idri, 2016).

Data Collection Process

In the data collection phase, in May 2024, using the keywords "Artificial Intelligence" or "AI" in the WoS database, "subject" was selected as the search criteria, "Education Educational Research" and "Education Scientific Disciplines" were selected in the Web of Science categories, and "Article", "Proceeding Paper", "Review Article", "Early Access", "Book Chapters" and "Book" were selected in the document type, and 4935 academic studies on the subject were examined by bibliometric analysis method according to the search results. VOSviewer program was used to create and visualize bibliometric maps. While obtaining search data, the time interval was preferred as "all time interval". After selecting the filtering criteria, the studies to be included in the bibliometric analysis were added to the Zotero source data management application.

Necmettin Erbakan University Library preferred Web Of Science as a database with remote access.

↓

The keywords "Artificial Intelligence", "AI" were preferred using "OR".

↓

The Web of Science categories "Education Educational Research" and "Education Scientific Disciplines" were restricted.

↓

As a result of the criteria, 4935 studies were submitted to the VOSwiever program to respond to the research problems with numerical and visual analysis data.
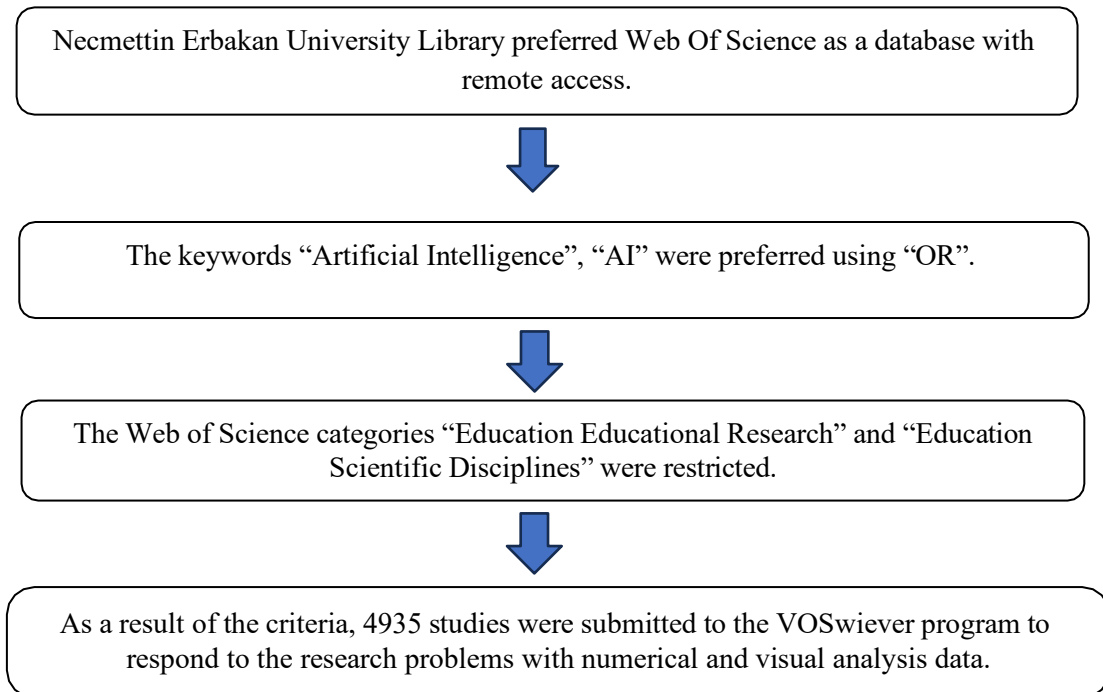
Figure 1. *Working Schematic*

Data Analysis

The data of this study were analyzed bibliometrically. Bibliometric analysis is a rigorous method used to map data results (Donthu et al., 2021). This method has become an indispensable part of the scientific field with the information it provides (Ellegaard & Wallin, 2015). VOSviewer, a free computer program developed for the creation and visualization of bibliometric maps, has an important position in the graphical representation of bibliometric studies (Van Eck & Waltman, 2010). The data of this study were visualized with bibliometric maps using VOSviewer, a bibliometric analysis software. The data obtained were presented as tables and graphs through Word program.

Validity and Reliability of the Study

Validity and reliability are the two most important criteria that determine the value of research. Validity in a quantitative research is closely related to the degree to which the collected data reflect the reality (Yıldırım & Şimşek, 2021). The VOSviewer program used for the analysis of the numerical data obtained, the bibliometric analysis method used in the research, the Web Of Science database that provides the data set of the research are important for the reliability and validity of the study. In this study, the validity and reliability of the research were kept at a high level, based on the opinions of the most frequently cited authors in the field and reliable sources published by internationally recognized institutions. In order to ensure the validity of the research, how the data were obtained, the details of the inclusion and exclusion criteria applied before the formation of the maps, and the steps of the process were given in a clear and understandable manner. Thus, validity and reliability were increased. In order to ensure the reliability of the research, the findings were presented without the author's interpretation and the consistency between the data was taken into consideration. In the conclusion and discussion section, the findings obtained in the study were supported by the literature. Since there was no human participation in this study, ethics committee approval was not required.

FINDINGS

Data on research on artificial intelligence in education are presented in tables and figures.

Statistics for the Research Study
The findings of the research study are given under headings.

Findings on the Number of Studies and Citation Data Statistics by Years

Citation analysis statistics for the outcome data related to the research topic are presented in Figure 2.

Figure 2. Citation Analysis of Studies on Artificial Intelligence in Education (WoS May, 2024).

As seen in "Figure 2", it was determined that there were 29944 citations belonging to 4935 studies for the year 1981 and after. Each study has an average citation rate of 6.07. The H-index value was found to be 65. As a result of the data obtained from the WoS database, the data ranges of the research studies published by the authors related to the study of artificial intelligence and the change of the studies depending on the citation data over time are given in Figure 3.
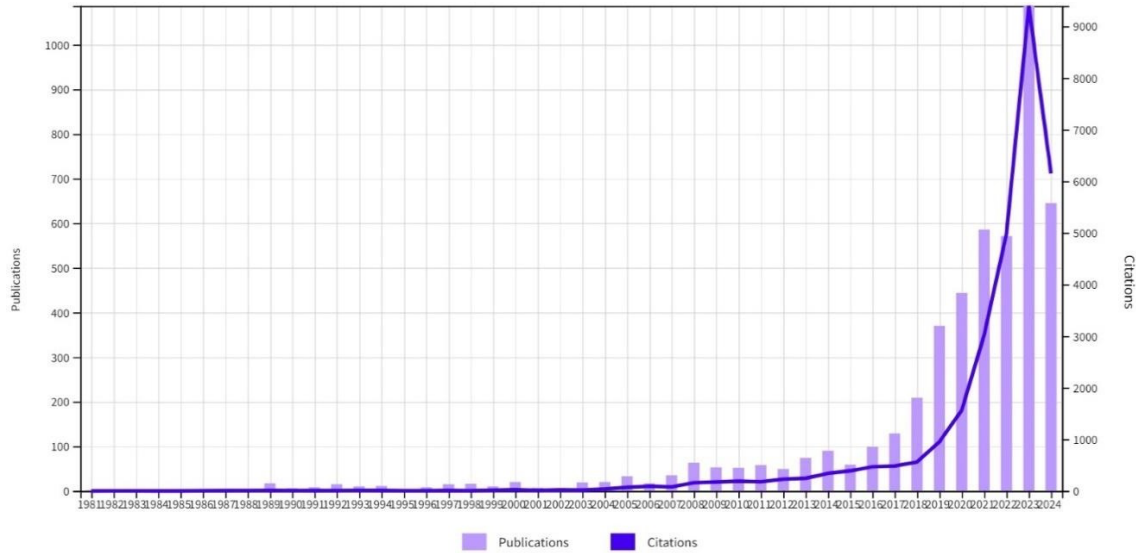
***Figure 3.** Research Numbers and Citation Data by Year (1981 and later) (WoS, May, 2024)*

"As can be seen in Figure 3, there has been an increase in the number of studies on artificial intelligence from 2007 onwards, and this increase has not been due to a constant acceleration. Until 2023, it was determined that there was an increase in the number of citations to studies. It was determined that the first research on this subject was conducted in 1981 and the most intensive studies were conducted in 2023 with 1087 studies.

Findings on Frequency Distribution According to Publication Types

The density distribution of studies published in WoS on artificial intelligence in education according to publication types is shown in Figure 4.
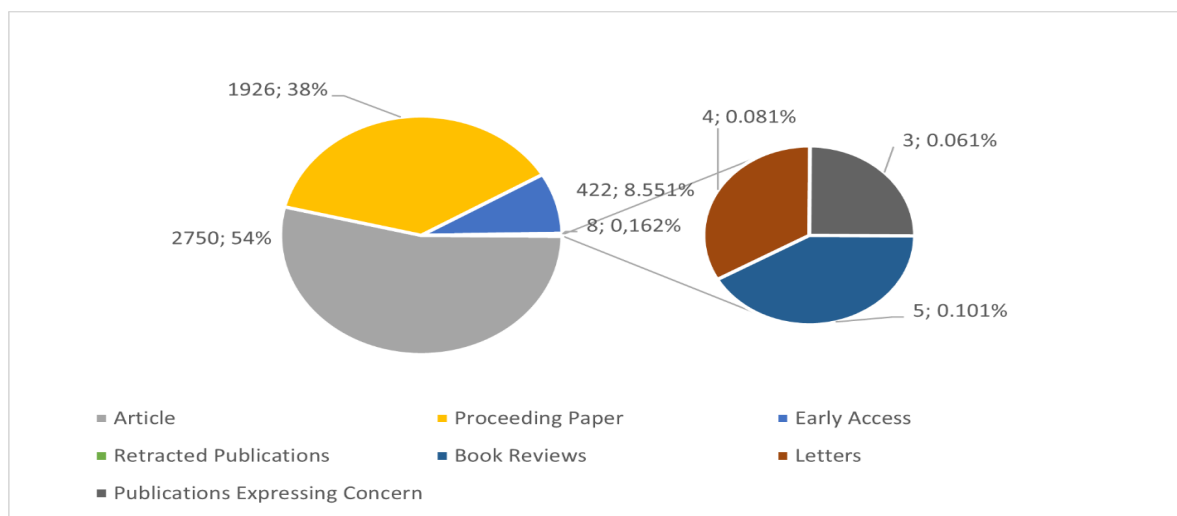
***Figure 4.** Distribution of Data on Artificial Intelligence by Publication Types (WoS, May, 2024)*

"As can be seen in Figure 4, the majority of academic studies published on artificial intelligence are articles (f= 2750, 55.724%), followed by papers (f=1926, 39.027%), early access (f=422, 8.551%), retracted publications (f=8, 0.162%), book reviews (f=5,0.101), letters (f=4, 0.081) and publications expressing concern (f=3, 0.061). The types of publications with lower percentages in the pie chart are visualized more clearly with an additional pie chart to the right of the pie chart for a clearer understanding of the chart. The first number indicates the frequency of the publication types and the second number indicates the percentage of these types in the research.

Findings on the Distribution According to the Languages of Preparation

The distribution of the languages in which the studies on artificial intelligence in education were published in WoS is shown in Table 1.

Table 1. *Distribution of Academic Studies on Artificial Intelligence by Languages Tablo 1.*

No	Languages	Frequency	Percentage (%)
1	English	4768	96.616
2	Spanish	93	1.884
3	Portuguese	17	0.344
4	Russian	17	0.344
5	Chinese	13	0.263
6	French	4	0.081
7	Turkish	4	0.081

"As can be seen in Table 1, the languages with the most intensive use in relation to this topic are English (f=4768, 96.616%), Spanish (f=99, 1.884%), Portuguese (f=17, 0.344%), Russian (f=17, 0.344%), Chinese (f=13, 0.263%), French (f=4, 0.081%) and Turkish (f=4, 0.081%).

Findings on the Most Cited Authors and Number of Studies

In order to obtain information about the number of citations and studies of the authors on this subject, the criteria of at least 2 studies produced by an author and at least 20 citations to the studies produced by the author were applied and the visual of the data obtained by applying the criteria is shown in Figure 5 through VOSviewer. The high number of citations of a single study may be coincidental or may be related to the popularity of the topic in the year of the study. Since the evaluation of a single study may not accurately represent the overall impact of the author, the number of studies was set to at least 2. The number of citations of the author was chosen to be at least 20 to ensure that the map is both comprehensive to include important authors and free from the complexity that may arise due to frequent data. The selection criteria were evaluated in each case and varied.
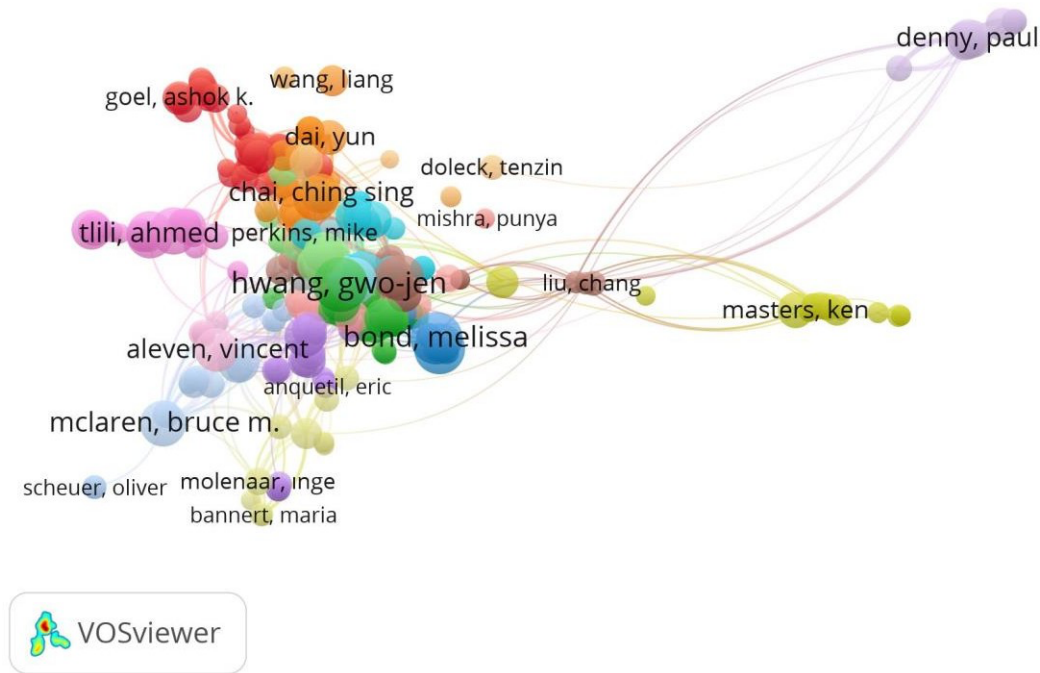
Figure 5. *Author Citation Network Map Visualization (VOSwiever, May ,2024)*

As seen in "Figure 5", the most cited authors in the field of artificial intelligence in the field of education are presented with a network map. 438 out of 13267 authors met the threshold value determined in the program by conducting a minimum of 2 studies on artificial intelligence and receiving at least 20 citations. 19 clusters, 357 items and 2522 links were identified. The data of these authors are given in Table 2.

Table 2. *Authors with the Most Cited Data and Number of Studies (VOSwiever, May, 2024)*

No	Author	Number of Studies	Number of Citations
1	Gwo-Jen Hwang	24	605
2	Melissa Bond	2	506
3	Olaf Zawacki-Richter	2	500
4	HXie aoran	15	394
5	Ahmed Tlili	9	373
6	Ronghuai Huang	7	370
7	Aras Bozkurt	7	358
8	Boulus Shehata	2	341
9	Bruce M. Mclaren	10	338
10	Thomas K.F. Chiu	17	321

"As seen in Table 2, the 10 most cited authors are Gwo-Jen Hwang (605), Melissa Bond (506), Olaf Zawacki-Richter (500), Haoran Xie (394), Ahmed Tlili (373), Ronghuai Huang (370), Aras Bozkurt (358), Boulus Shehata (341), Bruce M. Mclaren (338) and Thomas K.F. Chiu (321).

Accordingly, Gwo-Jen Hwang, the most cited author, is in a central position with his works and has influenced other authors. Melissa Bond and Olaf Zawacki-Richter are among the authors with the highest number of citations (506 and 500) despite having 2 studies.

Findings on Social Network Analysis and Usage Intensity of Commonly Used Keywords
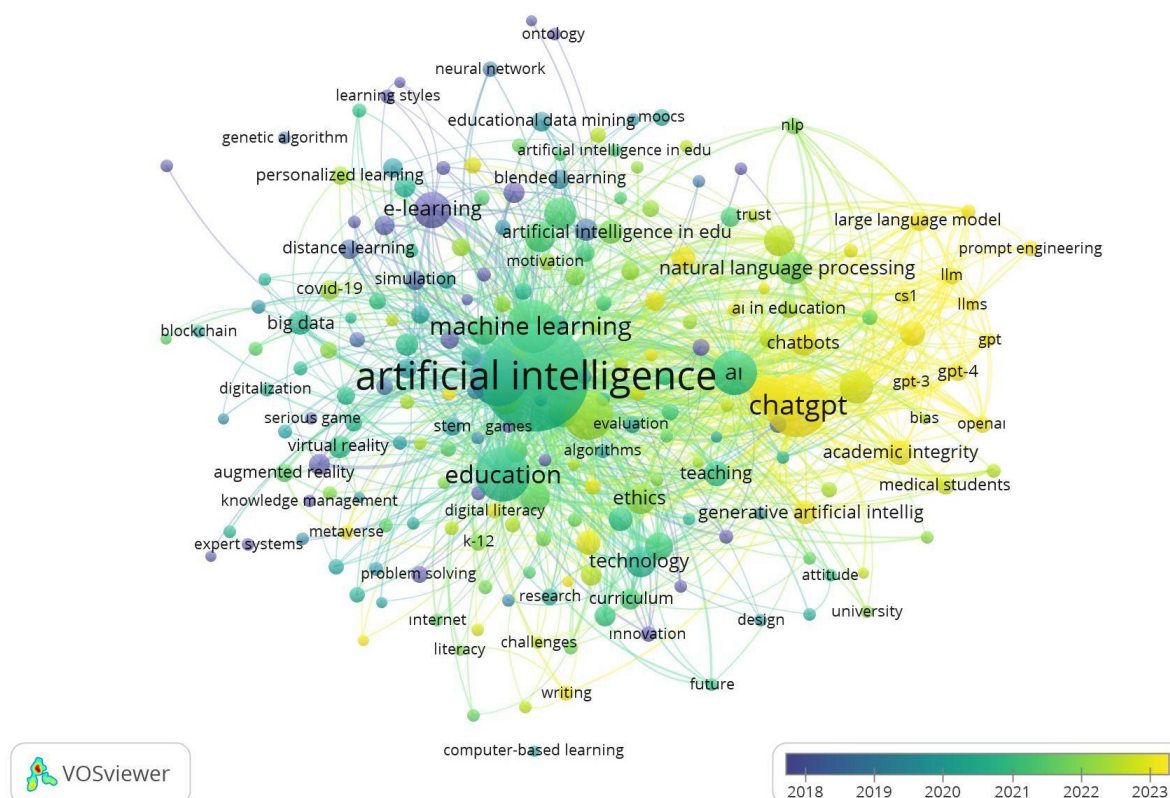
Figure 6. Common Word Analysis Layer (Visualization) Map Image in the Context of Author Keywords (VOSwiever, May, 2024)

In the co-occurrence analysis of keywords in Artificial Intelligence themed studies, the minimum number of repetitions was set as 10 and the results of the search are given in Figure 6. With this restriction, 219 out of 10248 keywords met the threshold value.

The areas of research on artificial intelligence and the social interaction network between these areas are shown in Figure 6. In this map, large circles represent the most used keywords and colors representpast and current (most popular) keywords. When the keyword network graph of the studies on artificial intelligence was analyzed, it was found that the keywords were grouped under 8 clusters and 218 topics.

The 10 keywords with the highest frequencies and relevance among the keywords in these subject groups are presented in Table 3.

Table 3. *Table of Frequency and Connection Strength of Commonly Used Keywords (VOSwiever, May, 2024*

No	Keyword	Frequency	Connection Strength
1	Artificial intelligence	1267	2323
2	Chatgpt	388	1037
3	Education	278	720
4	Machine learning	267	605
5	Higher Education	218	477
6	AI	182	541
7	Generative AI	116	349
8	Medical Education	100	346
9	Natural Language processing	91	290
10	Learning analytics	89	169

As seen in "Table 3", the most used keywords related to this topic is artificial intelligence (f=1267, cs=2323), followed by chatgpt (f=388, cs=1037) which is popular today, education (f=278, cs=720), machine learning (f=267, cs=605), AI (f=182, cs=541), Higher Education (f=218, cs=477), Generative AI (f=116, cs=349), Medical Education (f=100, cs=346), Natural Language Proces (f=91, cs=290), Learning Analytics (f=89, cs=169).

In bibliometric analysis studies, density visualizations are given with two types of mapping. These are "item density" maps and "cluster density" maps (Öztürk & Gürler, 2022). Figure 7 shows the item density map visual for keywords.
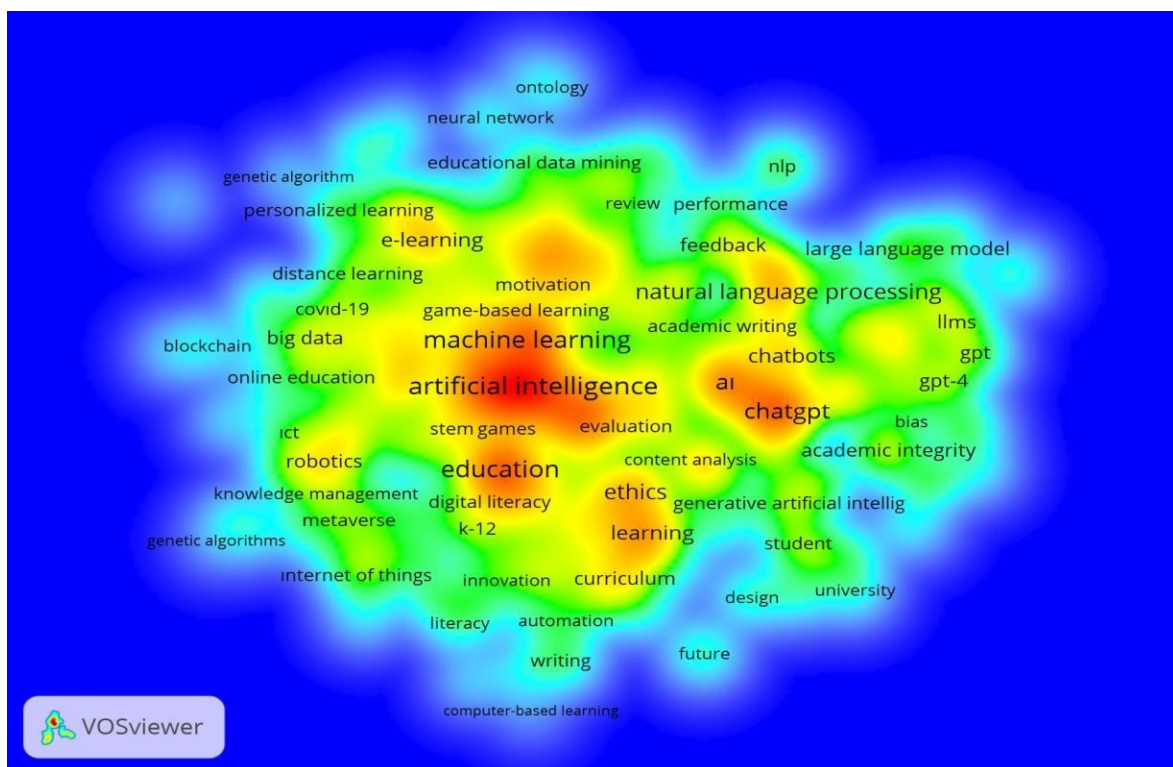
Figure 7. *Visualization of the Keywords' Item Density Map (VOSwiever, May, 2024)*

The colors in the item density maps indicate the number of studies on a particular topic. "As seen in Figure 7, artificial intelligence, ChatGPT, education, machine learning and AI are among the most intensively studied sub-topics.

Findings Regarding the Distribution of Authors According to the Institutions Where They Work

In order to look at the distribution of research on artificial intelligence according to the institutions where the authors work, the criteria of at least 2 publications in each institution and at least 30 citations to published studies were selected and 349 out of 4178 institutions met the threshold. Since some institutions were not linked to each other, 289 institutions that formed large linkage clusters from the dataset were included in the analysis. The map associated with the screening results is given in Figure 8.

In the research, when the distribution network graph of artificial intelligence researches according to the institutions where the authors work was examined, it was seen that the institutions were grouped under 14 clusters and 289 topics.
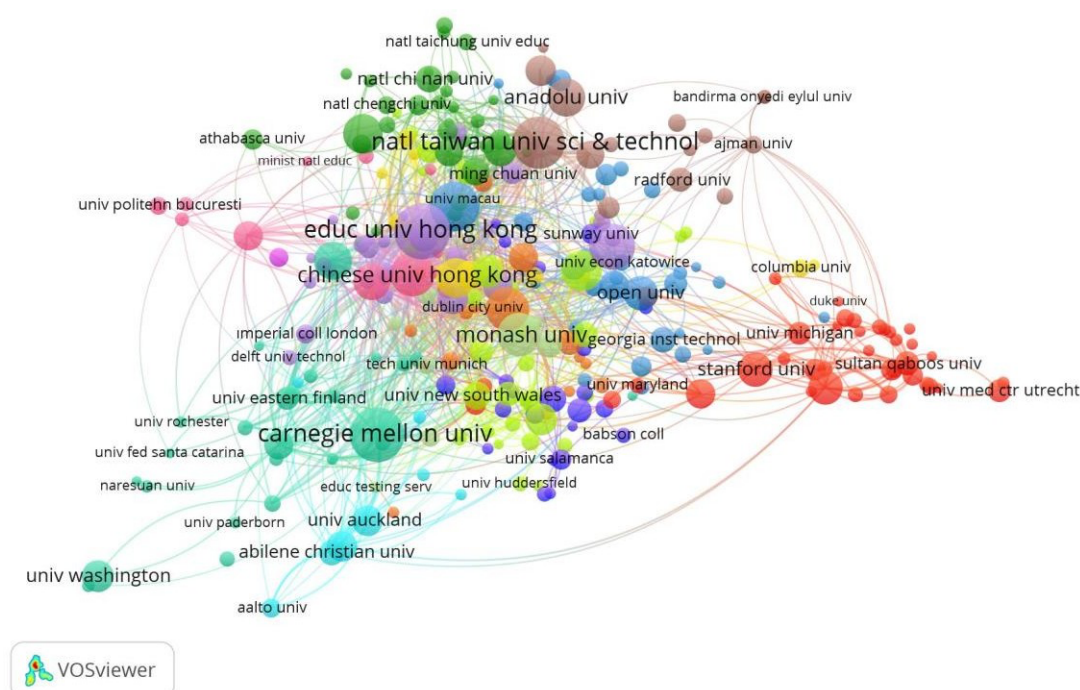
Figure 8. Network Map Visualization of the Distribution of Research on Artificial Intelligence According to the Institutions where the Authors Work (VOSwiever, May, 2024)

The data on the number of citations and studies of the institutions in research on artificial intelligence are given in Table 4.

Table 4. *Institutions Where Authors Work in Research on Artificial Intelligence (VOSwiever, May, 2024)*

No	Institutions	Number of studies	Citation Count
1	The Education University of Hong Kong	53	736
2	Carnegie Mellon University	55	705
3	National Taiwan University of Science and Technology	32	644
4	Beijing Normal University	44	600
5	Carl von Ossietzky University of Oldenburg	4	501
6	The Chinese University of Hong Kong	51	487
7	Monash University	47	471
8	University College London	41	458
9	The University of Edinburgh	28	401
10	RWTH Aachen University	7	391

As seen in "Table 4", the top three institutions with authors publishing on artificial intelligence are Hong Kong University of Education (f=736), Carnegie Mellon University (f=705) and National Taiwan University of Science and Technology (f=644).

Findings on the Distribution of Journals Publishing the Most Studies

The journals that published the most scientific studies on the subject are presented in Table 5 according to the results of Web of Science database analysis.

Table 5. *Journals Publishing the Most Research (WoS, May, 2024)*

No	Journal Name	Frequency	Percent (%)
1	Springer Nature	757	15.318
2	IEEE	463	9.369
3	Taylor & Francis	431	8.721
4	Assoc Computing Machinery	254	5.140
5	Wiley	232	4.694
6	Assoc Advancement Artificial Intelligence	197	3.986
7	Elsevier	188	3.804
8	Iated-Int Assoc Technology Education & Development	171	3.460
9	Sage	146	2.954
10	Emerald Group Publishing	89	1.801

"As seen in Table 5, Springer Nature (f=757, 15.318 %), IEEE (f=463, 9.369 %), Taylor & Francis (f=431, 8.721 %) are the top three journals with the highest number of research publications on this subject respectively.

Findings on Authors' Co-Citation Analysis in the Context of Cited Authors
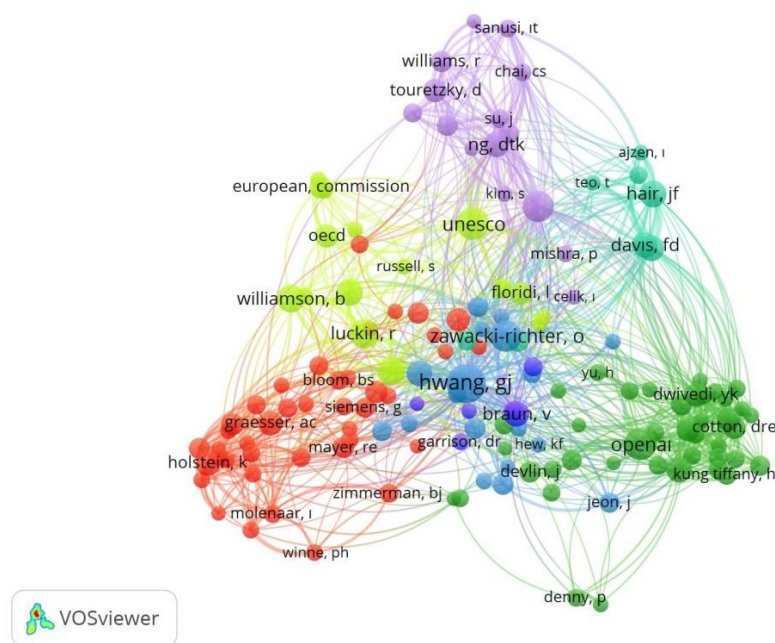
Figure 9. Authors' Co-Citation Analysis Network Map Visualization (Voswiever, May, 2024)

In the study, "co-citation" was selected as the type of analysis, "cited authors" was selected as the unit of analysis, the minimum number of documents was set at 50, and 146 authors met the threshold value. The co-citation analysis map of the authors with citation data is presented in Figure 9 through the VOSwiever program.

According to the network map of the co-citation analysis of the studies in the context of the cited authors, it was seen that the institutions were grouped under 7 clusters and 146 topics.

Table 6. Co-Citation Analysis Table in the Context of Cited Authors (Voswiever, May, 2024)

No	Authors	Common Citation Count	Total Link Strength
1	Gwo-Jen Hwang	356	2688
2	Unesco	241	1410
3	Openaı	239	1422
4	Thomas K.F. Chiu	228	2167
5	Olaf Zawacki- Richter	219	1821
6	Rose Luckin	199	1374
7	Ben Williamson	180	950
8	Wayne Holmes	171	1694
9	Neil Selwyn	161	1043
10	Joseph F. Hair	159	1536

"As seen in Table 6", the author with the highest number of co-citations is Gwo-Jen Hwang (356).

Findings on Countries and Collaborations in Coauthorship Analysis
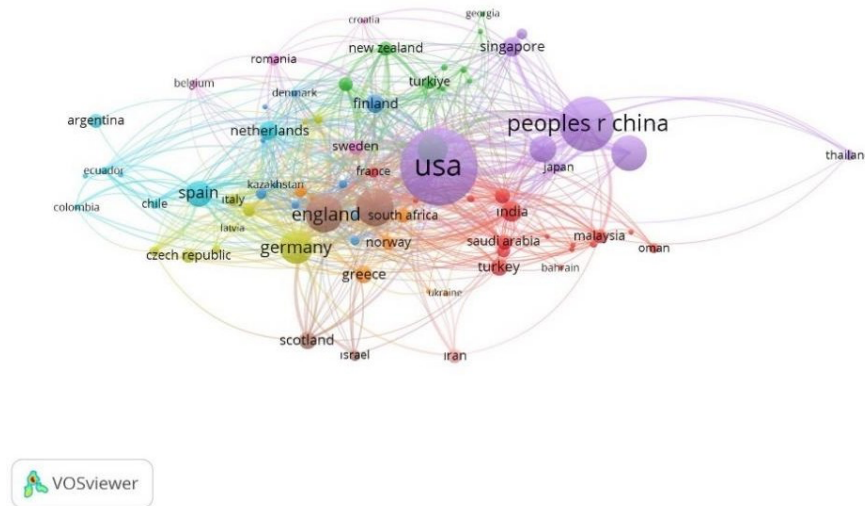
Figure 10. *Network Map of Countries and Collaborations in Co-Authorship Analysis of Studies Related to Artificial Intelligence (Voswiever, May, 2024)*

In the co-authorship analysis of studies on artificial intelligence, in order to look at the cross-country collaboration of publications, a search was made with the condition that each country should have a minimum of 4 studies and a minimum of 4 citations, and it was seen that 83 out of 121 countries met the specified threshold values. Of these countries, 79 countries with high connections were included in the data analysis and the analysis map is given in Figure 10 through the VOSwiever program.

In the co-authorship analysis of the studies, when the network graph presenting the cross-country collaborations of the publications was examined, it was seen that the institutions were grouped under 10 clusters and 79 topics.

Table 7. *Top 10 Countries in Co-authorship Analysis of Publications and Collaborations*

No	Countries	Number of Studies	Number of Citation
1	United States of America	1131	8557
2	Chine	672	4432
3	England	320	2270
4	Australia	257	2163
5	Taiwan	196	1999
6	Germany	219	1816
7	Canada	198	1431
8	South Korea	109	1209

| 9 | Spain | 249 | 1103 |
| 10 | India | 133 | 730 |

"As seen in Table 7, the USA has the highest number of cross-country linked publications with the highest frequency (number of studies=1131, number of citations=8557). The top 5 countries following the USA are People's Republic of China (number of studies=672, number of citations=4432), England (number of studies=320, number of citations=2270), Australia (number of studies=257, number of citations=2163), Taiwan (number of studies=196, number of citations=1999), Germany (number of studies=219, number of citations=1816).

China is at the forefront of artificial intelligence in education. China's desire for global leadership in this field, formalizing existing investments and increasing budget investments in this field with the presentation of the National Artificial Intelligence Strategy to the public in 2017, paved the way for it to become a global pioneer in the field of artificial intelligence (Şahin, 2023).

CONCLUSION and DISCUSSION

Within the scope of this study, firstly, a detailed literature review was conducted and bibliometric analysis studies on artificial intelligence in the field of education were examined. WoS database was used for the literature review and inclusion and exclusion criteria were determined. The studies considered to be included in the study were added to the Zotero bibliography management system. In the study, 4935 academic studies conducted between 1981 and 2024 were analyzed. In the study, the number of studies and citation statistics by years on the subject of artificial intelligence in education, the distribution of the number of publications according to publication types, the writing languages of the studies, the most cited authors and the number of studies, keyword analysis and usage intensity, the distribution of studies on artificial intelligence according to the institutions where the authors work, the journals with the most academic publications, countries and collaborations in co-authorship analysis were examined under the headings, and the data obtained from the analysis were presented. According to the results of the research:

It was observed that there was an increase in the studies on artificial intelligence in education in 2007 and after and that this increase was not due to a constant acceleration. The year with the highest number of studies was determined as 2023 with 1087 studies. It is thought that the reason for the decrease in the number of studies in 2024 may be related to the fact that the study was conducted in May 2024. The 2024 research findings showed that the H-index value was 65 and there were 6.07 citations per study.

The first academic study on artificial intelligence in education was John P. Gallagher's article in 1981. Gallagher (1981) experimentally evaluated two design features of an artificial intelligence system used to improve problem solving skills.

Most of the academic studies published on this subject are articles (55.724%, f=2750) and papers (39.027%, f=1926).

Articles are considered the most valuable type of academic publication because they are evaluated by impartial referees in periodicals. Unlike other types of publications, articles place more emphasis on discussion and conclusions. Papers, which are used to present the results of studies, are especially practical for novice researchers, and more qualified works can emerge thanks to the

exchange of information during the presentation through papers (Dinçer, 2021). These situations may have revealed the ratio results in the research findings.

According to the results of the research, the most studied language is English (f=4768, 96.616%). English is followed by Spanish (f=93, 1.884%) with a much lower rate. The widespread use of English as a language of science and the fact that most of the journals in comprehensive database platforms such as Web of Science (WoS) have adopted English as the language of publication may be considered as the reason why English language is preferred more than other languages in publications.

The 6 most cited authors are Gwo-Jen Hwang (605), Melissa Bond (506), Olaf Zawacki-Richter (500), Haoran Xie (394), Ahmed Tlili (373) and Ronghuai Huang (370). Gwo-Jen Hwang's work is central and has influenced other authors. Melissa Bond and Olaf Zawacki-Richter are among the authors with the highest number of citations (506 and 500) despite having 2 studies. Despite having a limited number of studies, their high number of citations indicates that their work has had a significant impact in this field. The most co-cited author is Gwo-Jen Hwang (356).

Hwang & Tu (2021) investigated the role of artificial intelligence in mathematics education with bibliometric mapping analysis. In addition, Lee et al. (2022) applied an artificial intelligence-based chatbot to students and showed that artificial intelligence-based chatbots positively affected students' motivation, academic performance, and learning attitude. Chiu et al. (2023) investigated how to integrate artificial intelligence into the learning, teaching, assessment and management parts of education. In another study, Chiu (2021) developed a curriculum design model for the applicability of artificial intelligence in K-12 schools. Zawacki-Richter et al. (2019) systematically reviewed the research on AI applications in higher education. They found that the articles were mostly written in Computer Science and STEM disciplines. In another study, Zawacki-Richter et al. (2024) investigated various effects of artificial intelligence in higher education.

Common-word analysis identifies research topics and themes in a field (Öztürk & Gürler, 2022). Layer visualization can identify the most popular common words by analyzing changes over time and can offer researchers practicality in identifying research topics in a field. It was determined that the most used keywords related to the subject were "artificial intelligence" (f=1267, bg=2323) and "ChatGPT" (f=388, bg=1037), which is one of today's popular applications.

ChatGPT is an artificial intelligence tool with high accessibility potential that students are increasingly using (Cotton et al., 2023). ChatGPT facilitates learning and teaching with its self-improvement capability and personalized and acceptable responses (Farrokhnia et al., 2024). ChatGPT can create practice questions for students on a specific topic and help them get feedback on the topic (Lodge et al., 2023). All these advantages have made the ChatGPT artificial intelligence tool one of the most studied topics in the research field. The USA is the most active country in the field of ChatGPT, but other countries such as China, Australia and Italy have also conducted significant research in the field of ChatGPT (Duran & Aydın, 2024).

The top five institutions where the authors worked or were supported were Hong Kong University of Education (f=736), Carnegie Mellon University (f=705), National Taiwan University of Science and Technology (f=644), Beijing Normal University (f=600), Oldenburg Carl Von Ossietszky University (f=501). When we examine the 10 universities that attract the most attention in artificial intelligence in education, we see 5 universities from the European region, 4 universities from the

Asian region and 1 university from the American region.

The 10 journals that published the most studies on the subject are given in the table. Springer Nature (f=757, 15.318 %), IEEE (f=463, 9.369 %), Taylor & Francis (f=431, 8.721 %) are the first three journals with the highest number of research publications respectively.

It was observed that the USA had the highest number of cross-country linked publications with the highest frequency (number of studies=1131, number of citations=8557). The top 5 countries following the USA are People's Republic of China (number of studies=672, number of citations=4432), England (number of studies=320, number of citations=2270), Australia (number of studies=257, number of citations=2163), Taiwan (number of studies=196, number of citations=1999), Germany (number of studies=219, number of citations=1816).

The efficiency, national security and social benefits of artificial intelligence have paved the way for countries to compete for global leadership in artificial intelligence (McLaughlin, 2021). Although the US is the leader in the field of artificial intelligence, it faces the risk of falling behind in this field with the rapid steps taken by China (Saygılı, 2020). The artificial intelligence policies adopted by China within the framework of its desire for global leadership have further strengthened the country with the adoption of the National Artificial Intelligence Strategy in 2017, making it one of the leading countries on a global scale (Şahin, 2023).

Artificial intelligence technologies offer significant potential for balancing personalized learning and equity in education. Thanks to AI, students have the opportunity to manage their own learning processes, work in collaborative environments and benefit from autonomous assessment mechanisms (Al-Badi et al., 2022). This situation both increases students' motivation and encourages their active participation in learning processes. In traditional education systems, personalized learning is often limited by high costs and various challenges. Artificial intelligence applications, on the other hand, can provide educational materials and methods suitable for the individual needs of each student.

With the increasing use of artificial intelligence technologies in the field of education, various ethical issues such as privacy, surveillance and bias have come to the fore. The most prominent of these issues is the protection and privacy of individuals' personal data. The fact that artificial intelligence systems collect and analyze students' personal data has raised the issue of privacy (Akgun & Greenhow, 2022). The capacity of AI to predict students' future preferences and actions raises ethical concerns.

LIMITATIONS and RECOMMENDATIONS

Researchers who want to conduct studies on artificial intelligence in the field of education will be able to identify internationally important sources, authors, institutions, countries and keywords in the light of the findings of this study. Keyword analysis will provide practicality for researchers to customize their research topics. Web of Science database, which provides access to effective and up-to-date publications, was used in the research and the research was limited to this database. This research topic can become more comprehensive with other databases. The research was conducted in May 2024 and the study can be repeated in the future to get healthier results for the year 2024. In this study, a bibliometric analysis of the studies on artificial intelligence in the field of education was conducted. Today, bibliometric analysis studies can be conducted on ChatGPT, an artificial intelligence tool that is increasing in popularity in the field of educational sciences.

According to the results of the analysis, the important issue of ethics related to the subject can also be made a research topic. Analyses can be made on issues such as prejudices and data privacy

related to artificial intelligence in the field of education. Studies can be conducted on how AI-supported education systems can be designed within the framework of ethical principles. A current research can be conducted to develop policy recommendations to increase the use of artificial intelligence in education and to eliminate prejudices against artificial intelligence. According to the results of the analysis, current research on machine learning can be conducted. It can be examined how differences in education systems affect artificial intelligence research areas. Differences in the trends of research on artificial intelligence in the field of education in developed and developing countries can be examined. Research can be conducted on the problems faced by teachers in using artificial intelligence tools. Research can be conducted to develop special artificial intelligence applications for students with learning difficulties.

As a result of the findings presented in the research, it is possible to say that the studies on the use of artificial intelligence in the category of education have increased over time and as a result, a wide research scope will exist in educational sciences. This scope will be a factor in updating and shaping the policies of academic studies and educational sciences.

Ethics Committee Approval
Ethics committee approval was not obtained because data from previously published studies were used in the study. Ethical principles and rules were followed throughout the study.

Author Contributions
The contribution rate of the authors is equal.

Funding Statement
This study was not supported by any institution.

Conflict of Interest

There is no conflict of interest between the authors.

REFERENCES
Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. AI and Ethics, 2(3), 431-440.

Akyel, Y., & Tur, E. (2024). Yapay Zekanın Potansiyelinin ve Eğitim Bilimlerindeki Uygulamalarının Araştırılması ve Araştırmalarda Beklentiler, Zorluklar ve Gelecek Yönelimleri. Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 25(1), 1-1.

Al-Badi, A., Khan, A., & Eid-Alotaibi. (2022). Perceptions of Learners and Instructors towards Artificial Intelligence in Personalized Learning. Procedia Computer Science, 201, 445-451. https://doi.org/10.1016/j.procs.2022.03.058

Block, J. H., & Fisch, C. (2020). Eight tips and questions for your bibliographic study in business and management research. *Management Review Quarterly*, *70*(3), 307-312. https://doi.org/10.1007/s11301- 020-00188-4

Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Chong, S. W., & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education*, *21*(1), 4. https://doi.org/10.1186/s41239-023-00436-z

Bozkurt, A. (2024). GenAI et al.: Cocreation, Authorship, Ownership, Academic Ethics and Integrity in a Time of Generative AI. *Open Praxis*, *16*(1), 1-10. https://doi.org/10.55982/openpraxis.16.1.654

Büyüköztürk, Ş., Kilic, E., Akgün, Ö., Karadeniz, Ş., & Demirel, F. (2018). *Bilimsel Araştırma Yöntemleri*. https://doi.org/10.14527/9789944919289

Coşkun, F., & Gülleroğlu, H. D. (2021). Yapay Zekanın Tarih İçindeki Gelişimi ve Eğitimde

Kullanılması. *Ankara University Journal of Faculty of Educational Sciences (JFES)*, *54*(3), Article 3. https://doi.org/10.30964/auebfd.916220

Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2023). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, 1-12. https://doi.org/10.1080/14703297.2023.2190148

Dinçer, S. (2021). *Akademik Yazım ve Araştırmacılara Öneriler*. https://a5c9067fb5de95ba1294b544b3b0d04c29bc1f2f.vetisonline.com/tr/kitap/akademik-yazim-ve- arastirmacilara-oneriler-9786052414378

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Duran, V., & Aydın, E. (2024). Eğitimde yapay zekanın kapsamlı incelenmesi: Web of Science veri tabanı üzerinden bir AI destekli bibliyometrik analiz görünümü. *International Journal of Social and Humanities Sciences Research*. https://jshsr.org/index.php/pub/article/view/2584/2491

Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, *105*(3), 1809-1831. https://doi.org/10.1007/s11192-015-1645-z

Elmas, Ç. (2021). *Yapay Zekâ Uygulamaları Yapay Sinir Ağı Makine Öğrenmesi – Derin Öğrenme ¦ Derin Ağlar – Bulanık Mantık ¦ Sinirsel Bulanık Mantık – Genetik Algoritma* (5. bs). Turcademy. https://a5c9067fb5de95ba1294b544b3b0d04c29bc1f2f.vetisonline.com/tr/kitap/yapay-zeka-uygulamalari- yapay-sinir-agi-makine-ogrenmesi-derin-ogrenme-derin-aglar-bulanik-mantik-sinirsel-bulanik-mantik- genetik-algoritma-9789750266577

Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2024). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, *61*(3), 460-474. https://doi.org/10.1080/14703297.2023.2195846

Gondal, Khalid Masud. (2018). Artificial Intelligence and Educational Leadership. *Annals of King Edward Medical University*, *24*(4), Article 4. https://doi.org/10.21649/akemu.v24i4.2591

Goralski, M. A., & Tan, T. K. (2020). Artificial intelligence and sustainable development. *The International Journal of Management Education*, *18*(1), 100330. https://doi.org/10.1016/j.ijme.2019.100330

Haenlein, M., & Kaplan, A. (2019). A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence. *California Management Review*, *61*(4), 5-14. https://doi.org/10.1177/0008125619864925

Harnal, S., Sharma, G., Anupriya, Mishra, A. M., Bagga, D., Saini, N., Goley, P. K., & Anupam, K. (2024). Bibliometric mapping of theme and trends of augmented reality in the field of education. *Journal of Computer Assisted Learning*, *40*(2), 824-847. https://doi.org/10.1111/jcal.12899

İdri, N. (2016). *Zotero Yazılımı: Bibliyografik Araştırma ve Veri Organizasyonunun Bir Aracı; Bibliyografik Araştırma Öğretimi-Web of Science Temel Koleksiyonu*. https://a8f59890210bb2a36cc265c34c80a801c14e01d5.vetisonline.com/wos/woscc/full-record/WOS:000369147000010

Jiang, Y., Li, X., Luo, H., Yin, S., & Kaynak, O. (2022). Quo vadis artificial intelligence? *Discover Artificial Intelligence*, *2*(1), 4. https://doi.org/10.1007/s44163-022-00022-8

Kaleci, F. (2023). *Ekonomi alanındaki inovasyon konulu uluslararası bilimsel yayınların bibliyometrik analizi*. https://hdl.handle.net/20.500.12452/10069

Koçyiğit, A., & Darı, A. B. (2023). Yapay Zekâ İletişiminde ChatGpt: İnsanlaşan Dijitalleşmenin Geleceği. *Stratejik ve Sosyal Araştırmalar Dergisi*, *7*(2), Article 2. https://doi.org/10.30692/sisad.1311336

Lodge, J. M., Thompson, K., & Corrin, L. (2023). Mapping out a research agenda for generative

artificial intelligence in tertiary education. *Australasian Journal of Educational Technology*, *39*(1), Article 1. https://doi.org/10.14742/ajet.8695

McLaughlin, D. C., Michael. (2021). *Who Is Winning the AI Race: China, the EU, or the United States? — 2021 Update*. https://itif.org/publications/2021/01/25/who-winning-ai-race-china-eu-or-united-states-2021- update/

Meço, G., & Coştu, F. (2022). Eğitimde Yapay Zekânın Kullanılması: Betimsel İçerik Analizi Çalışması. *Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Dergisi*, *12*(23), Article 23.

Melak, A., Aseged, T., & Shitaw, T. (2024). The Influence of Artificial Intelligence Technology on the Management of Livestock Farms. *International Journal of Distributed Sensor Networks*, *2024*, 1-12. https://doi.org/10.1155/2024/8929748

Nabiyev, V. (2021). *Yapay Zeka Derin Öğrenme – Stratejili Oyunlar Örüntü Tanıma – Doğal Dil İşleme* (6. bs). Seçkin Yayıncılık; Turcademy. https://a5c9067fb5de95ba1294b544b3b0d04c29bc1f2f.vetisonline.com/tr/kitap/yapay-zeka-derin-ogrenme-stratejili-oyunlar-oruntu-tanima-dogal-dil-isleme-9789750265891

Ouyang, F., Wu, M., Zheng, L., Zhang, L., & Jiao, P. (2023). *Integration of artificial intelligence performance prediction and learning analytics to improve student learning in online engineering course-Web of Science Core Collection*. https://doi.org/10.1186/s41239-022-00372-4

Öztürk, O., & Gürler, G. (2022). *Bir Literatür İncelemesi Aracı Olarak Bibliyometrik Analiz*. https://www.nadirkitap.com/bir-literatur-incelemesi-araci-olarak-bibliyometrik-analiz-kolektif-kitap729495.html

Pratama, M. P., Sampelolo, R., & Lura, H. (2023). Revolutionizing education: harnessing the power of artificial intelligence for personalized learning. Klasikal: Journal of education, language teaching and science, 5(2), 350-357.

Pritchard, A., & Wittig, G. (1981). *Bibliometrics: A bibliography and index. Volume 1: 1874-1959, by Alan Pritchard in collaboration with Glenn R. Wittig.*

Saçan, S., Yaralı, K. T., & Kavruk, S. Z. (2022). Çocukların "Yapay Zeka" Kavramına İlişkin Metaforik Algılarının İncelenmesi. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, *64*, Article 64. https://doi.org/10.21764/maeuefd.1074024

Sánchez Vera, M. D. M. (2023). La inteligencia artificial como recurso docente: Usos y posibilidades para el profesorado. *EDUCAR*, *60*(1), 33-47. https://doi.org/10.5565/rev/educar.1810

Saygılı, H. (2020). *Yapay zekâ kamu politikaları: ABD ve Çin'in yapay zekâ kamu politikalarının karşılaştırılması*. Ankara Yıldırım Beyazıt Üniversitesi.

Şahin, B. (2023). Educatıonal Aspect Of Natıonal Artıfıcıal Intellıgence Strategıes: Example Of Chına And Türkiye. *Scientific Journal of Finance and Financial Law Studies*, *3*(2), Article 2.

Tellan, T. (2020). Duyarlı Makine: Yapay Zekanın Olgunluk Çağı. *Yeni Medya*, *2020*(9), Article 9.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523-538. https://doi.org/10.1007/s11192-009-0146-3

Yıldırım, A., & Şimşek, H. (2021). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*. https://pegem.net/urun/Sosyal- BilimlerdeNitel-Arastirma-Yontemleri/2166

Zhang, D., Zhang, Z., & Managi, S. (2019). A bibliometric analysis on green finance: Current status, development, and future directions. *Finance Research Letters*, *29*, 425-430. https://doi.org/10.1016/j.frl.2019.02.003

Zhu, J., & Liu, W. (2020). A tale of two databases: The use of Web of Science and Scopus in academic papers. *Scientometrics*, *123*(1), 321-335. https://doi.org/10.1007/s11192-020-03387-

Teachers' Attitudes Towards Inclusive Education: A Mixed Method Study*

Hasan SAVAŞ¹ 🆔   Yıldız İSAOĞLU²* 🆔

¹ Dr., Ministry of National Education, Konya, Türkiye

² Ministry of National Education, Ankara, Türkiye

Article Info	ABSTRACT
	Teachers' attitudes play a key role to implement quality education for all. Hence, in the current study teachers' attitudes towards inclusive education (IE) and factors affecting them in the context of Turkey were explored with a mixed method. As a result, it was found out that teachers in Turkey have a narrow conceptualization of inclusive education and mixed attitudes towards it. Furthermore, type and severity of special educational needs and disabilities (SEND) was proved to be a significant predictor of embracing IE. Lack of knowledge, training and practical experience were identified as the most influential barriers against IE which also shape and inform teachers' attitudes. The results indicate a need for a change at a societal level, professional teacher development for in-service as well as pre-service teachers, well-established partnership between stakeholders so that teachers can develop more positive attitudes and implement inclusive practices in their teaching contexts.

---

* This study, which was presented as a master's dissertation at the University of Leeds, has been shortened and converted into an article.

Öğretmenlerin Kapsayıcı Eğitime Yönelik Tutumları: Karma Bir Çalışma

ÖZET

Herkes için kaliteli eğitimin temin edilmesinde öğretmenlerin tutumları önemli bir rol oynar. Bu doğrultuda mevcut çalışmada öğretmenlerin kapsayıcı eğitime (KE) yönelik tutumları ve bu tutumları etkileyen faktörler Türkiye bağlamında karma araştırma yöntemiyle incelenmiştir. Araştırma sonucunda, öğretmenlerin kapsayıcı eğitime dair dar anlayışa ve karışık tutumlara sahip olduğu ortaya çıkmıştır. Ayrıca özel eğitim ihtiyacının türü ve şiddetinin öğretmenlerin kapsayıcı eğitime yönelik tutumlarının önemli bir yordayıcısı olduğu bulunmuştur. Aynı zamanda öğretmenlerin tutumlarını şekillendiren konuya ilişkin bilgi ve eğitim eksikliği ve özel eğitime ihtiyacı olan bireylerle birebir deneyim KE'in önündeki en büyük engeller olarak belirlenmiştir. Araştırma sonuçları öğretmenlerin KE'e yönelik olumlu tutum geliştirerek eğitim ortamlarında daha kapsayıcı bir yaklaşım benimsemeleri için toplumsal düzeyde bir algı değişikliğinin, öğretmenler ve aday öğretmenler için profesyonel gelişim odaklı eğitimlerin, paydaşlar arasında sıkı iş birliği kurulmasının gerekliliğini ortaya koymaktadır.

*Corresponding Author: Yıldız İsaoğlu, isaogluyildiz@gmail.com

INTRODUCTION

Inclusive education, which supports high-quality, fair learning opportunities for everyone, ensuring no one is excluded (UNESCO, 2020), has gained momentum and priority in the global agenda with the declaration of the Salamanca Statement (UNESCO, 1994). Since then, governments around the world have confirmed their commitments to this, and following global initiatives such as the Dakar Framework for Action (UNESCO, 2000) and Education 2030 (UNESCO, 2016), they have implemented inclusive policies to ensure education for all. Despite the efforts to leave no one behind, inequalities and barriers persist for too many learners to access quality education, which has even deteriorated with the outbreak of the COVID-19 pandemic (UNESCO, 2020).

Although inclusive education is emphasized and even guaranteed in political documents, as the implementers of these policies, teachers' perceptions of the accommodation of all children with individual differences and needs in diverse classrooms may differ (Savolainen et al., 2020). Considering that in an inclusive school context, it is a prerequisite to meet all students' learning needs and ensure their safety (Nougaret, 2005), positive attitudes towards inclusion play a critical role to ensure education for all in practice in line with the policies.

In this context, investigating teachers' attitudes towards inclusion has gained attention by researchers in recent years (Avradimis et al., 2020). There have been quite many studies conducted on this popular subject around the world (Savolainen et al., 2020), and Türkiye is no exception. Nevertheless, in most of these studies, the notion of inclusion is associated with students with special educational needs and disabilities (SEND), mostly with a narrower conceptualization of inclusion. Similarly, inclusive education in Türkiye is generally conceptualized as limited to the education of children with SEND and children of Syrian refugees (UNICEF, 2011). Therefore, to contribute to the related literature with a broader conceptualization of inclusive education, the aim of this research is to investigate the factors affecting teachers' attitudes towards inclusion of all students in a diverse teaching context in Türkiye.

Towards Inclusive Education: Do Teachers' Attitudes Matter?

Teachers are the key factors in successful implementation of inclusive education policies since they are the ones with whom the students interact most in their immediate settings at schools. The relationship students have with their teachers influences their progress, and at this point, teacher attitudes play a crucial role (Boyle et al., 2020). Because according to Ajzen (2005), values and attitudes shape the actual behavior. Hence, teachers' attitudes towards inclusion should be investigated to get better insights about the dynamics of IE with the aim of turning inclusive policies into real classroom practices (Fives et al. 2008).

In this regard, as a first step, it is important to understand the nature of teachers' attitudes. Ajzen (2005, p. 3) defines attitudes as ―a disposition to respond favorably or unfavorably to an object, person, institution, or event." According to Eagly et al. (1993), attitudes are formed by three components: cognitive (beliefs and knowledge), affective (feelings and emotions), and behavioral (actions or responses), which is adopted as a model in this study.

It is acknowledged that successful implementation of inclusive education policies largely depends on positive teacher attitudes (Avradimis et al., 2000; Boyle et al., 2020;

Saleem, 2017; Saloviita, 2020). Because —commitment to inclusion begins with each educator‖ (Boyle et al., 2012, p. 77). However, it should also be noted that teachers in favor of inclusion may also feel themselves insufficient to implement inclusive provision (Forlin et al., 2009). Positive attitudes are crucial, yet not enough alone to ensure IE. In this regard, rather than just focusing on whether teachers hold positive or negative values to IE, understanding the factors shaping teacher attitudes and the barriers against it will provide more crucial and fruitful insights to support teachers to implement inclusive practices in the classroom.

Inclusive Education in Türkiye

As a developing country, the Turkish education system relies on Article 42 of the Constitution, which guarantees the right to education for everyone for free and compulsory at public schools (Constitution of the Turkish Republic, 1982). Furthermore, Türkiye has also declared its commitment to the global initiatives like the Salamanca Statement, the Dakar Framework for Action, Education 2030, etc.; however, IE still —exists under the umbrella of the special education system‖ (Erkılıç et al. 2013, p. 466). Therefore, it is no surprise that the legislation of IE in Türkiye has been constructed around SEND. Although the legislation in Türkiye is found to be satisfactory and in harmony with international policies in terms of SEND (Düşkün, 2016), problems and challenges persist in the practice of these laws. Nevertheless, when it comes to gender, language, religion, and ethnicity, equally comprehensive explanations of income were not included in the national legislation (Sarı et al., 2020). Especially in line with the harmonisation process with the EU, some international-funded projects for the other disadvantaged groups, such as Promoting Gender Equality in Education, Promoting Inclusive Education for Syrian Kids in the Turkish Education System, the Conditional Cash Transfer Programme, etc., have been implemented. Further, in close cooperation with UNICEF, support programs and Turkish language classes are being offered to help Syrian students integrate into Turkish schools, with additional measures like catch-up programs and summer schools provided for those who have missed or never attended school. These projects have a special focus on the professional development of teachers via in-service trainings to raise awareness and develop positive attitudes towards inclusion and social justice (MoNE, 2018).

As for the research into IE in the context of Türkiye, many studies have revealed that teachers hold negative attitudes towards IE (Artan et al., 2003; Demir et al., 2010; Gök et al., 2011; Rakap et al., 2010). However, there are also recent studies concluding that teachers have moderately positive attitudes toward inclusion (Tuncay et al., 2020) and make efforts to make use of inclusive strategies in their classroom yet find themselves insufficient about it (Demir-Başaran, 2020). As for the underlying reasons for their negative attitudes, it has been revealed that teachers are not adequately supported by the school management and families of students with SEND (Sadioglu et. al., 2010), feel themselves lack of knowledge and confidence to teach in inclusive classes (Aktan, 2020), have difficulty in preparing and applying IEPs (Kocyiğit, 2015), and have problems with classroom management with students with SEND (Kuruyer et al., 2017).

In conclusion, in Türkiye, not only policies but also research have a narrow conceptualization of IE. Most studies on teacher attitudes towards IE have focused on namely children with disabilities and Syrian refugee children (Kesik et al., 2022) and adopted qualitative methods (Yılmaz, 2021). Yet, IE should aim to —remove barriers to learning and participation, allocate resources to support learning and participation, and provide support for

diversity with a perspective providing ground for the voice of marginalized individuals and groups to get heard' (Sakız et al. 2020, p. 297). Therefore, in this study, teacher attitudes towards IE and factors affecting them will be explored with a conceptualization of education for all by employing both qualitative and quantitative methods. In line with this aim, the research questions to be answered are:

1- How do the teachers in Türkiye conceptualize IE?

2- What are the attitudes of teachers in Türkiye towards IE?

3- What are the factors affecting teachers' attitudes towards IE?

4- What are the challenges influencing teachers' attitudes towards IE?

METHOD

In this research to explore attitudes of teachers towards IE in Türkiye and the factors affecting them, a mixed methods approach was utilized. Considering that teachers' attitudes depend on a variety of variables, this method will enable us to capture the implications of these variables by using more than one data collection tool (Cohen et al., 2013). From different designs of mixed-type research, the explanatory sequential design, in which first quantitative data is collected via survey, analyzed, and then qualitative data is gathered via semi-structured interviews to get further insights about the patterns (Bryman, 2021).

Sampling and Participants

In this study, considering the time constraint from non-probability sampling techniques, a snowball sampling method was employed in recruiting the participants. In this regard, first I asked my friends working as teachers in Turkey to participate in my research on a voluntary basis and then recommended other possible teachers to be sampled, as Creswell (2018) suggests. In total, 59 teachers participated in the quantitative part of this study. The background information of the participants is summarized in Table 1. It is apparent from the table that most of the respondents were female (82%), aged between 31 and 40 (62%) and work in secondary schools (49%) in urban areas (78%).

Table 1. Demographic information of survey participants

Variable	Groups	Frequency	Percentage (%)
Gender	Female	45	82
	Male	10	18
Age	21-30	11	20
	31-40	34	62
	40+	10	18
Grade Level	Primary	4	7
	Secondary	27	49
	High school	24	44
Location	Suburban	12	22
	Urban	43	78

Table 2 demonstrates the teaching background information of the participants for the survey. The participant teachers mostly have teaching experience of 10–14 years (33%). While 44% of them have no teaching experience with students with SEN, the majority of them (93%) claimed that they received training in in-service trainings, at the university, etc.

Table 2. Teaching background of survey participants

Variable	Groups	Frequency	Percentage (%)
Teaching Experience	Less than 1 year	2	4
	1-4 year	6	11
	5-9 year	15	27
	10-14 year	18	33
	14+	14	25
SEND Experience	Never	24	44
	Less than 2 years	11	20
	2-5 years	7	13
	5+	13	23
Training in SEN	Yes	96	93
	No	4	7

In terms of the participants in the interviews, Table 3 shows that the majority of participants were female (N = 3), working in public schools (N = 3), and with a range of teaching experience. Half of the interviewees had training in IE and experience working with students with SEND.

Table 3. Background information of interviewees

Aliases	Gender	Teaching experience	School type	Training on IE	Experience in SEND
T(1)	Female	9 years	Public	No	Yes
T(2)	Female	3 years	Private	No	No
T(3)	Male	12 years	Public	Yes	Yes
T(4)	Female	16 years	Public	Yes	Yes

Research Instruments and Processes

For the quantitative part of the study, data was collected via questionnaire, while interviews were utilized for the qualitative part. In the process of determining the questionnaire to be used, the related literature was used to find an appropriate instrument for this study and context since the earlier instruments may have been used in different studies and proved to be reliable. Therefore, the below selection criteria were set:

✓ investigating IE for all rather than one specific learning difficulty or disability,

✓ exploring attitudes based on the three-component model (cognitive, affective, behavioral)

✓ having complete psychometric properties.

Among the questionnaires examined, MTAIS (Stoiber et al., 2007) and STORI (Avradimis et al., 2000) were combined since these two tools meet the selection criteria, were used by different researchers, and proved to determine factors affecting attitudes towards inclusion more effectively, as seen in Table 4. In the combined version of the questionnaire, some modifications were made based on the context of Türkiye. The questionnaire was piloted with three teachers. Based on the expert opinions, some changes regarding terminology and wording were made. The questionnaire has 6 different sections, which are respectively an information sheet and consent form, background information, teacher opinions, emotional reactions, intentions, skills, and factors interfering with inclusion practices. It consists of 53 Likert scale items in total, including items like —The needs of students with special educational needs (SEN) are best served through special, separate classes." The overall reliability of the test as measured by Cronbach's alpha was found to be 0.84.

Table 4. Properties of questionnaires combined

Authors	Questionnaire	Reliability	Attitude Components/ Dimensions	Limitation(s)
Avradimis et al. (2000)	A Survey of Teacher's Opinions Relative to the Inclusion (STORI)	.90 - .85	1-Cognitive 2-Affective 3-Behavioural	Factors affecting IE as well as methods to improve inclusion is missing
Stoiber et al. (2007)	My Thinking About Inclusion Scale (MTAIS)	.91	1-Core perspectives 2-Expected outcomes 3-Classroom practices	No attitude components

As for the semi-structured interview, the questions were prepared based on the three-component-model of attitudes (Eagly et al. 1993) in line with the questionnaire. In this regard, semi-structured interview questions are determined to seek greater understanding of teachers' conceptualization of IE, how they perceive and feel when they have students with SEN, their self-perception of preparedness to teach in an inclusive setting, and the challenges of inclusive practice.

Data Analysis

To analyze quantitative data for the research questions 2, 3, and 4, Statistical Package for the Social Sciences (SPSS) 26 software was used. Since the Kolmogorov-Smirnov test results indicated significant results for the whole and sub-scales ($p > .05$), parametric tests were utilized. To investigate teacher attitudes towards IE in general as well as separately based on components of attitude and factors interfering with IE, descriptive statistics (mean, median, mode, variance, and standard deviation) were calculated. To test the difference between attitudes and some variables, an independent sample t-test and a one-way ANOVA were applied.

To address questions 1, 3, and 4, reflexive thematic analysis was employed in six phases as outlined by Braun et al. (2013). During the coding, largely inductive analysis was applied, but also deductive coding was adopted to proceed in line with the research questions and quantitative findings. Furthermore, not only semantic but also latent meanings were taken into consideration. At the final stage, 3 themes and 8 sub-themes emerged, as seen in Figure 1.
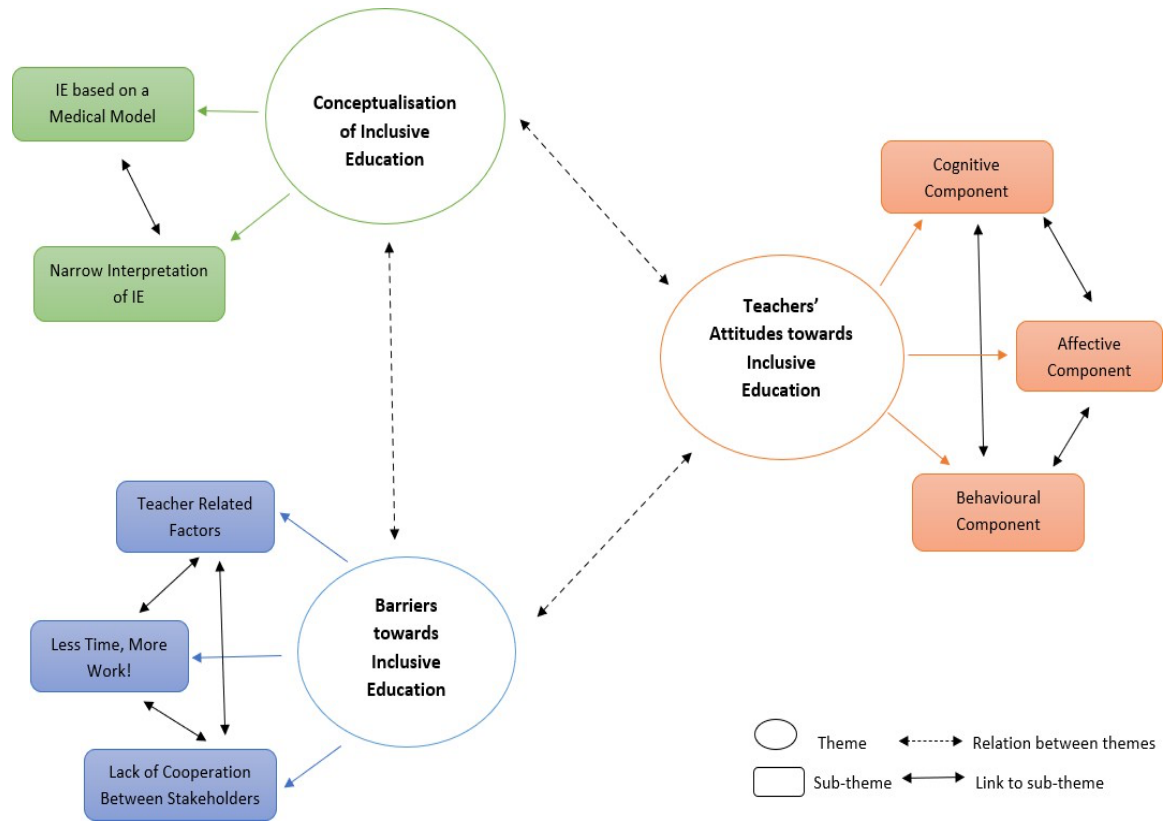
Figure 1.

Figure 1. *Thematic map*

Ethic

This study is found to be ethically appropriate to be conducted with the decision of University of Leeds, School of Education dated 15.06.2022.

RESULTS

The Concept of Inclusive Education

In addressing the first research question based on qualitative data analysis, one theme and two sub-themes were identified as seen in Figure 2. The theme conceptualization of IE explores participants' understandings and definitions of IE throughout the dataset. This theme is interrelated with the other two themes in that teachers' conceptualization of IE shapes and/or informs their attitudes towards IE and barriers towards IE identified by them and vice versa.
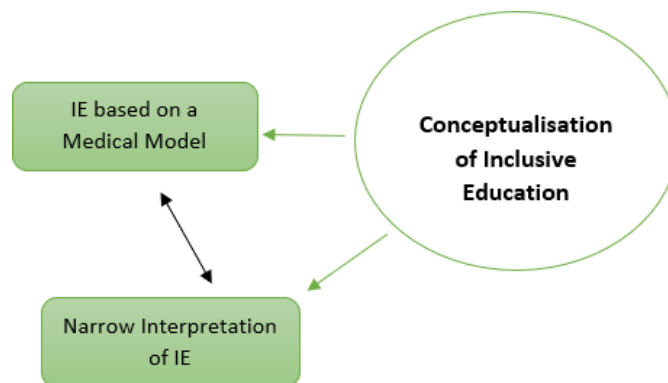
Although IE is viewed as a broad concept, as a quality education for all within the scope of this study, it is revealed that participants have a limited understanding of this term. Teachers limit IE to SEND only rather than inequalities based on ethnicity, gender, religion, socio-economic situation, linguistics, etc. It is also concluded that although some teachers are not sure about its scope, there is a pattern among the responses that teachers use the terms inclusion and mainstreaming interchangeably.

The implicit analysis of the dataset indicates that participant teachers conceptualize IE based on the medical model. They seem to think that students with SEND have certain problems or disorders diagnosed by the _experts' that prevent them from learning in inclusive classes, as seen in the below script from T(2). This idea of IE may also explain why teachers generally seem to be more embracing of IE in terms of social and emotional development of students rather than academic development.

T(2): I think one of the first things to be done is trying to fix the problem these children have. For example, I know that there are medications for hyperactive children. Like that. If there is a solution, we should look for it first. Then, in the second phase, we can think about our skills as teachers.

Teachers' Attitudes towards Inclusive Education

To answer research question 2 which seeks to explore teachers' attitudes towards, both quantitative and qualitative data were analyzed and findings presented respectively.

Quantitative Findings

Considering the range of the questionnaire which ranges from 1-5 for cognitive and behavioral components and 1-7 for affective one, the mean score for the components of attitudes as a whole and separately demonstrated negative attitudes towards IE for the participants. As Table 5 indicates, the means of cognitive, affective and behavioral components were M= 2.52, 3.37 and 2.03 which are below the central points (3.0 for cognitive and behavioral and 4.0 for affective component). The affective component had the highest mean score which can be interpreted as teachers were more likely to hold negative feelings about accommodating students with severe needs.

Table 5. Descriptive Statistics Results for General and Component Attitude Score

	Cognitive Component	Affective Component	Behavioral Component	General Attitudes
Mean	2.52	3.37	2.03	2.73
Median	2.58	3.42	2.12	2.72
Mode	2.67	1.00	2.13a	2.65
Std. Deviation	.50	1.72	.66	.67
Skewness	.354	.416	.624	.129
Std. Error of Skewness	.311	.311	.311	.311
Range	2.50	6.00	3.38	3.35
Minimum	1.00	1.00	1.00	1.00
Maximum	3.50	7.00	4.38	4.35

a. Multiple modes exist. The smallest value is shown

When each component is examined separately with its items, it can be seen in Table 6 that the mean scores for teachers' attitudes on cognitive component range from 1.71 to 3.47.

Table 6. Mean and Standard Deviation Scores for Cognitive Component

Items	N	M	SD
1. The needs of students with special educational needs (SEN) are best served through special, separate classes.	59	1.71	.832
2. The challenge of being in an inclusive classroom will promote the academic growth of the child with SEN.	59	2.76	1.179
3. Inclusion offers mixed group interaction which will foster understanding and acceptance of differences.	59	2.24	1.072
4. Isolation in a special class has a negative effect on the social and emotional development of a student with SEN.	59	3.31	1.118
5. The child with SEN will probably develop academic skills more rapidly in a special classroom than in a regular classroom.	58	1.88	.860
6. The contact with included students may be harmful for the other students.	59	3.47	1.165
7. Including the child with SEN will promote his/her social independence.	59	2.20	.906
8. The inclusion of students with SEN can be beneficial for all the students.	59	2.76	1.072
9. Inclusion is likely to have a negative effect on the emotional development of the child with SEN.	59	2.78	1.035
10. The child with SEN will be socially isolated by other students.	59	3.03	1.066
11. Students with SEN should be given every opportunity to function in the general-classroom setting, where possible.	59	2.10	.781
12. The presence of students with SEN will promote acceptance of differences on the part of other students.	59	2.03	.946

The majority of teachers (88%) seem to agree with the idea that _the needs of children with SEN are best served through special, separate class' (M= 1.71). 84.5 % of them also believe that _the child with SEN will develop academic skills more rapidly in a special classroom than in a mainstream classroom' (M= 1.88). Although the item _The contact mainstream-class children have with included children may be harmful' (M = 3.47) is opposed by more than half of the participants (57%), interestingly a considerable number of teachers (25.4%) holds neutral views about it.

Teachers' attitudes in terms of affective dimension were investigated via semantic differential scale consisting of bipolar adjectives such as negative-positive for two situations, severe learning difficulties (LD) and severe emotional and behavioral difficulties (EBD). The mean and standard deviation of affective component for two situations are presented in Table 7.

Table 7. Mean and Standard Deviation Scores for LD and EBD

Feelings	LD			EBD		
	N	Mean	SD	N	Mean	SD
Uncomfortable vs Comfortable	59	3.26	2.00	45	3.11	1.95
Negative vs Positive	59	3.77	1.96	45	3.44	2.01
Unconfident vs. Confident	59	3.16	1.94	53	3.00	2.01
Pessimistic vs. Optimistic	59	3.91	2.00	46	3.37	1.91
Worried vs. Assured	59	3.43	1.94	54	3.19	1.99
Disinterested vs. Interested	59	4.78	2.43	46	4.63	2.37

Unhappy vs. Happy	59	3.58	2.01	44	3.45	1.84

As seen in Table 8, the mean values for the behavioral component are ranged from 3.24 to 1.75. It is an interesting finding that except for the first item, most of the participants preferred to choose either agree or neutral options while almost no participant answered strongly disagree. Overall, it can be stated that teachers are willing to develop themselves, their teaching and classroom management skills via trainings, collaboration with parents, self-assessment etc. to provide IE. The mean and standard deviation of affective component for two situations are presented in Table 3.

Table 8. Mean and Standard Deviation Scores for Behavioral Component

Items	N	M	SD
1. I will be supportive towards the idea of including children with severe learning difficulties in my classroom.	59	3.24	1.15
2. I will be willing to engage in in-service training on teaching children with severe learning difficulties.	59	1.86	.84
3. I will engage in developing the appropriate skills to teach children with severe learning difficulties in their classroom.	59	1.80	.80
4. I will engage in developing skills for managing the behavior of children with severe learning difficulties.	59	1.75	.70
5. I will accept responsibility for teaching children with severe learning difficulties within a whole-school policy.	59	2.17	.79
6. I will continuously assess myself to inform my teaching practice.	59	1.90	.78
7. I will change my teaching processes to accommodate children with severe learning difficulties in my classroom.	59	1.85	.76
8. I will co-operate with the parents of the children with severe learning difficulties for the benefit of their children.	59	1.71	.76

In this regard, 44.1% of participants were against the idea of including children with severe learning difficulties in their classrooms while a considerable number of them (30.5%) are neutral about it. However, interestingly, 62.7% of them also accepted the responsibility of teaching children with severe difficulties. A majority of participants (88.2%) seemed open to the idea of collaboration with the parents for implementing IE.

Qualitative Findings

This theme focuses on teachers' beliefs, feelings, and actions in inclusive classes. As adopting the three-component-model of attitudes, dataset was analyzed accordingly to complement qualitative findings with quantitative ones and three sub-themes were generated as shown in the Figure 3.
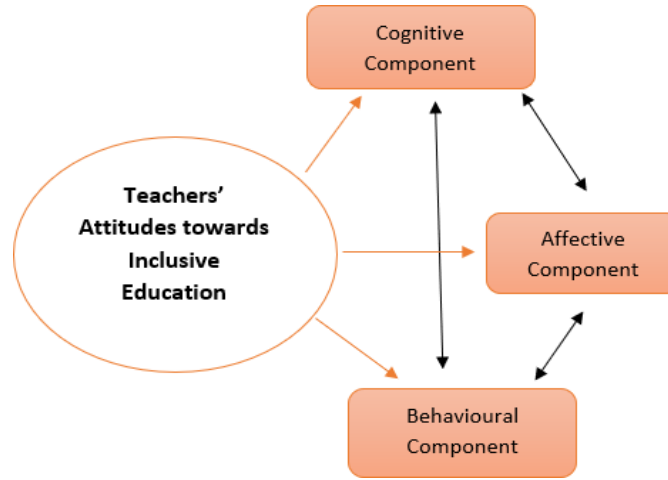
Figure 3. *'Teachers' attitudes towards IE' theme and its sub-themes*

This theme focuses on teachers' beliefs, feelings, and actions in inclusive classes. As adopting the three-component model of attitudes, the dataset was analyzed accordingly to complement qualitative findings with quantitative ones, and three sub-themes were generated as shown in Figure 3.

As for the cognitive component, it is apparent in teachers' expressions that participants feel themselves lacking theoretical and practical knowledge about implementing IE, which hinders positive attitudes towards IE.

T(1): First of all, we really don't know what it is or what we should do when we have such students. Therefore, we don't know how to provide quality teaching for all students.

Furthermore, it seems that teachers have dilemmas about the benefits of IE. Although they have positive ideas in terms of the social impact of IE, academically, they do not support the idea of teaching in the same classes for the sake of the progress of both students with SEND and their peers.

T(4): For the student with disability, if the disability is mild, s/he can adapt to the environment. But if the mental disability is severe, it is obviously difficult. It is difficult for other students as well as for that child. They stand up a lot in class and disrupt the teacher's lecture.

As for the affective component, teachers generally state negative emotions like ―desperate, anxious, worried‖ to describe their feelings when they have a student with severe needs. Furthermore, when the dataset is considered as a whole and as seen in the below scripts, it can be deduced that their negative feelings might stem from their lack of theoretical and practical knowledge about IE, which proves the intertwined nature of themes/sub-themes.

T(2): First of all, I would feel very ignorant, which would probably make me worried. Since I haven't received any training on this, I would feel anxious because I did not know how to behave or teach! I could have an anxiety problem. I think these are the emotions I would feel the most.

In terms of the behavioral component, participants mostly stated that they do not carry out any activity or apply strategy or method to foster inclusion, as seen in the below script. It also seems that they do not feel responsibility for doing so. When this finding is considered together with their conceptualization of an IE-based medical model, it is not surprising, though.

T(1): I can't say that I use a special strategy or activity for it. But, in the past, when I had

this kind of student, I tried to teach them individually. But I can't really say that it worked indeed. I mean, I couldn't really succeed in it.

Factors Affecting Teachers Attitudes Towards Inclusion

Factors affecting teachers' attitudes towards inclusion were analyzed and findings presented respectively.

Interaction with someone with SEND

As seen in Table 9, the independent samples t-test indicates that there is no significant difference between teachers who had someone in their close environment with SEN and who did not on attitudes towards IE (t=-.342, df=57, p=0.734, equal variances assumed, Cohen's d=0.10). The mean scores for participants knowing someone in their close environment with SEN and without were 2.68 and 2.75 respectively and according to the usual effect size guidance (Cohen, 1988), this difference is _small'.

Table 9. Independent *Samples T-Test Results For General Attitude Score according to*

		F	Sig.	t	df	Sig. (2-tailed)
General Attitudes	Equal variances assumed	.142	.707	-.342	57	.734

Interaction with Someone with SEND

Training

As seen in Table 10, he independent samples t-test indicates that there is no significant difference on attitudes towards IE between teachers who received training and those who did not (t=-.182, df=57, p=0.856, equal variances assumed, Cohen's d=0.09). The mean scores for participants with training and without were 2.74 and 2.67 respectively and according to the usual effect size guidance (Cohen, 1988), this difference is _small'.

Table 10. Independent *Samples T-Test Results for General Attitude Score according to Training*

		F	Sig.	t	df	Sig. (2-tailed)
General Attitudes	Equal variances assumed	.055	.816	.182	57	.856

Factors Affecting Teachers Attitudes Towards Inclusion

While addressing this research question, both quantitative and qualitative methods were applied which will be elaborated respectively.

Quantitative Findings

In this study teachers were also asked about the challenges affecting their attitudes towards IE. As Table 11 shows, the mean values ranged from 1.80 to 2.05. The limited time had the highest mean score (M=2.05, SD=1.26) whilst parent's attitudes had the lowest (M=1.80, SD=1.03). Overall, it can be stated that there is not a considerable amount of difference between mean values of challenges rated by teachers.

Table 11. Mean and *Standard Deviation Scores for The Challenges* against IE

Challenges	N	Mean	SD

Limited time	59	2.05	1.26
Limited opportunities for collaboration	59	2.02	1.20
Teacher attitudes	59	2.00	1.19
Lack of experience regarding inclusion	59	2.00	1.23
Little knowledge in this area	59	1.97	1.17
Current work commitments	59	1.95	1.41
Lack of material	59	1.92	1.14
Little support from school/district	59	1.83	1.20
Parents' attitudes	59	1.80	1.03

Lack of knowledge and experience regarding inclusion were found to be the most salient barriers against IE by majority of the teachers (80%). The least influential barrier on the other hand was limited time although 71% of teachers agreed that it interfere with IE. As seen in Table 20, the percentages of the factors are close to each other. Hence, it can be concluded that limited collaboration, teachers' attitudes, current work commitments, parents' attitudes and lack of materials were determined as factors hindering inclusive practices by teachers. Finally, it is notable that the item _teacher attitudes' was also rated as a salient challenge by most participants (74%).

Qualitative Findings

The theme _barriers against IE' explores the challenges teachers encounter while implementing IE which might affect their attitudes towards inclusion negatively. Three sub-themes, which are namely _teacher related factors', _less time, more work' and _lack of cooperation between stakeholders' were identified to explain factors hindering IE as shown in the Figure 4.
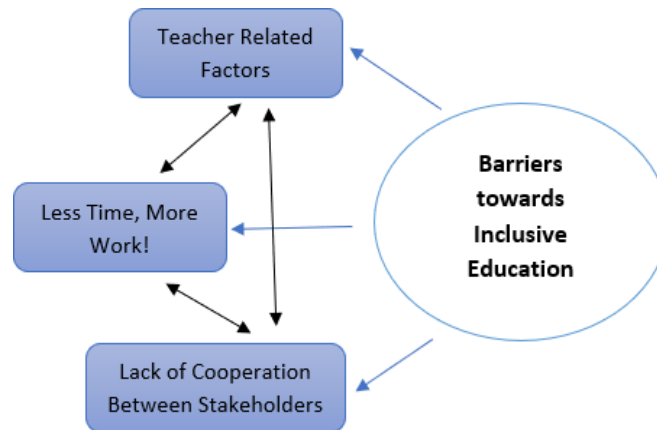
Figure 4. *'Barriers to IE' theme and its sub-themes*

Throughout the dataset, lack of knowledge and the need for training to implement IE were constantly articulated by teachers. Teachers' accounts also provide some insights regarding the level and content of the trainings. Accordingly, equipping student teachers with the necessary knowledge and skills at the university level is of importance, as seen in the script from T(1). However, current trainings on the subject were found limited in that they do not offer much about practice in real contexts.

T(1): The best thing to be done will be training. It could be a kind of in-service teacher training as well as pre-service teacher training for prospective students. But these trainings should be based on practice rather than theorical.

As for the challenges faced by teachers while implementing IE in class due to time constraints and workloads, It can be concluded that there is a bigger problem underlying these barriers, which is the exam-oriented education system. The evidence in the below extracts shows that the main priority for teachers is to prepare students for the national exams, which hinders IE by ignoring the needs and rights of students with SEND.

T(1): Due to lack of time and the number of students in a class, we now have sometimes more than 35 students; we are not able to teach these students individually. We have a curriculum to follow and a responsibility to prepare others for the national exams, so I believe, for the sake of all sides, it is better to educate them in separate classes.

In terms of cooperation between stakeholders, as key partners, parents were viewed as not open to collaboration. Instead, they were defined as resistant to accepting the situation of their children in most cases, which can be seen in the below extract:

T(2): Secondly, when we talk with parents about their children's academic problems and learning difficulties, we have a really hard time. Because they are too sensitive about their children and we talk about something negative, they take it personally somehow. They perceive it as if we speak ill of their children. But what we try to do is just inform them about the realities and try to solve the problem if we can.

In terms of the cooperation with the school management, there were different views based on school types. While T(2), working in a private school, underlined the communication problems due to school management's concerns for commercial profits, public school teachers stated that the school management was embracing and fulfilling their responsibilities for IE. However, what teachers meant by responsibility of the management is equal placement of students with SEND into mainstream classes, which is again related to teachers' limited conceptualization of IE focusing on the accession to education, mainly as seen in the script from T(4).

T(4): Frankly, I have had no problems with the school administration based on my own more than 15 years of experience. The administration is supportive in this sense. Because they accept students with SEND and try to place them equally in each class.

DISCUSSION

It was found out that teachers in Türkiye conceptualize IE narrowly—mostly limited to integration. It was revealed that although the teachers were inclined to use the term inclusion interchangeably with mainstream education, which is also interpreted as educating the students with SEND with their peers under the same roof. The findings of this study are consistent not only within the context of Türkiye (e.g., ERI, 2016; Erkılıç, 2013; Sarı et al., 2020) but also around the world (e.g., Arduin, 2015; Forlin, 2009), which is not surprising as any political updates in terminology might not be internalized by the society unless it complies with the current social realities and beliefs (Wedel, 2009).

It is apparent in the latent and semantic meanings of the interviews that IE is viewed according to a medical model in which teachers generally perceive SEND as a deficit, disorder, or attribute of the students rather than socially generated labels (Hodkinson, 2015; Demetriou, 2020). Earlier and recent studies in Türkiye have also yielded similar results (Erkılıç, 2013; Kesik et al., 2022; Rakap et al., 2010). This conceptualization may explain other findings, such as teachers' not feeling responsible for implementing quality IE for all and advocating the idea of separate classes for those students, which signals a need for change at a societal level for a quality IE.

Within the context of the second research question, teachers were found to hold mixed attitudes, mostly negative close to the neutral. In the context of Türkiye, while earlier studies indicated negative attitudes (Artan et al., 2003; Demir et al., 2010; Gök et al., 2011; Rakap et al., 2010), there are also current studies (Demir-Başaran, 2020; Tuncay et al., 2020) concluding positive attitudes. When studies around the world are concerned, it can be concluded that research in developing countries has indicated generally negative or moderately positive attitudes (Al-Zyoudi, 2006; Ramli, 2017; Saleem, 2017), while quite the reverse can be observed in developed countries (Lorman et al., 2007; Saloviita, 2020).

It was also revealed that teachers were more welcome to accommodate children with mild needs rather than severe intellectual and behavioral needs. Both quantitative and qualitative findings assured that the type and severity of SEND is an important determinant for embracing IE for teachers, which is in line with the findings of previous studies (Avradimis et al., 2000; Ramli, 2017; Saleem, 2017; Saloviita, 2020).

As for training on IE, no significant difference was found in the current study between teachers who had received training and those who had not. This finding is inconsistent with earlier research in the Turkish context (e.g., Bayar et al., 2017; Karasu, 2019; Ozokcu, 2018). Similarly, in the interviews, teachers consistently highlighted the importance of teacher training throughout the dataset. The contradiction might stem from the current nature of training on IE, which is described by the interviewees as theory-based, perfunctory training. In this regard, training alone may not be sufficient for teachers to develop affirmative attitudes toward IE (Costello et al., 2013).

In the literature, teachers' attitudes were closely associated with interaction with someone with SEND (Avradimis et al., 2002; Rakap et al., 2010; Özokçu, 2018; Tuncay et al., 2020). However, based on the quantitative data, it was not found to influence teachers' attitudes towards inclusion. When qualitative findings were considered in this context, it can be stated that teachers believe interaction with students with SEND in the class helps other students to develop empathy; however, they also think that these students prevent other students' academic progress, which can also be interpreted as signs of a medical model. When all these findings evaluated together, it can be claimed that qualitative findings explain for quantitative findings in that due to their conceptualization of IE based on a medical approach, interaction with someone with SEND was not found to be a significant predictor for teachers' attitudes towards IE.

Although implementation of inclusive education highly relies on teachers, teachers practices as well as their attitudes can be negatively affected by many factors. In this context, lack of knowledge, training, and experience on IE seemed to be the most influential factor interfering with inclusive practices, according to teachers supporting similar findings reported by Avradimis et al. (2007). Furthermore, parents' as well as teachers' attitudes, limited time, and lack of partnership and collaboration were also reported as the salient barriers against inclusion. In addition to these, qualitative data reflected that crowded classes in Türkiye hinder implementation of quality IE.

CONCLUSION AND IMPLICATIONS

Societal values shape education systems (Arduin, 2015). Teachers in this study portrayed a narrow conceptualization and mixed attitudes close to the negative and neutral towards IE, which can be interpreted as the reflections of beliefs, understanding, and approaches Turkish society has about inclusion. Hence, it can be argued that to achieve the goal of quality IE for all, a mindset change is necessary at a societal level, including teachers, who are the key persons of educational

change. On the other hand, it is obvious that such a macro-level change will not take place shortly and easily (Wedel, 2010). One of the best and fastest ways can be using media and communication as means, considering our era of technology.

It was found out that teachers are concerned about teaching in inclusive classes due to their lack of knowledge and practical experience. In this regard, MoNE should provide hands-on professional development opportunities for teachers to equip them with the necessary skills to meet all students' needs in the class. Considering teachers' accounts of the perfunctory nature of current trainings, these trainings should be organized based on the needs of teachers and applicable to the classroom contexts. Furthermore, for the prospective teachers, regardless of their teaching subject, IE should be taught as a compulsory module at the university level by the Council of Higher Education. Because it is easier to develop positive attitudes towards inclusion during undergraduate initial teacher training programs (Loreman et al., 2013). As for the other barriers identified in this study, MoNE should also take necessary steps with regard to class size, materials, and human resources to ensure implementation of IE.

At a school level, a well-established partnership should be built between school management, teachers, and parents, which is one of the fundamentals of achievement in IE (Beveridge, 2005). In this regard, school management's responsibility should be seen as more than equal placement of students with SEND into mainstream classes, and they should be active partners and actors of education for all. As underlined in this study, parental involvement was not found adequate by teachers; however, it should also be noted that engaging parents in inclusive education is also the responsibility of school management and policymakers, as Csozier (2000) puts forth.

In conclusion, teachers are at the heart of teaching, and their attitudes towards inclusion, willingness to accommodate all children in their classes, and perception of self-confidence to work with students with individual differences and needs determine the effectiveness of inclusive education practices (McLeskey et al., 2001). Therefore, understanding teachers' attitudes and the factors affecting them is of great importance, and this study revealed that teachers' positive attitudes and inclusive practices are multidimensional, depending on not only themselves but also related partners, educational environments, policies, and society. Accordingly, in order to develop positive attitudes for teachers that will inform and shape their actions in inclusive settings, collaboration and commitment from all stakeholders are key factors in promoting education for all.

Ethical Statement

This study is based on the master's thesis entitled "Teachers Attitudes Towards Inclusive Education: A Mixed Method Study", submitted under the supervision of Dr. Paula Clark in 04/09/2022.

Ethics Committee Approval

15/06/2022 dated ethics approval was given by University of Leeds, Ethical Committee of School of Education.

Author Contributions

Research Design (CRediT 1) Author 1 (%20) – Author 2 (%80)

Data Collection (CRediT 2) Author 1 (%60) – Author 2 (%40)

Research - Data analysis - Validation (CRediT 3-4-6-11) Author 1 (%10) – Author 2 (%90)

Writing the Article (CRediT 12-13) Author 1 (%30) – Author 2 (%70)

Revision and Improvement of the Text (CRediT 14) Author 1 (%50) – Author 2 (%50)

Finance

No financial support was received from any institution or organization.

Conflict of Interest

There is no conflict of interest among the authors.

Sustainable Development Goals (SDG)

Sustainable Development Goals: 4 Quality Education

Sustainable Development Goals: 10 Reduced Inequalities

REFERENCES

Arduin, S. (2015). A review of values that underpin the structure of an education system and its approach to disability and inclusion. *Oxford Review of Education*, *41*(1), 105-121. https://doi.org/10.1080/03054985.2015.1006614

Artan, İ. and Uyanık-Balat, G. (2003). Okul öncesi eğitimcilerinin entegrasyona ilişkin bilgi ve düşüncelerinin incelenmesi. Kastamonu Eğitim Dergisi, *11*(1), 65-80.

Al-Zyoudi, M. (2006). Teachers' attitudes towards inclusive education in Jordanian schools. *International Journal of Special Education, 21*, 55-62.

Avramidis, E., P. Bayliss., &. Burden, R. (2000). Student teachers' attitudes towards the inclusion of children with special educational needs in the ordinary school. *Teaching and Teacher Education, 16*, 277–293. https://psycnet.apa.org/doi/10.1016/S0742-051X(99)00062-1

Avramidis, E., & Norwich, B. (2002). Teachers' attitudes towards integration/inclusion: A review of the literature. *European Journal of Special Needs Education, 17*(2), 129-147. https://doi.org/10.1080/08856250210129056

Bayar, M., & A. Üstün. (2017). The Investigation of Elementary School Teachers' Emotions, Attitudes, and Concerns about Inclusive Education. *Turkish Studies*, *12*(17), 73–88. http://dx.doi.org/10.7827/TurkishStudies.11872

Beveridge, S. 2006. *Children, families and schools: Developing partnerships for inclusive education.* London: Routledge Falmer.

Braun, V., & Clarke, V. 2013. *Successful qualitative research: a practical guide for beginners,* SAGE.

Bryman, A. 2021. *Social research methods (Fifth edition)*. Oxford University Press.

Boyle C., Topping, K., Jindal-Snape, D., & Norwich, B. 2012. The importance of peer-support for teaching staff when including children with special educational needs. *School Psychology International*. *33*(2), 167-184. http://doi:10.1177/0143034311415783

Costello, S. & Boyle, C. 2013. Pre-service secondary teachers' attitudes towards inclusive education *Australian Journal of Teacher Education*, *38*(4), 129-143. http://doi:10.14221/ajte.2013v38n4.8

Demetriou, K. 2020. Special Educational Needs Categorisation Systems: To Be Labelled or Not?, *International Journal of Disability, Development and Education*. https://doi:10.1080/1034912X.2020.1825641

Demir, M. K. & Açar, S. 2011. Kaynaştırma eğitimi konusunda tecrübeli sınıf öğretmenlerinin görüşleri. *Kastamonu Education Journal*, *19*(3), 719-772.

Düşkün, Y. 2016. Inclusive education situation analysis in secondary education in Türkiye. İstanbul: Education Reform Initiative.

Eagly, A. H. & Chaiken, S. 1993. *The psychology of attitudes.* Harcourt Brace Jovanovich

College Publishers.

Erkılıç, M. & Durak, S. Tolerable and inclusive learning spaces: An evaluation of policies and specifications for physical environment that promote inclusion in Turkish primary schools. *International Journal of Inclusive Education*, *17*, 462-479. https://doi:10.1080/13603116.2012.685333

Fives, H. & Buehl, M. M. 2008. What do teachers believe? Developing a framework for examining beliefs about teachers' knowledge and ability. *Contemporary Educational Psychology*, *33*, 134-156.

Florian, L. 2008. Inclusion: special or inclusive education: future trends. *British Journal of Special Education*, *35*, 202-208. https://doi.org/10.1111/j.1467-8578.2008.00402.x

Forlin, C., Loreman, T., Sharma, U., & Earle, C. 2009. Demographic differences in changing pre-service teachers' attitudes, sentiments and concerns about inclusive education. *International Journal of Inclusive Education*. *13*, 195–209. https://doi:10.1080/13603110701365356

Gök, G. & Erbaş, D. 2011. Early childhood teachers' opinions about and suggestions for inclusion programs. *International Journal of Early Childhood Special Education*, *3*(1), 66-87.

Hodkinson, A. 2016. *Key issues in special educational needs and inclusion.* London: SAGE.

Kesik, F. & Beycioglu, K. 2022. Turkish education policies: inclusive or exclusionary? *International Journal of Inclusive Education*. https://doi:10.1080/13603116.2022.2058625

Kuruyer, H. G., & Çakıroğlu, A. 2017. Sınıf Öğretmenlerinin Özel Öğrenme Güçlüğü Olan Öğrencilerin Eğitsel Değerlendirme ve Eğitimsel Müdahale Sürecinde Görüş ve Uygulamaları. *Journal of Turkish Studies,* *12*(28), 539-555. https://doi:10.7827/TurkishStudies.12494

Loreman, T., Sharma, U. & Forlin, C. 2013. Do pre-service teachers feel ready to teach in inclusive classrooms? *Australian Journal of Teacher Education*, *38*(1), 27-44. https://doi:10.14221/ajte.2013v38n1.10

McLeskey, J. Waldron, N. L., So, T., Swanson K. and Loveland, T. 2001. Perspectives of teachers toward inclusive school programs. *Teacher Education and Special Education*, *24*(2), 108-115. https://doi:10.1177/088840640102400205

MEB, 2018. *Kapsayıcı eğitim bağlamında okul öncesi ve sınıf öğretmenlerinin rehberlik becerilerinin geliştirilmesi projesi.* https://oygm.meb.gov.tr/www/kapsayici-egitim-baglaminda-okul-oncesi-ve-sinif-ogretmenlerinin-rehberlik-becerilerinin-gelistirilmesi-projesi/icerik/1003

Nougaret, A. A., Scruggs, T. E., & Mastropieri, M. A. 2005. Does teacher education produce better special education teachers? *Exceptional Children*, *71*(3), 217–229. https://doi:10.1177/001440290507100301

Parasuram, K. 2006. Variables that affect teachers' attitudes toward disability and inclusive education in Mumbai. *India Disability Society,* *21*(3), 231–242. https://doi:10.1080/09687590600617352

Ramli, L. I. B. 2017. *Attitudes of preschool teachers towards the introduction of inclusive education (IE) in Malaysian government preschools.* Ph.D. thesis, University of Leeds.

Rakap, S., & Kaczmarek, L. 2010. Teachers' attitudes toward inclusion in Türkiye. *European Journal of Special Educational Needs.* *25*(1), 59–75. https://doi:10.1080/08856250903450848

Tuncay, A. A. & Kizilaslan, A. 2021. Pre-service teachers' sentiments, attitudes and concerns about inclusive education in Türkiye, *European Journal of Special Needs Education*, *37*(3), 1-14. https://doi:10.1080/08856257.2021.1873524

UNESCO. 1994. *The Salamanca statement on principles, policy and practice in special needs education.* Salamanca: UNESCO. [Accessed 25 July 2022]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000098427

UNESCO. 2016. Incheon declaration. Education 2030: Towards inclusive and equitable quality education and lifelong learning for all. [Online]. [Accessed 15 June 2022]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000233813

UNESCO. 2000*. Dakar framework for action, Education for all: Meeting our collective commitments* (adopted by the World Education Forum). Dakar: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000121147 [Accessed 23 June 2022].

UNESCO. 2020. *Inclusive education: All means all.* Global Education Monitoring Report. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000373724 [Accessed 5 June 2022].

UNICEF (2011). *The right of children with disabilities to education: A rights-based approach to inclusive education.* Geneva: UNICEF Regional Office for Central and Eastern Europe and the Commonwealth of Independent States. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.unicef.org/media/126506/file/UNI CE F-Right-to-Education-Children-Disabilities-ENG.pdf. [Accessed 6 June 2022].

Saleem, M. A. A. 2017. *Teachers' attitudes towards the inclusion of children with special educational needs in Jordanian ordinary schools.* Ph.D thesis, University of Nottingham

Saloviita, T. 2020. Teacher attitudes towards the inclusion of students with support needs. *Journal of Research in Special Educational Needs. 20*(1), 64-73. https://doi.org/10.1111/1471-3802.12466

Sarı, T. Nayir F. & Kahraman, Ü. 2020. A study on inclusive education in Türkiye. *Journal of Education and Future, 18*, 69-82. https://doi.org/10.30786/jef.642954

Savolainen, H., Malinen O. P. & Schwab, S. 2020. Teacher efficacy predicts teachers' attitudes towards inclusion- A longitudinal cross-lagged analysis. *International Journal of Inclusive Education.* https://doi:10.1080/13603116.2020.1752826

Sharma, U., Forlin, C., & Loreman, T. 2008. Impact of training on pre-service teachers' attitudes and concerns about inclusive education and sentiments about persons with disabilities. *Disability Society*. *23*(7), 773–785. http://doi:10.1080/09687590802469271

Stoiber, K. C. Gettinger, M. & Goetz, D. 1998. Exploring factors influencing parents' and early childhood practitioners' beliefs about inclusion. *Early Childhood Quarterly*, *13*(1), 107-124. https://doi.org/10.1016/S0885-2006(99)80028-3

Sucuoglu, B., S. Akalin, & E. Sazak-Pinar. 2010. The Effects of Classroom Management on the Behaviors of Students with Disabilities in Inclusive Classrooms in Türkiye. *The Journal of the International Association of Special Education, 11*(1), 64–74.

Wedell, M. 2009. *Planning for educational change.* NewYork: Continuum International Publishing Group.

Yılmaz, E. 2021. *Yabancı dil öğretmenlerinin kapsayıcı eğitime yönelik tutumları ve özyeterliklerinin değerlendirilmesi*. MA Thesis, Erciyes University.

The Effect of Coding Activities on Cognitive Tempo of Preschool Children

Yasemin KARAGÖZ[1]* Özden KUŞCU[2] Elif ZARARSIZ SEPETÇİOĞLU[3]

[1] Aile ve Sosyal Hizmetler Bakanlığı, Konya, Türkiye

[2] Selçuk Üniversitesi, Sağlık Bilimleri Fakültesi, Çocuk Gelişimi Bölümü, Konya, Türkiye

[3] MEB, Konya, Türkiye

Article Info	ABSTRACT
	Coding activities support cognitive thinking skills by increasing children's imagination and creativity, improving their problem-solving skills, enabling them to produce different solutions to an problem situation, and transferring these solutions to similar problem situations. This research aims to examine the effects of coding activities on the cognitive styles of preschool children. This research is an experimental design with a pretest-posttest control group. Consists of a total of 25 children, 13 of whom are in the experimental group and 12 of whom are in the control group, studying in a public kindergarten in Selçuklu district of Konya province. The data collection tool used in this study to determine the cognitive tempo of participating children was KRISP-A (Kansas Reflection-Impulsivity Scale for Preschoolers, Form A), developed by Wright (1971) and adapted into Turkish by Seçer and colleagues (2010). A total of 20 sessions of Coding Activities were carried out with the children in the experimental group twice a week for ten weeks. No study was conducted with the control group, and the preschool program continued. The study concluded that coding activities shortened the response time of the children in the experimental group; in other words, coding activities supported the children's ability to respond faster.

Kodlama Etkinliklerinin Okul Öncesi Dönem Çocuklarının Bilişsel Tempolarına Etkisi

Makale Bilgisi	ÖZET
	Kodlama etkinlikleri, çocukların hayal gücü ve yaratıcılığını artıran, problem çözme becerilerini geliştiren, var olan bir problem durumuna farklı çözüm yolları üretebilmesini sağlayan ve bu çözüm yollarını benzer problem durumlarına transfer ederek bilişsel düşünme becerilerini desteklemektedir. Bu araştırma kodlama etkinliklerinin okul öncesi dönemi çocuklarının bilişsel stillerine etkisini incelemeyi amaçlamaktadır. Öntest-sontest kontrol gruplu deneysel desenli olan bu araştırmanın çalışma grubunu Konya ili Selçuklu ilçesinde bulunan bir devlet anaokulunda eğitim almakta olan 13'ü deney grubunda, 12'si kontrol grubunda olmak üzere toplam 25 çocuk oluşturmaktadır. Çalışmaya katılan çocukların bilişsel tempolarını belirlemek amacıyla Wright (1971) tarafından geliştirilen ve Seçer ve ark. (2010) tarafından Türkçe'ye uyarlaması yapılan KRISP-A (Kansas Okul Öncesi Dönemdeki Çocuklar için Düşünsellik – İçtepisellik Ölçeği A Formu) veri toplama aracı olarak kullanılmıştır. Deney grubundaki çocuklar ile on hafta olmak üzere haftada iki oturum şeklinde toplam 20 oturumluk Kodlama Etkinlikleri yapılmıştır. Araştırmanın kontrol grubuyla herhangi bir çalışma yapılmayıp okul öncesi programa devam edilmiştir. Araştırmada kodlama etkinliklerinin deney grubu çocuklarının yanıt süresini kısalttığı, başka bir deyişle kodlama etkinliklerinin çocukların daha hızlı yanıt verebilme becerisini desteklediği sonucuna ulaşılmıştır.

*Corresponding Author: Yasemin KARAGÖZ, *karagozyasemin5@gmail.com*

INTRODUCTION

Our age is developing rapidly in terms of technology and science. It is imperative to shape the competencies of today's children within the framework of our age and the vision of the future. In this context, it is aimed for children to become more active and integrated into the future. The importance of applications for coding education, which is an important reflection of technology and is accepted as one of the skills of the 21st century, has increased. Coding activities have begun to be included in educational programs (Özbey, 2018; Ünsal, 2019). Odacı and Uzun (2017) describe coding as a kind of problem solving method.

When examining global research on programming, the emphasis on coding education, particularly during early childhood, becomes evident. Preschool education is acknowledged as a crucial period for acquiring various skills. Consequently, there is a prevailing belief that coding training should be introduced during this developmental stage. Coding applications enhance children's imagination and creativity while fostering the development of problem-solving, spatial, and analytical thinking skills. It encourages both process- and result-oriented thinking, instilling the practice of undertaking comprehensive, product-oriented projects and resolving issues through the integration of smaller projects. Coding facilitates the generation of diverse skills to address existing problems. Children also develop their problem-solving skills by finding solutions to existing problems through technology and their cognitive thinking skills by transferring them to similar situations (Demirer & Sak, 2017; Odacı & Uzun, 2017). Coding activities, especially those carried out using robotic kits, provide an environment for preschool children to test their hypotheses in the face of a problem situation, produce solutions to the problem situation, and make meaningful discoveries (Bers, 2008).

The preschool period, during which coding practices play a crucial role, represents one of the most intense and rapid phases in children's brain development. Brain development significantly influences cognitive development. Cognitive processes, encompassing perception, learning, concept acquisition, thinking, and problem-solving skills, hold paramount importance for cognitive development (Keleş & Çepni, 2006). These concepts differ for each child, resulting in differences in cognitive styles. Differences in how children perceive, process, and remember information do not indicate differences in abilities that measure their performance; instead, they are distinctions commonly defined as thinking styles. The way children individually approach a task constitutes a cognitive style, with numerous cognitive styles identified through research. Among these cognitive styles, cognitive tempo stands out as the most extensively studied. Cognitive tempo can be categorized as impulsive or reflective (Gander &Gardiner, 2010). Preschool children can produce various hypotheses in order to find a solution when faced with any problem. The various hypotheses that children form arise from differences in their cognitive tempo (Zelniker & Jeffrey, 1979).

The process involving a child's choice to react quickly or slowly when producing a solution to a problem is termed cognitive tempo and has two types: impulsive and reflective. When children exhibit a reflective tempo, they respond by thoroughly examining all stimuli and options, attempting to conceal their hesitations before determining the correctness of the hypothesis generated for the solution and before reacting. Due to their tendency to plan and think before reacting, they generally achieve successful results. Conversely, children with an impulsive tempo, when faced with any problem or situation, react without using the possible solution hypothesis as a basis. They do not concentrate on secondary important clues, express what comes to their mind in a hurry, and are driven by a fear of failure. Consequently, problem situations often end unsuccessfully (Gander & Gardiner, 2004). In other words, impulsive children dedicate little time to analysis, respond hastily without thorough examination, and therefore make many mistakes. Reflective children, on the other hand, are more cautious, utilizing more time for data analysis, leading to fewer mistakes (Gargallo, 1993).

Kagan and his colleagues made reflective and impulsive cognitive styles measurable by using the 'Matching Familiar Figures Test (MFFT)' (Kagan and his colleagues, 1964). The Matching Familiar Figures Test is a visual comparison test designed to identify the same shape among various alternative shapes. The test measures response time and the number of errors (expressed as 'correct responses'). Kagan and his colleagues divided individuals into two groups based on the scores obtained from the test. According to this grouping, reflective individuals are those with a longer thinking time and more correct answers, while impulsive individuals are those with a shorter thinking time and more incorrect answers (Kagan and his colleagues, 1964).

Wright (1971) developed the Kansas Reflection-Impulsivity for Preschool (KRISP) scale to determine whether preschool children fall into categories such as fast correctors, slow correctors, fast incorrectors, and slow incorrectors. The classification of children into these categories is based on the errors obtained from the scale, considering both the number of errors and their response time. Children are then labeled as fast correctors, slow correctors, fast incorrectors, or slow incorrectors.

When the literature was reviewed, no research was found on the effects of coding activities on the cognitive styles of preschool children. In light of this, the study aims to examine the impact of coding activities on the cognitive styles of preschool children.

Research Purpose:

The primary objective of this research is to investigate the influence of coding activities on the cognitive tempo of preschool children. To address this, the study sought answers to the following question:

Do coding activities affect the cognitive tempo of preschool children?

Sub-Aims of the Research:

Based on the main purpose of the research, the following questions were addressed:

- Do coding activities affect preschool children's response time scores on the Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP - Form A)?
- Do coding activities affect the number of error scores of preschool children on the "Kansas Reflection–Impulsivity Scale for Preschoolers" (KRISP – Form A)?

METHOD

Research Model:

In order to examine the effects of coding activities on the cognitive tempo of preschool children, a quasi-experimental model with a pre-test post-test control group was used. Group assignment was somehow made from existing groups. Therefore, a full design was not used in the study.The experimental model aims to examine the cause-and-effect relationship between variables. In the pretest-posttest control group model, two groups were created through unbiased assignment: the experimental group and the control group. Data were collected in two stages for both groups—before and after the experiment. In this regard, the independent variable of the study was determined as "Coding Activities," and the dependent variable was "Cognitive Tempo of Preschool Children."

Study Group

The study group of the research consisted of children aged 5-6 years who received pre-school education in a kindergarten in Selçuklu district of Konya province in the 2021-2022 academic year. Consent forms

were obtained from the participants' families stating that they voluntarily participated in the study.A total of 25 children were included in the study, 13 in the experimental group and 12 in the control group. Demographic characteristics of the experimental and control groups are presented in Table 1.

Table 1.

Demographic Characteristics of the Experimental and Control Groups

		Gender			Age		
		Girl	Boy	Total	5 Years	6 Years	Total
Experimental Group	*n*	8	5	13	11	2	13
	%	61.5	38.5	100	84.6	15.4	100
Control Group	*n*	8	4	12	1	11	12
	%	66.7	33.3	100	8.3	91.7	100

The experimental group consists of 13 children, 8 (61.5%) girls and 5 (38.5%) boys. It is known that 11 of these children (84.6%) are 5 years old and 2 (15.4%) are 6 years old. The control group consists of a total of 12 children, 8 (66.7%) girls and 4 (33.3%) boys. 1 of these children (8.3%) is 5 years old, and 11 (91.7%) are 6 years old.

Data Collection Tools and Processes

KRISP – form A

The Reflection – Impulsivity Scale for Preschoolers – Form A (KRISP – Form A) was developed by Wright (1971) to unveil the cognitive styles of preschool children. Seçer and colleagues (2010) conducted validity and reliability studies to adapt the scale to Turkish. For the reliability study, 30 students in preschool education were assessed by two observers. In the evaluation of students' reaction times in the KRISP - Form A, the correlation between the two observers for reaction time was found to be 0.83, and the number of errors was 0.78. As an additional indicator of the reliability of the KRISP - Form A, a test-retest reliability examination was conducted. Accordingly, 303 samples receiving preschool education were identified.

KRISP – Form A was administered twice to the sample with a two-week interval. Following the application, the Pearson Moment Correlation Coefficient between the two application scores was examined. As a result, the number of errors for the KRISP – A Form was found to be 0.74, and the response time was 0.89 (Seçer et al., 2010). The findings from the two separate applications of KRISP – A Form on the same group revealed a positive and significant relationship ($p < 0.01$). Based on the research results, it was determined that the consistency of KRISP - A Form between the two applications was at an acceptable level. The Spearman–Brown Correlation Coefficient for the reaction time of KRISP – A Form was determined as 0.85, and the number of errors was 0.71.

Within the scope of KRISP – Form A, the time until the first correct or incorrect answer is given is expressed in seconds after each stage. In the context of KRISP – A Form, the term 'number of errors' refers to the total number of incorrect answers given at each stage until the correct answer is found (Seçer et al., 2010).

Within the scope of KRISP - A Form, students are categorized as 'Fast Correctors,' 'Slow Correctors' (reflectives), 'Fast Incorrectists' (impulsives), and 'Slow Incorrectists' based on the median of the entire group and the division system of the number of errors along with response time scores, as outlined below:

• Fast Correctors: Refers to students within the scope of KRISP – A Form who make errors below the median and have a response time below the median.

• Slow Correctors (Reflectives): Refers to students within the scope of KRISP – A Form who make errors below the median and have a response time above the median.

• Fast Incorrectists (Impulsives): Refers to students within the scope of KRISP – A Form who make more errors than the median and have a response time below the median.

• Slow Incorrectists: Refers to students within the scope of KRISP – A Form who make more errors than the median and have a response time above the median.

KRISP – Form A consists of 10 items and 10 shapes. In the initial stage of administering the KRISP – A Form, the total time taken by each child to respond to the first appearance of the 10 shapes, and the overall number of errors made by them, are coded separately.

Data Collection Process and Application

During the two-day pretest phase, researchers collected scores from both the experimental and control groups using the Kansas Reflection-Impulsivity Scale for Preschool. The participants were individually brought to a designated environment for the pretest, ensuring it was quiet and suitable for their developmental level. No negative situations were encountered during this process.

Coding activities, averaging 60 minutes, were implemented twice a week in the classrooms where the children were studying for the experimental group. Before each session, researchers organized the classroom environment according to the planned activity.

In addition to the Republic of Turkey Ministry of National Education's preschool education program, the experimental group underwent 20 sessions of Coding Activities created by researchers over 10 weeks, twice a week. Meanwhile, the control group continued their regular preschool program without any additional intervention.

Following the completion of coding activities, the KRISP was readministered to both experimental and control groups, and the post-test scores of the children were recorded.

Analysis of Data

If the total number of participants in the experimental and control groups is less than 30, non-parametric tests are used in the research. In the study, the data obtained from the data collection tools were analyzed using the SPSS 25.0 software package. The significance of the difference between scores was tested at a significance level of .05. To determine the analyses to be applied to the collected data, it was checked whether the data exhibited a normal distribution. The results of the normality test are presented in Table 2.

Table 2.

Values of Data Regarding Normality Test

	Shapiro-Wilk	*p*
KRISP-A Formu (Response Time Pretest)	0.781	0.000
KRISP-A Formu (Number of Errors Pretest)	0.900	0.019

KRISP-A Formu (Response Time Pretest)	0.859	0.003
KRISP-A Formu (Number of Errors Pretest)	0.919	0.049

As a result of the Shapiro-Wilk test for KRISP, it was concluded that the data did not follow a normal distribution since p was < .05. Therefore, non-parametric tests were chosen for the data analysis in the study. Consequently, the Mann-Whitney U Test and the Wilcoxon Signed Rank Test were utilized to analyze the data.

FINDINGS

To see whether the control and experimental groups are equivalent, the results regarding the children's pre-test mean scores on KRISP – Form A are given in Table 3.

Table 3.

Mann Whitney U Test Results Regarding Pre-test Scores of Experimental and Control Groups

KRISP-A Form	Groups	n	X	S.S.	Mean Rank	Rank Sum	U	p
Response Time	Experiment Group	13	63.46	23.52	15.31	199.00	48.00	.103
	Control Group	12	54.21	24.62	10.50	126.00		
	Total	25						
Number of Errors	Experimental Group	13	3.76	3.05	11.62	151.00	60.00	.322
	Control Group	12	4.66	2.34	14.50	174.00		
	Total	25						

p<.05*

When examining Table 3, it is evident that there is no statistically significant difference in response time in the average pre-test scores between the experimental and control groups (U=48.00, p > .05). It was observed that there was also no statistically significant difference between the pre-test average scores of the experimental and control groups regarding the number of errors (U=60.00, p > .05). These values confirm that there is no statistically significant difference between the pre-test scores of the experimental and control group children, indicating that the cognitive tempos of the groups are statistically equivalent.

The following results were obtained in the research conducted to examine the effect of coding activities on the cognitive tempo of children aged 5-6. Post-test scores and error numbers of children in the experimental and control groups regarding KRISP – Form A were analyzed with the Mann-Whitney U test, and the results are presented in Table 4.

Table 4.

Mann Whitney U Test Results Regarding Post-test Scores of Experimental and Control Groups

KRISP-A Form	Groups	n	X	S.S.	Mean Rank	Rank Sum	U	p
Response Time	Experiment Group	13	51.44	14.08	15.15	197.00	50.00	.128
	Control Group	12	45.11	20.40	10.67	128.00		
	Total	25						
Number of Errors	Experimental Group	13	2.69	1.31	12.50	162.50	71.50	.718
	Control Group	12	2.91	1.78	13.54	162.50		
	Total	25						

p<.05*

According to the results in Table 4, there is no statistically significant difference among the post-test scores of the experimental and control groups regarding response time (U=50.00, p>.05). It was observed that there was no statistically significant difference among the post-test mean scores of the experimental and control groups regarding the number of errors (U=71.50, p>.05). Therefore, it can be said that coding activities have no effect on the post-test response time and number of errors of the experimental and control groups.

The pre-test and post-test scores of the experimental group children regarding response time and number of errors were analyzed with the Wilcoxon Signed-Rank Test and the results are given in Table 5.

Table 5.

Wilcoxon Signed Rank Test Results for Pretest and Posttest Scores of the Experimental Group

KRISP-A Form		n	Mean Rank	Rank Sum	z	p
Response Time	Negative rank	10	7.70	77.00	-2.201	**.028***
	Positive rank	3	4.67	14.00		
	Equal	0				
	Total	13				
Number of Errors	Negative Rank	5	6.00	30.00	-.905	.365
	Positive Rank	4	3.75	15.00		
	Equal	4				
	Total	13				

p<.05*

As seen in Table 5, a statistically significant differentation was observed between the pre-test and post-test scores regarding the response time of the children in the experimental group (z = -2.201, p <.05). No statistically significant differentation was observed between the pre-test and post-test scores regarding the number of errors of the children in the experimental group (z = -.905, p>.01). The response time of the children who received coding activities decreased after the application, and no change was observed in the number of errors.

Pre- and post-test scores of control group children regarding response time and number of errors were analyzed with the Wilcoxon Signed-Rank Test and the results are given in Table 6.

Table 6.

Wilcoxon Signed Rank Test Results for Pre-test and Post-test Scores of the Control Group

KRISP-A Form		n	Mean Rank	Rank Sum	z	p
Response Time	Negative rank	9	7.78	70.00	-2.432	**.015***
	Positive rank	3	2.67	8.00		
	Equal	0				
	Total	12				
Number of Errors	Negative Rank	9	6.22	56.00	-2.059	**.039***
	Positive Rank	2	5.00	10.00		
	Equal	1				
	Total	12				

p<.05*

When Table 6 is examined, it is seen that there is a statistically significant difference in response time (z = -2.432, p <.05) and number of errors (z = -2.059, p <.05) between the pre-test and post-test scores of the control group children. There was a decrease in the response times and number of errors of children who received a traditional preschool education program.

DISCUSSION

In the study, the effects of coding activities conducted for preschool children on their cognitive tempo were examined. Coding sessions were carried out in a total of 20 different sessions, twice a week for 10 weeks. As a result of the research, the post-test scores of the children in the experimental and control groups using KRISP - Form A were examined, and no statistically significant difference was observed between the post-test scores concerning the response time of the experimental and control groups. As a result of the analysis in terms of the number of errors, no statistically significant difference was found between the post-test average scores of the experimental and control groups.

As a result of the analysis conducted to determine whether there was a statistically significant difference between the pre-test and post-test scores regarding the response time and number of errors of

the children in the experimental group, it was concluded that there was a statistically significant difference between the pre-test and post-test scores regarding the response time of the children in the experimental group. However, it was determined that there was no statistically significant difference between the pre-test and post-test scores regarding the number of errors of the children in the experimental group. Based on these two findings of the study, the response time of children who received coding activities decreased after the application and no change was observed in the number of errors. In other words, coding activities shortened the response time of preschool children and supported children to respond faster.

Yüce (2023), in his experimental design study examining the effect of SCAMPER activities on the cognitive tempo of preschool children, revealed that SCAMPER activities reduced the response time and number of errors of the experimental group children, in other words, SCAMPER activities positively affected the cognitive tempo of preschool children. It is known that the SCAMPER technique is a technique that enables the child to find more than one solution when faced with any problem situation and encourages the child to find creative solutions. Coding activities also increase children's creativity, enable them to acquire problem-solving and analytical thinking skills, and enable them to produce solutions to an existing problem using different skills. When looked at in this context, it can be seen that SCAMPER technique and Coding applications contain similar gains. It seems that the results of the study conducted by Yüce (2023) support this finding of the research.

The analysis conducted to determine whether there is a statistically significant difference between pre-test and post-test scores of the control group children in terms of response time and the number of errors revealed that there is a statistically significant difference. In other words, a decrease in response time and the number of errors was found in the control group children.

Seçer and colleagues (2009) found, among the results obtained from their study examining the cognitive tempo of a total of 1276 children aged between 4 and 7 attending preschool education in terms of different variables, that there is a decrease in the number of errors as the children's ages advance. This suggests that the higher average age of the children in the control group compared to those in the experimental group may also have an impact on this finding of the research.

In experimental design research, although no differences are anticipated between the pre-test and post-test scores of the control group, the children in the control group actively continued to receive preschool education throughout the implementation period. It is assumed among the hypotheses that the gains achieved during this period may have a positive impact on the cognitive tempo of preschool children. In this study, a statistically significant difference was observed in the response time and number of errors in the control group. In Ergin's (2020) study, which investigated the impact of activities in Tübitak's "Meraklı Minik Dergisi" on the cognitive tempo of children in the 48-60 month preschool period, it was revealed that the response times of children in the control group also decreased in the post-test.

In his 2019 study, Konyaoğlu aimed to examine the impact of robotic coding education on the problem-solving skills of middle school children. He designed a five-week experimental research, and the results of the study revealed that the five-week robotic coding education had a statistically positive effect on the problem-solving skills of the children.

CONCLUSION

As a result, this study examines the effects of coding activities on the cognitive tempo of preschool children, aiming to increase their imagination and creativity, improve problem-solving skills, enable the

generation of different solutions to existing problem situations, and support cognitive thinking skills by transferring these solutions to similar problem situations. It was determined that there was a decrease in the response time of the experimental group children who received coding activities. In other words, coding activities supported the ability of preschool children to respond faster.

SUGGESTIONS

The recommendations based on the results of the research are as follows:

- The impact of coding activities on the cognitive tempo of preschool children has been in

- Vestigated in the study. In parallel with this research, experimental studies can be conducted to examine the effects of coding activities on other cognitive styles.

- The study group of the research consists of preschool children. It is known that coding activities are also used with children in primary and secondary education. Therefore, studies can be conducted by creating different study groups with diverse characteristics, examining the impact of coding activities on cognitive tempo in primary and secondary school-age children.

- In this study, coding activities have been broadly addressed to create a program. Specific types of coding activities such as robotics coding, block coding, screenless coding, etc., can be customized to create programs, and the effects of these programs on children's cognitive tempos can be investigated.

- Preschool teachers can be provided with training on how to create activities for children with different cognitive tempos. Specifically, training can focus on developing activities that enhance the attention span and encourage accurate responses for impulsive children.

Ethics Committee Approval

This research was found ethically appropriate by the Selçuk University Faculty of Health Sciences Non-invasive Clinical Research Ethics Committee decision dated 31.03.2022 and numbered 2022/271.

Author Contributions

Research Design (CRediT 1) Author 1 (%10) – Author 2 (%80) – Author 3 (%10)

Data Collection (CRediT 2) Author 1 (%30) – Author 2 (%10) – Author 3 (%60)

Research - Data analysis - Validation (CRediT 3-4-6-11) Author 1 (%60) – Author 2 (%40) – Author 3 (%00)

Writing the Article (CRediT 12-13) Author 1 (%70) – Author 2 (%30) – Author 3 (%00)

Revision and Improvement of the Text (CRediT 14) Author 1 (%60) – Author 2 (%40) – Author 3 (%00)

Finance

This study was not supported by any other institution. No financial support was received during the research process.

Conflict of Interest

No financial support was received during the research process. There is no conflict of interest in this study.

REFERENCES

Bers, M. (2008). Blocks to robots: Learning with technology in the early childhood classroom. New York: Teachers College Press

Demir, B. E. & Demir, F. (2021). Coding, Robotics and Computational Thinking in Preschool Education: The Design of Magne-Board. European Journal of Science and Technology, (23), 52-61.

Demirer, V. and Sak, N. (2016). Programming Education and New Approaches Around The World and in Turkey. Theory and Practice in Education, 12 (3), 521-546. Retrieved from https://dergipark.org.tr/tr/pub/eku/issue/26697/280853

Ergin G, (2020). Investigation of the effects of activities in the TÜBİTAK Meraklı Minik magazine on social skills and cognitive tempo levels in preschool children (48-60 months). Master's Thesis, Dumlupınar University Graduate Education Institute, Kütahya.

Gander, M. J. and Gardiner H.W. (2001). Child and adolescent development. (A. Dönmez, N. Çelen and B. Onur, Trans.) Ankara: İmge Kitabevi.

Gargallo, B. (1993). Basic variables in reflection-impulsivity: A training programme to increase reflectivity. European Journal of Psychology of Education, 8(2), 151-167.

Kagan, J., Rosman, B. L., Day, D., Albert, J., & Phillips, W. (1964). Information processing in the child: Significance of analytic and reflective attitudes. Psychological Monographs, 78 (1), 578.

Karasar N. (2009). Scientific research method. Ankara, Nobel Publishing

Keleş E. and Çepni S., (2006), Brain and Learning, Turkish Science Education Journal, Year 3, Issue 2, December.

Konyaoğlu (2019), The Effects of Robotic Coding Education on Problem Solving Skills of Secondary School Students and Students' Views on Robotic Coding Activities. Master's Thesis. Bolu Abant İzzet Baysal University, Institute of Educational Sciences. Bolu

Odacı, M. M., and Uzun, E. (2017). Information Technologies Teachers' Views on Coding Education and Usable Tools in Preschool: A Case Study. 11th International Computer and Educational Technologies Symposium (pp. 702-709). Malatya: İnönü University.

Özbey T. (2018). Coding Education and Coding Tools in Preschool Period. Discussion Texts. Istanbul Commerce University, Social Sciences Institute, Department of Family Education and Counseling, Family Education and Counseling

Secer Z, Çeliköz N, Yaşa S. (2008). Cognitive styles of preschool children According to the understanding of moral and social rules. Selcuk University Social Sciences Institute Journal, 20, 561 – 576.

Secer Z, Sari H, Celikoz N, Ure O, (2009). Investigation of cognitive styles of preschool children in terms of some variables. Selcuk University Social Journal of the Institute of Sciences, 21, 407.

Secer Z, Çeliköz N, Koçyiğit S, Seçer F, Kayılı G. 2010. Social skills and problem behaviors of children with different cognitive styles who attend preschool education. Australian Journal of Guidance and Counselling, 20(1), 91 – 98.

Tozduman Yaralı, K. & Güngör Aytar, F. A. (2019). Investigation of Self-Perception of Preschool Children According to Their Cognitive Tempo. Journal of Social Sciences And Education, 2 (2), 287-299. Retrieved from https://dergipark.org.tr/tr/pub/josse/issue/49908/594370

Ünsal L. (2019). Examining the views of preschool and primary school administrators on coding education (Bağcılar district example). Institute of Social Sciences.

Yüce M. (2023)., The Effect of Scamper Applications on the Cognitive Tempo of Preschool Children,

Master's Thesis. Selçuk University Institute of Health Sciences. Konya

Zelniker, T., & Jeffrey, W. E. (1979). Attention and cognitive style in children. In G. H. Hale & M. Lewis (Eds.), Attention and cognitive development (pp. 275–293). New York: Plenum Press

Investigation of the Reflections of Prospective Science Teachers' Preferred Assessment and Evaluation Approaches on Lesson Plans

Serpil KARA[1]*

[1]Prof. Dr., Necmettin Erbakan University, Ahmet Kelesoglu Education Faculty, Science Education Department, Konya, Türkiye

Article Info	**ABSTRACT**
	The aim of the study is to examine the assessment and evaluation approaches preferred by pre-service science teachers through the lesson plans they prepared within the scope of Teaching Practice 1 course. The lesson plans prepared by the pre-service teachers were analysed in terms of the assessment and evaluation techniques they preferred according to the science subject areas and the distribution of the subjects according to the grade levels. The study was conducted with the document analysis method. In the study, lesson plans prepared by 65 prospective science teachers were analysed. The data obtained were analysed by document analysis and Excel program. The results demonstrated that pre-service science in the lesson plans prepared by the teachers, they mostly preferred traditional assessment and evaluation techniques, and among the traditional techniques, they mostly preferred physics subjects and mostly preferred multiple-choice tests and true-false techniques. Among alternative techniques, they mostly preferred biology subjects, and in biology subjects, they mostly preferred the structured grid technique. In the findings related to the distribution of the subjects in which they used assessment and evaluation techniques according to grade levels, it was found that pre-service teachers mostly preferred the subjects at the 5th and 6th grade levels, and in these subjects, they preferred true-false techniques from traditional techniques at both grade levels. Among the alternative techniques, structured grid and diagnostic branched tree techniques at the 5th grade level, concept map at the 6th grade level. 8th grade level subjects are included at a limited level.

Fen Bilgisi Öğretmeni Adaylarının Tercih Ettikleri Ölçme ve Değerlendirme Yaklaşımlarının Ders Planlarına Yansımalarının İncelenmesi

ÖZET

Araştırmanın amacı, fen bilgisi öğretmeni adaylarının öğretmenlik uygulaması 1 dersi kapsamında hazırladıkları ders planları aracılığıyla tercih ettikleri ölçme ve değerlendirme yaklaşımlarının incelenmesidir. Öğretmen adaylarının hazırladıkları ders planları, fen bilgisi konu alanlarına göre ve konuların sınıf düzeylerine göre dağılımında tercih ettikleri ölçme ve değerlendirme teknikleri bakımından değerlendirilmiştir. Bu çalışmada durum çalışması araştırma metodolojisi ve veri toplama aracı olarak doküman analizi yöntemi kapsamında dokümanlar kullanılmıştır. Fen bilgisi öğretmen adaylarının öğretmenlik uygulaması I dersi kapsamında hazırladıkları ders planları doküman olarak ele alınmış, öğretmen adaylarının ölçme ve değerlendirme yaklaşımlarına ilişkin tercihleri analiz edilmiştir. Araştırmanın verilerini 2023-2024 eğitim-öğretim yılı güz döneminde öğretmenlik uygulaması I dersini alan ve bu ders kapsamında fen bilgisi öğretmen adaylarının (N=65) hazırladıkları ders planları oluşturmaktadır. Elde edilen verilerin doküman analizinde Microsoft Excel programı kullanılmıştır. Analiz sonuçlarına göre öğretmen adayları hazırladıkları ders planlarında en fazla geleneksel ölçme ve değerlendirme tekniklerini tercih ettikleri, geleneksel tekniklerden en fazla fizik konularını ve bu alanda çoğunlukla çoktan seçmeli test ve doğru-yanlış tekniklerini tercih ettiği, alternatif tekniklerden ise en fazla biyoloji konularını, bu alanda ise en fazla yapılandırılmış grid tekniğini tercih ettikleri tespit edilmiştir. Ölçme ve değerlendirme tekniklerini kullandıkları konuların sınıf düzeylerine göre dağılımına ilişkin bulgularında ise, öğretmen adayları çoğunlukla 5. ve 6. sınıf düzeylerindeki konuları tercih ettikleri, bu konularda ise geleneksel tekniklerden her iki sınıf düzeyinde de doğru-yanlış teknikleri tercih ettikleri saptanmıştır. Alternatif tekniklerden 5. sınıf düzeyinde en fazla yapılandırılmış grid ve tanılayıcı dallanmış ağaç tekniği tercih edilirken 6. sınıf düzeyinde ise kavram haritasının tercih edildiği sonuçlarına ulaşılmıştır. 8. sınıf düzeyi konularına ise sınırlı düzeyde yer verdikleri görülmektedir. Çalışmanın bulguları ışığında önerilere yer verilmiştir.
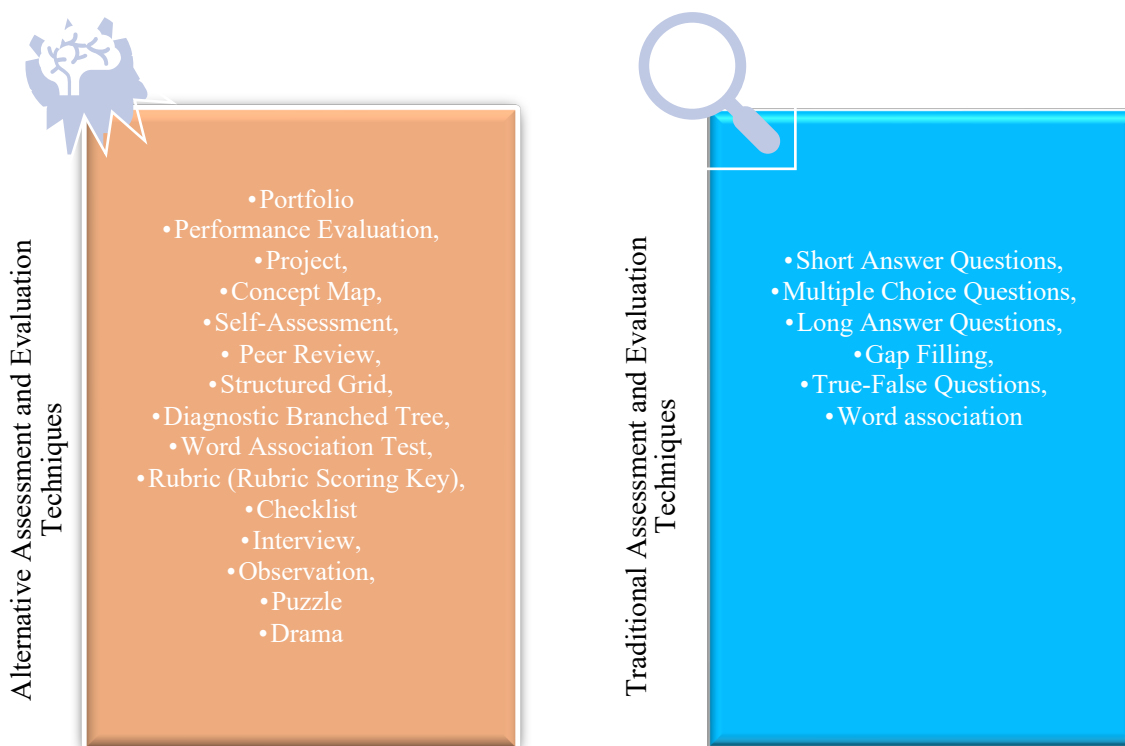
*Corresponding Author: Serpil KARA, *serpilkara@erbakan.edu.tr*

INTRODUCTION

Rapid changes and developments in the fields of science and technology in the global context have brought about differences in the needs of individuals and societies. The differentiation of the roles expected from individuals within the scope of changing needs has also led to significant changes in the learning and teaching processes of individuals. Assessment and evaluation approaches play an important role in tracking the development and change of individuals, managing the improvement process and using resources effectively (Can, 2007; Özer, 2009). One of the educational inputs that enhance both academic and administrative work in higher education institutions is resource management (Akpan & Etor, 2015). According to Akpan & Etor (2015), the purpose of resource management in higher education is to produce quality graduates who can contribute meaningfully to the development of the nation. For this reason, it is important to evaluate the learning outcomes of prospective teachers in order to ensure that they have the necessary skills, knowledge and competence. There are at least three purposes for educational assessment: formative assessment to aid learning in the classroom; summative assessment for use at the classroom, school, or district level to determine student achievement levels; and program evaluation for comparison across classrooms, schools, districts, states, or countries. In the findings related to the distribution of the subjects in which they used assessment and evaluation techniques according to grade levels, it was found that pre-service teachers mostly preferred the subjects at the 5th and 6th grade levels, and in these subjects, they preferred true-false techniques from traditional techniques at both grade levels. Among the alternative techniques, structured grid and diagnostic branched tree techniques at the 5th grade level, concept map at the 6th grade level. 8th grade level subjects are included at a limited level researchers to study how new assessment methods can be used in classrooms, how assessments can be designed so that they are administered fairly to all students, and how various forms of assessment affect student learning, teacher practice, and educational decision-making (National Research Council (NRC), 2012)

Diversity arising from different factors in education (i.e., individual, educational level, course content, social environment, school facilities, etc.) plays an important role in ensuring the effectiveness and efficiency of assessment and evaluation practices. It is seen that alternative assessment and evaluation, which includes multi-focused assessment and evaluation approaches that can take into account individual differences, are included under different titles in the literature (DiMartino, Castaneda, Brownstein, & Miles 2007; Hamayan, 1995; Tan, 2019). The main purpose of using alternative assessment and evaluation techniques in the evaluation of classroom learning is to reveal what students can do, not what they have done, and to measure skills that cannot be measured by traditional assessment and evaluation methods (Dilmaç & Dilmaç, 2020). There are many different types of alternative assessment such as performance assessment, self-assessment, portfolio, peer assessment, journals, and student-teacher discussions (Bland & Gareis, 2018; Singh, Muhammad, Mostafa, Yunus, Noordin, & Darmi, 2022). In addition to offering new ways and approaches that motivate and inspire students to learn, alternative assessment types assess students' language skills on the basis of the originality of their language use (Alokozaya, 2022), encourage students to take responsibility as they evaluate the learning product together with the process (Ministry of National Education, 2018), and help educators measure mental and artistic processes more accurately and help students organize their own processes (Dilmaç & Dilmaç, 2020). Alternative assessment and evaluation techniques and traditional techniques in the literature are presented in Figure 1. (Bahar et al., 2015; Başol, 2015; Özenç, 2013):

Figure 1
Assessment and evaluation techniques

Alternative Assessment and Evaluation Techniques

- Portfolio
- Performance Evaluation,
- Project,
- Concept Map,
- Self-Assessment,
- Peer Review,
- Structured Grid,
- Diagnostic Branched Tree,
- Word Association Test,
- Rubric (Rubric Scoring Key),
- Checklist
- Interview,
- Observation,
- Puzzle
- Drama

Traditional Assessment and Evaluation Techniques

- Short Answer Questions,
- Multiple Choice Questions,
- Long Answer Questions,
- Gap Filling,
- True-False Questions,
- Word association

Purpose and Importance of Research

In the Ministry of National Education (MoNE) (2018) program, it is stated that the measurement and evaluation process being "suitable for everyone", "valid and standardized for everyone" is contrary to the nature of human beings and therefore, it is emphasized to act with the understanding of maximum diversity and flexibility in the measurement and evaluation process. On the other hand, the Higher Education Institutions (CoHE, 2018), which has an important contribution to the training of future teachers, has added the course of 'evaluation of classroom learning' to the science teaching undergraduate program, which is taken by 4th grade students as a field education elective course. When this situation is evaluated in the global context, in recent years the collection of assessment methods used especially in higher education has greatly expanded (Alokozaya, 2022) and their use in different disciplines and different fields has increased (Dilmaç & Dilmaç, 2020). The fact that pre-service teachers take the 'measurement and evaluation in education' course as well as the 'assessment of classroom learning' course in their undergraduate education shows that measurement and evaluation has an important place in education and training and that pre-service teachers are trained in the best way in this regard. However, it is also important to evaluate the efficiency of this situation, that is, how effective the assessment of classroom learning course taken by pre-service teachers is and how much pre-service teachers can reflect the information they have received in this course to other fields. On the other hand, it is thought that with the current study, On the other hand, this study can provide insights into

determining the extentthe extent to which pre-service teachers can reflect the information they have received in the 'assessment of classroom learning' course to the 'teaching practice I' course content, which they are independent of this course, in line with the objectives determined as the answer.

Within higher education, especially in teacher education undergraduate programs, importance to train qualified and competent teacher candidates in order to make an effective contribution to national development. In this context, it is necessary not only to provide prospective teachers with theoretical knowledge but also to meet their expectations regarding their practical experiences before graduation. In particular, the evaluation of pre-service teachers' education at the 4th grade level is a critical stage in terms of their preparation for their teaching careers.

Evaluating serves as a key factor the degree to which pre-service teachers reflect the knowledge gained from the "assessment of classroom learning" course to other fields of education. This study aims to determine how pre-service teachers associate the knowledge they acquire from this course with the content of the "Teaching Practice I" course. In this context, revealing to what extent this information is effective in the lesson plans of the pre-service teachers during the adaptation process to the field will make a valuable contribution to the efficiency of the "Teaching Practice II" course that they will take in the second semester of the 4th grade.

In addition, considering the pre-service teachers' measurement and assessment preferences before graduation, it is aimed to assess the extent to which alternative measurement and assessment approaches in the updated curricula (MoNE; 2018, 2024) are adopted. This evaluation has the potential to guide researchers in the field and hopes to contribute to the development of innovative and effective teaching approaches.

Literature review

In a study evaluating the frequency of teachers' use of traditional and alternative assessment tools and strategies, it was found that teachers preferred to use traditional methods (Williams-McBean, 2022). Uygun and Saraç (2020), investigating pre-service classroom teachers' preferences for assessment and evaluation techniques were examined through lesson plans, demonstrated pre-service teachers' preference fortraditional assessment and evaluation techniques more. According to prospective primary school teachers, it was determined that it is appropriate to use alternative assessment and evaluation techniques in science subjects in order to realize permanent and meaningful learning (Palaz, 2022). As a result of the research on alternative assessment strategies and classroom practices of foreign language teachers, also they used traditional approaches as well as alternative assessment, and it was also found that teachers need to be exposed to current assessments that they can use in teaching and need training in this regard (Singh et al., 2022). In a similar study conducted with Turkish teachers, it was put forward that Turkish teachers did not use process-oriented complementary assessment and evaluation tools at a sufficient level and that traditional tools were preferred more by teachers (Türkben, 2022). Congruent with these results, Bulut et al. (2022) revealed that teachers predominantly preferred traditional methods (Bulut, Ceylan & Ceylan, 2022). On the other hand, students' perceptions of alternative assessment at university and school level were investigated and it was found that students had a positive perception of the application of alternative assessment (Alokozaya, 2022).

The existing literature embodies some studies conducted on the attitudes of teachers or pre-service teachers towards alternative assessment and evaluation (Avan et al., 2019), perceptions/opinions (Alokozaya, 2022; Alçın & İnanıcı, 2020; Bulut, Ceylan, & Ceylan, 2022; Karakuş, 2020; Kaya, 2018; Uygun, 2020), knowledge or usage levels (Singh et al., 2022; Şahin & Soylu, 2019; Williams-McBean, 2022; Yıldız & Yıldız, 2019), competencies (Çelebi & Kuşuçuran, 2019; Dilmaç & Dilmaç, 2020) or the effects of alternative assessment and evaluation approaches on students' academic achievement

(Bektüzün & Yel, 2019; Kepek & İzci, 2021) or attitudes (Aydoğdu, Tutak, & Kaya, 2020) as a result of their application to educational environments. In parallel with these results, in the analysis of the studies on alternative assessment and evaluation, it was found that there were studies in which the opinions of teachers / prospective teachers were mostly taken between 2008-2020 (Alokozaya, 2022; Şahin & Kaya, 2020). However, it was seen that the studies examining the level of transferring what they learned to another course content independently of the course they took remained at a limited level. Especially in terms of evaluating the ability of pre-service teachers to use and transfer the knowledge they have learned in one field to another field, this study is considered to be important in terms of evaluating the level of reflecting their knowledge of traditional or alternative assessment and evaluation approaches that they have learned while taking the course on the evaluation of classroom learning of the measurement and evaluation approaches preferred by pre-service teachers in the lesson plans they prepared in the Teaching Practice I course to other application areas without grade anxiety and will make important contributions to the literature. In this context, the research questions of the study are as follows:

In the lesson plans prepared by the prospective science teachers,

1- What are their preferred assessment and evaluation techniques?

2- What are the measurement and assessment techniques they prefer according to the subjects?

3- How is the distribution of the measurement and assessment techniques they use in subject areas according to grade levels?

METHOD

Research Design

In this study, case study research methodology was used. A case study can basically be defined as an intensive study about a person, a group of people or a unit, aiming to make generalizations about more than one unit (Heale & Twycross, 2017). As a data collection tool, documents were used within the scope of document analysis method. The document analysis method is the process of analyzing and interpreting written materials containing information about the phenomenon or phenomena under investigation (Yıldırım & Şimşek, 2018). This process involves the evaluation of data to create meaning and develop empirical knowledge (Bowen, 2009. age. p.27; cited in Özkan, 2021).

Document review is a method used for scientific research and provides research data by collecting, reviewing, questioning and analyzing various documents (O'Leary, 2017; Özkan, 2021). Documents that can be used in research can be agendas, attendance records, meeting minutes, manuals, notes, books, diaries, journals, program records, letters, charts, newspapers, artworks, program details, survey data, various public records and notebooks. These documents can be used as data sources for researchers (Labuschagne, 2003; as cited in Kıral, 2020). In the current study, the lesson plans prepared by pre-service science teachers within the scope of the Teaching Practice I course were handled as documents, and pre-service teachers' preferences for measurement and evaluation approaches were examined in terms of different variables.

Research Group

While determining the research group, convenience sampling, one of the purpose-oriented sampling methods, as well as criterion sampling methods were taken into consideration. Convenience sampling is the most frequently used but least desirable strategy in qualitative research (Patton, 2005). The aim of adopting this method is mainly related to its potential to lead (Bernard, 2011). In criterion sampling, as useful in terms of reflecting the characteristics of predetermined criteria to collect

information about targeted situations (Patton, 2014). While determining the research group, it was determined as a criterion that the pre-service teachers had taken measurement and evaluation, evaluation of classroom learning, Science Teaching I and II courses. The pre-service teachers completed all of these courses in the fall semesters of the 3rd and 4th grades. In this context, the pre-service teachers participating in the study meet the specified criteria. The data of the study consisted of the lesson plans prepared by pre-service science teachers (N=65) who took the Teaching Practice I course in the fall semester of the 2023-2024 academic year.

Collection of the Data

The data in the study were obtained from the lesson plans prepared by the prospective teachers for the subjects they were to teach in the internship schools within the scope of the Teaching Practice I course in accordance with the purpose of the research. According to the agreement signed between the Republic of Turkey MoNE (2018) and Council of Higher Education (CoHE, 2018) in line with the "Directive on the Teaching Practice of Prospective Teachers in Educational Institutions Affiliated to the Ministry of National Education" prepared by the Ministry of National Education General Directorate of Teacher Training and Education, prospective teachers have to fulfill the task of lecturing at least 4 (four) times during the practice period (MoNE, 2018; Article 7). However, this number is determined depending on the number of practicum students per practicum teacher. In this context, pre-service teachers are expected to plan the lesson for the subjects they will teach. Since the pre-service teachers were exposed to various teaching methods, approaches and models within the scope of the Science Teaching I and II courses they took in the 3rd grade, no criteria/limitations were imposed on the pre-service teachers in terms of both the method/model/approach they would use and the physical structure of the plan (such as giving a lesson plan template, including measurement and evaluation techniques/approaches in their plans). The pre-service teachers were not intervened in this regard. As a result, every lesson plan should include an assessment and evaluation section. In this context, the internship files submitted by the 4th grade pre-service teachers at the end of the Teaching Practice I course were collected and one lesson plan in this file was included in the evaluation. The lesson plan to be included in the evaluation was the first one among the plans in the internship file of each pre-service teacher. The reason for this is that a standard order was determined in the selection of the plans and the time period when all pre-service teachers first started their teaching practice courses was preferred. Since in the following weeks of the teaching practice courses, different mentor teachers in different practice schools and different faculty members working in the teaching practice course at the faculty will intervene in the lesson plans and their revision suggestions will be different, and this situation may affect the pre-service teachers' choices in the lesson plans, the first plans were evaluated with the idea that the evaluation would be healthier. The pre-service teachers prepared their lesson plans to cover one lesson hour (40 minutes) by using their knowledge of lesson plan preparation, which they frequently experienced in various course contents they took during their undergraduate education.

Analysis of the Data

The data were analyzed by document analysis in accordance with the nature of the research. The scholarly work indicates that the stages of document analysis are followed in different ways in the literature (Altheide & Sak, 2017; O'Leary, 2017), and based on these different stages, in the process of data analysis in the current research; data collection protocol, coding, data analysis -comparison- and reporting stages were followed (Sak et al., 2021). Within the scope of the research, a total of 65 lesson plans were analyzed. The measurement and evaluation section of the lesson plans were analyzed separately by the researcher and a faculty member who is an expert in science education, and codes and frequencies were determined. For the reliability of the study (Reliability= Agreement/Agreement + Disagreement x 100), the agreement between the coders was calculated (Miles & Huberman, 1994), and

as a result, 96% agreement was achieved. The remaining data were recorded by the researcher by creating codes for each of the measurement and evaluation techniques on the Microsoft Excel program and the necessary analyzes were made.

FINDINGS

In this section, firstly, the findings related to the assessment and evaluation techniques preferred by pre-service science teachers in the lesson plans they prepared are presented. Then, the findings related to the measurement and evaluation techniques they preferred according to the subject areas were presented.   Finally, the findings related to the distribution of the subject areas in which they used measurement and assessment techniques according to grade levels were presented.

Findings Related to the Assessment and Evaluation Techniques Preferred by Prospective Science Teachers in Their Lesson Plans

The findings regarding the assessment and evaluation techniques preferred by pre-service teachers are presented in Table 1.

Table 1
Assessment and evaluation techniques preferred by pre-service teachers in their lesson plans

Assessment and Evaluation Approaches	Assessment and Evaluation Techniques	frequency (f)
Traditional Assessment and Evaluation Techniques	Question and answer	7
	Open-ended questions	7
	Fill in the blank/short answer	10
	True-False	16
	Multiple choice test	24
	Pairing	7
	Total	**71**
Alternative Assessment and Evaluation Techniques	Concept map	4
	Structured grid	8
	Diagnostic branched tree	8
	Meaning analysis table	4
	Puzzle	1
	Concept network	2
	Mind map	1
	Total	**28**

According to the findings in Table 1, it is seen that pre-service teachers mostly preferred traditional assessment and evaluation techniques (f=71) in their lesson plans, while alternative assessment and evaluation techniques (f=28) were significantly less preferred. The analysis of the preference of pre-service teachers for traditional assessment and evaluation techniques demonstrated that the most preferred techniques were multiple-choice tests (f=24), and the least preferred techniques were question-answer and open-ended questions (f=7).   Among the alternative assessment and evaluation techniques, the most preferred techniques were structured grid and diagnostic branched tree (f=8) and the least preferred techniques were puzzle and mind map (f=1). The distribution of the frequencies of traditional and alternative techniques on the graph is shown in Figure 2.

Figure 2
Distribution of the frequency of preference of traditional and alternative techniques on the graph

Findings Related to The Assessment and Evaluation Techniques Preferred by Prospective Science Teachers in Their Lesson Plans According to Subject Areas

Table 2 shows the tendencies regarding the assessment and evaluation techniques preferred by pre-service teachers for physics, chemistry and biology subjects in their lesson plans.

Table 2

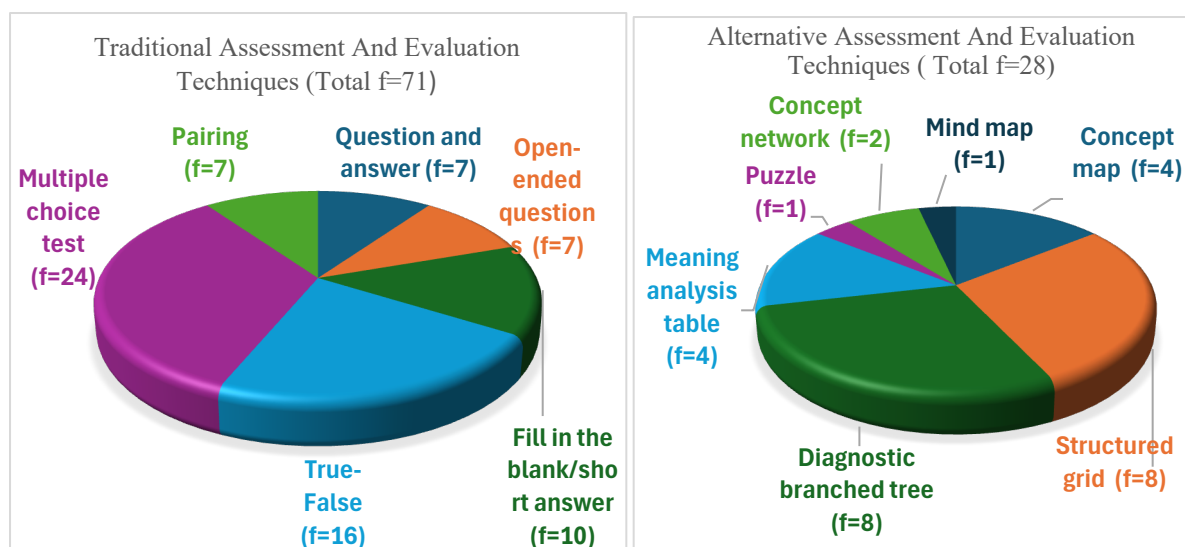*Assessment and evaluation techniques preferred by pre-service teachers in their lesson plans according to subject areas*

Assessment and Evaluation Techniques		Science subject areas		
		Physics (f)	Chemistry(f)	Biology (f)
Traditional Assessment and Evaluation Techniques	Question and answer	2	1	4
	Open-ended questions	6	-	1
	Fill in the blank/short answer	8	1	1
	True-False	10	1	5
	Multiple choice test	11	3	10
	Pairing	4	1	2
	Total	**44**	**7**	**23**
Alternative Assessment and Evaluation Techniques	Concept map	1	-	3
	Structured grid	2	1	5
	Diagnostic branched tree	3	4	1
	Meaning analysis table	1	-	3
	Puzzle	1	-	-
	Concept network	2	-	-
	Mind map	-	-	1
	Total	**10**	**5**	**13**

According to the findings in Table 2, pre-service teachers mostly preferred physics subjects (f=44) from traditional techniques in their lesson plans, and mostly preferred multiple-choice test (f=11) and true-false (f=10) techniques in physics subjects.

On the other hand, among the alternative techniques, pre-service teachers mostly preferred biology subjects (f=13), and in biology subjects, they mostly preferred the structured grid (f=5) technique. On the other hand, the least preferred traditional techniques were question and answer in physics (f=2), question-answer, fill-in-the-blank/answer, true-false and matching in chemistry (f=1),

open-ended questions and fill-in-the-blank/answer in biology (f=1); alternative techniques were concept map and semantic analysis table in physics (f=1), structured grid in chemistry (f=1) and diagnostic branched tree and mind map in biology (f=1).

Among the traditional techniques, open-ended questions in chemistry; among the alternative techniques, puzzles and mind maps in physics; semantic analysis table, puzzles, concept network and mind map in chemistry; and puzzles and concept network in biology were not preferred at all.

In general, pre-service teachers preferred chemistry subjects the least in both assessment and evaluation approaches.

Findings Related to The Distribution of Assessment and Evaluation Techniques Used by Prospective Science Teachers in Their Subject Areas According to Their Grade Levels

Table 3 presents the findings regarding the distribution of the assessment and evaluation techniques used by pre-service teachers in the subject areas of their lesson plans according to their grade levels.

Table 3
The distribution of the assessment and evaluation techniques used by pre-service teachers in their subject areas according to their grade levels

	Assessment and Evaluation Techniques	Physics subject area Class levels(f)				Chemistry subject area Class levels(f)				Biology subject area Class levels(f)			
		5.	**6.**	**7.**	**8.**	**5.**	**6.**	**7.**	**8.**	**5.**	**6.**	**7.**	**8.**
Traditional Assessment and Evaluation Techniques	Q. and ans.	3				1				1	1	2	
	Op-en Q.	3	3							1			
	Fill blank/short	4	3		1				1	1			
	True-False	6	2	1	1	1					5		
	Mul. C. test	3	1	5				2	1	2	2	2	4
	Pairing	2	1		2	1					2		
	Total	**21**	**10**	**6**	**4**	**3**	**-**	**2**	**2**	**3**	**12**	**2**	**4**
Alternative Assessment and Evaluation Techniques	Concept map			2							3		
	Structured grid	1	2						1	3	1		
	Diagnostic b.t	1	3			2					1		
	Mea. An. table										3		
	Puzzle												
	Concept net.		1										
	Mind map									1			
	Total	**2**	**1**	**7**	**-**	**2**	**-**	**-**	**1**	**4**	**8**	**-**	**-**

When Table 3, which shows the findings on the distribution of the assessment and evaluation techniques used by the pre service teachers in the subject areas in their lesson plans according to the grade levels. The pre-service teachers mostly preferred the subjects at the 5th (f=21) and 6th (f=12) grade levels. At the 5th grade level, mostly physics topics were used, and it was determined that they preferred the true-false technique (F=6) among the traditional techniques, while they preferred the structured grid and diagnostic branched tree technique (f=1) among the alternative techniques. At the 6th grade level, biology subjects were preferred the most, and it was observed that the true-false technique (f=5) was used the most among the traditional techniques, while concept map and semantic analysis table techniques (f=3) were used among the alternative techniques.

Conclusion and Discussion

In this study, the assessment and evaluation techniques selected by pre-service science teachers in line with their preferences in the lesson plans they prepared in the Teaching Practice I course and the distribution of these techniques according to subject and grade level components were examined. It was found that the pre-service teachers mostly preferred traditional assessment and evaluation techniques in their lesson plans and among these techniques, they mostly preferred multiple-choice test technique. Among the alternative assessment and evaluation techniques, pre-service teachers mostly used structured grid and diagnostic branched tree techniques in their lesson plans.

The current body of research integrates studies revealing that teacher (Duran, 2013; Okur, 2008; Williams-McBean, 2022) or pre-service teachers (Uygun & Saraç, 2020) mostly prefer traditional measurement and evaluation techniques in studies conducted in various time periods, which is in parallel with the results of the current study. While Uygun and Saraç (2020) concluded that the question-and-answer technique was preferred the most among the traditional techniques in their study, the current study indicated varied findings in that the multiple-choice technique is mostly preferred. Another situation that differs from the studies is that while performance/project assignments are mostly preferred among alternative techniques (Karakuş, 2020; Okur, 2008; Uygun & Saraç, 2020), structured grid and diagnostic branched tree techniques are the most preferred techniques in this study. Yunus (2018) took students' opinions about the alternative techniques used in the teaching process in a study and concluded that students enjoyed using structured grid and then diagnostic branched tree techniques the most. Similarly, Kepek and İzci (2021) and Halacı (2012) took the opinions of students about alternative techniques in their studies and concluded that students generally had positive opinions about the use of structured grid and diagnostic branched tree and wanted them to be used in teaching. When evaluated in the context of these positive opinions, the pre-service teachers' preference for these two techniques among the alternative techniques in their lesson plans reflects the consistency between the results. In addition, it is among the results that these techniques are significantly more effective in increasing academic achievement (Kepek & İzci, 2021).

Studies conducted in various countries and at different grade levels are generally conducted to determine students' perceptions or attitudes about alternative assessment and evaluation (Alokozaya, 2022; Ayu Fajarsari, 2016; Barnard Bachelor, 2017; Hameda Suwaed, 2018; Irawan, 2017). As a result of these studies, it was concluded that students' perceptions and attitudes towards the use of alternative techniques were positive. The fact that alternative techniques perceived positively by students are less preferred by teachers or pre-service teachers in national or international studies so far with the current study (Duran, 2013; Singh et al., 2022) is important and should be among the issues that need to be studied.

Another important issue that draws attention in the issue that of the current study but is not reflected in the findings because it is not included in any of the traditional or alternative assessment techniques categories in the literature is the Wordwall technique (f=13). Wordwall is defined as an online assessment tool that gamifies assessment categories such as question-answer, matching, short answer, multiple choice and true-false in the form of interactive tests (Khairunisa, 2021; Rahmasari, Murdiono, Sunarso, 2022; Shiddiq, 2021). Although Wordwall is technology-supported in accordance with today's conditions, it is noteworthy that it is based on traditional assessment and evaluation approaches, but it can also be used effectively in individual and group assessments. On the other hand, there is the "Scratch and Challenge Board" technique that has taken its place in literature under the name of alternative assessment techniques. This technique is defined as an alternative assessment that brings together different materials such as visuals, colors, and visual effects, and evaluates student performance through presentation, action, peer and group activities, or a combination of these through collaborative

visualization of creative ideas (Sulaiman et al., 2021). At the same time, when the content of CoHE (2018) science teaching undergraduate program is examined, the teaching of web 2.0 tools is among the subjects of the 'Material Design in Science Teaching' course in the 3rd grade and techniques such as Scratch and Wordwall are taught within the scope of this subject content. At this point, why did the pre-service teachers prefer the Wordwall technique, which reflects the traditional understanding, instead of the 'Scratch and Challenge Board' technique? As an answer to this question, although the opinions about alternative techniques are positive and support academic achievement, traditional methods cannot be easily abandoned.

The distribution of the subjects included in the lesson plans prepared by the prospective teachers is as follows. They included mostly physics and least chemistry subjects in traditional assessment and evaluation techniques and mostly biology and least chemistry subjects in alternative assessment and evaluation techniques. Based on these results, pre-service teachers prefer physics subjects and multiple-choice test technique among traditional techniques, while they prefer biology subjects and structured grid technique among alternative techniques, so they feel themselves more competent in these fields and techniques. On the other hand, it can be inferred that they did not feel themselves at a sufficient level because both techniques included chemistry subjects the least. When we look at the distribution of the questions in the PISA 2022 (OECD, 2023) exam, which measures science literacy at the international level, most of the questions are related to matter and therefore reflect chemistry topics. Therefore, it can be concluded that it is important to give importance to the preference of chemistry subjects in lesson plans and to utilize alternative assessment and evaluation techniques in this subject area.

When the findings related to the distribution of the subjects in which pre-service teachers used measurement and evaluation techniques in their lesson plans according to the grade levels were examined, it was found that pre-service teachers generally prepared their lesson plans by preferring the subjects at the 5th and 6th grade level. On the other hand, 8th grade level subjects are included at a limited level. It was observed that the pre-service teachers who went to the internship said that exam-oriented studies were carried out in the 8th grade, so mostly multiple-choice tests were used and alternative evaluations were given very little space. Based on the findings of the study, when analyzed according to the grade levels, it can be interpreted that the reason why pre-service teachers prefer the lesson plan the least at the 8th grade level is that these grade levels are more exam-oriented rather than lecturing and multiple-choice test questions are included. As a matter of fact, Williams-McBean (2022) concluded in his study that school policies requiring grade point averages and express positive attitudes towards exams affect teachers to use traditional methods despite the type of school. However, the fact that the lesson plans prepared by pre-service teachers mostly did not include alternative methods at the 5th and 6th grade levels, which was not in line with the expectations, was found to be a surprising finding despite the expected results of the study.

SUGGESTIONS

The results of the studies in the related literature show that teachers' knowledge and skills in participating in effective assessment practices need to be improved (Sewagegn, 2019; Organization for Economic Cooperation and Development [OECD], 2019). In order to determine what teachers need, it is important to identify current assessment practices and to be able to understand and explain these practices (Williams-McBean, 2022).

It was determined that answer keys (rubrics) related to the measurement and evaluation approaches preferred by the pre-service teachers in their lesson plans, which is considered as an important issue observed during the process of the study. Among the 4th grade undergraduate courses, within the scope of the 'assessment of classroom learning' course, theoretical knowledge of both

traditional and alternative techniques is given, the creation of a rubric for the measurement and evaluation technique used, the issues to be considered while creating it, and the information that this rubric should be added to the lesson plan.

Teaching practice is a period in which pre-service teachers are part of the education process. During this period, pre-service teachers can develop their teaching skills in one or more classrooms under the supervision of the teacher in charge. During this practicum, pre-service teachers follow the teachers in charge at their grade levels and teach lessons under their supervision. In this process, pre-service teachers may have different experiences and expectations depending on the grade levels and subjects. Pre-service teachers may think that the choice of a particular class and subject should be in accordance with their preferences. However, pre-service teachers' choice of grade level and subject matter in the teaching practicum process may not only depend on the pre-service teacher's preference. Since pre-service teachers had to follow teachers in charge of different grade levels in their internship schools, they may have had to choose the subject areas and grade levels reached in the study. Although the first lesson plans were taken into consideration in order to prevent these situations from affecting the study, different approaches and criteria can be considered in this regard. In our country, more detailed analysis of criteria such as the schools preferred within the scope of teaching practice, determination of responsible teachers, etc. can be made, and more comprehensive information can be obtained by examining the lesson plans within the scope of the teaching practice II course.

Another issue that was observed among the results of the study but not reflected in the findings of the study and considered to be important, was that the pre-service teachers mostly (N=57) prepared their lesson plans according to the 5E or 3E learning model and to a limited extent (N=8) according to the TGA (Prediction-Observation-Explanation) learning model. It is noteworthy that pre-service teachers mostly used the 5E or 3E learning model in their lesson plans although they learned many learning models, methods and approaches in the 'science learning and teacher approaches' course among the 2nd year undergraduate courses. The extent to which the selected learning models, methods and approaches can affect the lesson plan process and even the preferred assessment and evaluation approach can also be investigated.

Ethical Statement

In this study, qualitative research design was applied using document analysis method. In the document analysis method, there is no need for ethical permission as written materials containing information about the phenomenon or phenomena being analyzed are analyzed.

Author Contributions

Research Design, Data Collection, Research - Data analysis – Validation, Research - Data analysis – Validation, Writing the Article and Revision and Improvement of the Text (CRediT 1) Author 1 (%100)

Finance

No financial support was received for this study

Conflict of Interest

There are no conflicts of interest to declare

Sustainable Development Goals (SDG)

Sustainable Development Goals: 4 Quality Education (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all)

Sustainable Development Goals: 17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

REFERENCES

Akpan, C. &Etor, C. (2015). Resource management ın hıgher educatıon ın nıgerıa: problems and measures for ımprovement. 7th International Conference on Education and New Learning Technologies, Dates: 6-8 July.

Alokozaya, W. J. (2022). Students' perception of alternative assessment: A qualitative meta-analysis. *International Journal of Curriculum and Instruction 14*(2), 1419–1441.

Altheide, D. L., & Schneider, C. J. (2017). *Qualitative media analysis*. SAGE Publications.

Alçın, Ö. C., & İnanıcı, M. K. (2020). Müzik öğretmenlerinin ölçme ve değerlendirme sürecine ilişkin görüşlerinin incelenmesi. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi, 40*(2), 727-811.

Altunışık, M., & Aktürk, A. O. (2021). Türkiye'de Web 2.0 araçlarının eğitim-öğretim ortamlarında kullanımına bir bakış: 2010-2020 Dönemi Tezlerinin İncelenmesi. *Bilim, Eğitim, Sanat ve Teknoloji Dergisi (BEST Dergi), 5(2*), 205-227. https://doi.org/10.46328/bestdergi.66

Arslan, K., & Coştu, F. (2021). Web 2.0 applications in the teaching Process: A swot analysis. *Shanlax International Journal of Education, 9*(4), 460-479. https://doi.org/10.34293/education.v9i4.4238

Aydoğdu, M., Tutak, T., Kaya, S. (2020). Ortaokul 7. sınıf rasyonel sayılar konusunun öğretiminde kavram haritası kullanımının öğrencinin akademik başarısına ve tutumuna etkisi. *Turkish Journal of Educational Studies, 7*(3), 79-85.

Ayu Fajarsari, L. (2016). *Students' perceptions to alternative assessment ın english learning at sma kristen satya wacana salatiga*. Undergraduate Thesis. Universitas Kristen Satya Wacana, Salatiga.

Avan, Ç., Akbaş, V., & Gülgün, C. (2019). Öğretmenlerin ölçme değerlendirmeye yönelik tutumları: Kastamonu örneği. *Gazi Eğitim Bilimleri Dergisi, 5*(3), 20-31. DOI: https://dx.doi.org/110.30855/gjes.2019.05.03.002

Bahar, M. Nartgün, Z., Durmuş, S. ve Bıçak, B. (2015). Geleneksel-tamamlayıcı ölçme ve değerlendirme teknikleri öğretmen el kitabı. Ankara: Pegem Akademi.

Barnard Bachelor, R. (2017). Alternative assessments and student perceptions in the world language classroom. *TFLTA Journal, 6*, 30-44.

Başol, G. (2015). *Eğitimde ölçme ve değerlendirme.* Ankara: Pegem Akademi.

Bektüzün, B. & Yel, M. (2019). Canlıların sınıflandırılması ve biyolojik çeşitlilik konusunun kavram

haritası ile öğretimin 9. sınıf öğrencilerinin akademik başarılarına etkisi. Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi, 39(1), 91-113.

Bernard, H. R. (2011). Research methods in anthropology: Qualitative and quantitative approaches. New York: Rowman Altamira.

Bland, L.M., & Gareis, C.R. (2018). Performance assessments: A review of definitions, quality characteristics, and outcomes associated with their use in K-12 schools. *Teacher Educators' Journal, 11*, 52-69.

Bulut F, Ceylan D. & Ceylan B. (2022). Investigation of the assessment and evaluation methods used in primary school in accordance with teachers' opinions. *BSJ Pub Soc Sci, 5*(2): 48-55.

Can, N. (2007). Prımary educatıon school admınıstrators' profıcıency level as ınstructıonal leaders ın developıng and applyıng new currıcula. *Journal of Theory and Practice in Education, 3*(2):228-244

Council of Higher Education (CoHE, 2018). The higher education system in Türkiye. https://www.yok.gov.tr/en

Çelebi, M. & Kuşuçuran B. N. (2019). İngilizce öğretmenlerinin alternatif değerlendirme yöntemlerini kullanma yeterliliklerinin incelenmesi. *OPUS–Uluslararası Toplum Araştırmaları Dergisi (International Journal of Society Researches) 13*(19), 983- 1009. https://doi.org/10.26466/opus.591260

Dilmaç, S. & Dilmaç, O. (2020). Visual art teachers' determination of the self sufficiency to use alternative assessment tools. *International Journal of Evaluation and Research in Education (IJERE), 9*(2), 292-302 ISSN: 2252-8822, http://doi.org/10.11591/ijere.v9i2.20496.

DiMartino, J., Castaneda, A., Brownstein, M., & Miles, S. (2007). Authentic Assessment. *Principal's Research Review*, *2*(4), 1-8.

Duran, A. (2013). *Sınıf öğretmenlerinin sosyal bilgiler dersinde kullandıkları alternatif ölçme değerlendirme tekniklerine ilişkin görüşlerinin değerlendirilmesi*. [Yayımlanmamış yüksek lisans tezi]. Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü, Hatay.

Hamayan, E. (1995). Approaches to Alternative Assessment. *Annual Review of Applied Linguistics, 15*, 212-226. https://doi.org/10.1017/S0267190500002695

Heale R & Twycross A. (2018). What is a case study?*Evidence-Based Nursing, 21*, 7-8.

Irawan, M. O. (2017). Students' *perceptions on traditional and alternative assessment (a case study at department of english language education.* (Doctoral dissertation, UIN Ar-Raniry Banda Aceh).

Karakuş, S. (2020). Tarih öğretmenlerinin alternatif ölçme-değerlendirme sürecinde karşılaştıkları sorunlara ilişkin görüşleri. *Muallim Rıfat Eğitim Fakültesi Dergisi (Journal of Muallim Rıfat Faculty of Education (JMRFE) 2*(2), 80-96(2020).

Karakuş, S. (2020). Tarih Öğretmenlerinin alternatif ölçme-değerlendirme yöntemlerinin kullanılma sıklığına ve işlevlerine yönelik görüşleri, *NEÜ Ereğli Eğitim Fakültesi Dergisi, 2*(1), 62-79.

Kepek, T. & İzci, K. (2021). Alternatif değerlendirme yöntemlerinin akademik başarıya etkisinin ve bu yöntemlerle ilgili öğrenci görüşlerinin incelenmesi. *Necmettin Erbakan Üniversitesi Ereğli Eğitim Fakültesi Dergisi, 3*(1), 34-50.

Khairunisa, Y. (2021). Pemanfaatan fitur gamifikasi daring maze chase–wordwall sebagai media pembelajaran digital mata kuliah statistika dan probabilitas. *Mediasi, 2*(1), 41–47.

https://doi.org/10.46961/mediasi.v2i1.254.

Kıral, B. (2020). Nitel bir veri analizi yöntemi olarak doküman analizi. *Sosyal Bilimler Enstitüsü Dergisi, 15,* 170-189.

Ministry of National Education (2018). Science curriculum (primary and middle school grades 3, 4, 5, 6, 7 and 8).

Ministry of National Education (2024). Science curriculum (primary and middle school grades 3, 4, 5, 6, 7 and 8). https://mufredat.meb.gov.tr/

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. SAGE Publications Inc.

Montiel, I., Delgado-Ceballos, J., Ortiz-de-Mandojana, N., & Antolin-Lopez, R. (2020). New Ways of Teaching: Using Technology and Mobile Apps to Educate on Societal Grand Challenges. *Journal of Business Ethics, 161*(2), 243-251. https://doi.org/10.1007/s10551-019-04184-x

NRC (National Research Council). 2012. Nutrient requirements of swine. 11th rev. ed., National Research Council, Natl. Acad. Press, Washington, DC.

O'Leary, Z. (2017). *The essential guide to doing your research project*. SAGE Publications Inc.

Okur, M. (2008). *4. ve 5. sınıf öğretmenlerinin fen ve teknoloji dersinde kullanılan alternatif ölçme ve değerlendirme tekniklerine ilişkin görüşlerinin belirlenmesi.* [Yayınlanmamış yüksek lisans tezi]. Bülent Ecevit Üniversitesi Sosyal Bilimler Enstitüsü, Zonguldak.

OECD (2019). PISA 2018 *Assessment and analytical framework*. OECD. https://doi.org/10.1787/b25efab8-en

OECD (2023), PISA 2022 Results (Volume I): The state of learning and equity in education, PISA, OECD Publishing, Paris, https://doi.org/10.1787/53f23881-en.

Özer, M. A. (2009). Performans yönetimi uygulamalarında performansın ölçümü ve değerlendirilmesi. *Sayıştay Dergisi, 73*, 3-29.

Özerdem Temel, A. & Türkoğlu, B. (2023). Okul Öncesi Öğretmenlerinin Eğitimde Web 2.0 Araçlarının Kullanımına Yönelik Görüşlerinin İncelenmesi. Necmettin Erbakan *Üniversitesi Ereğli Eğitim Fakültesi Dergisi, 5*(Özel Sayı), 217243. https://doi.org/10.51119/ereegf.2023.43

Özenç, M. (2013). Sınıf öğretmenlerinin alternatif ölçme ve değerlendirme bilgi düzeylerinin belirlenmesi. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, 21, 157-178.

Özkan, U. B (2021). *Eğitim bilimleri araştırmaları için doküman inceleme yöntemi.* Pegem Akademi.

Patton, M. Q. (2005). *Qualitative research*. New York: John Wiley & Sons, Ltd.

Patton, M. Q. (2014). *Nitel araştırma ve değerlendirme yöntemleri*. Ankara: Pegem Akademi.

Palaz, Ş. (2022). *Fen öğretiminde kullanılan ölçme ve değerlendirme yaklaşımlarına yönelik sınıf öğretmeni adaylarının değerlendirilmesi*. Yüksek Lisans tezi. Nevşehir Hacı Bektaş Veli Üniversitesi, Sosyal Bilimler Enstitüsü, Nevşehir.

Rahmasari, R. Murdiono, M. & Sunarso (2022). The influence of utilizing gamification media wordwall on the improvement of pancasila education learning outcomes. *Qalamuna - Jurnal Pendidikan, Sosial, dan Agama*, *14*(2), 671-684.

Sak, R., Şahin Sak, İ. T., Öneren Şendil, Ç., & Nas, E. (2021). Bir araştırma yöntemi olarak doküman analizi. *Kocaeli Üniversitesi Eğitim Dergisi, 4*(1), 227-250. http://doi.org/10.33400/kuje.843306

Shiddiq, J. (2021). Inovasi Pemanfaatan word-wall sebagai media game-based learning untuk bahasa arab. *JALIE; Journal of Applied Linguistics and Islamic Education, 5(1), 151–169.*

Singh, C. K. S., Muhammad, M. M., Mostafa, N. A, Yunus, M. M., Noordin, N., & Darmi, R. (2022). Exploring ESL teachers' alternative assessment strategies and practices in the classroom. *Journal of Language and Linguistic Studies, 18*(1), 411-426. http://doi.org/10.52462/jlls.191.

Sulaiman, T., Abdul Rahim,S. S., Wong, K. & Wan Jaafar, W. M. (2021). The use of "scratch and challenge board" as an alternative assessment tool to enhance university students' skills. *Asian Journal of University Education (AJUE), 17(*3), 85-98.

Şahin, Ç. & Kaya, G (2020). Alternatif ölçme değerlendirme ile ilgili yapılan araştırmaların incelenmesi: Bir içerik analizi. *Nevşehir Hacı Bektaş Veli Üniversitesi SBE Dergisi, 10*(2), 798-812.

Şahin, Ö., & Soylu, Y. (2019). Matematik öğretmeni adaylarının ölçme ve değerlendirme bilgi gelişimleri. *Kuramsal Eğitimbilim Dergisi [Journal of Theoretical Educational Science], 12*(1), 47-76.

Türkben, T. (2022). Türkçe öğretmenlerinin sınıf içi öğrenme becerilerini ölçme ve değerlendirme yeterlikleri. *Eğitim ve İnsani Bilimler Dergisi: Teori ve Uygulama, 13*(25), 45-72

Uygun, N. (2020). Sınıf öğretmeni adaylarının matematik dersindeki ölçme ve değerlendirme tekniklerine ilişkin görüşleri: birleştirilmiş sınıf uygulaması örneği. *Harran Maarif Dergisi, 5*(2), 29-45. http://dx.doi.org/10.22596/2020.0502.29.45

Uygun, N. & Saraç, E. (2020). Sınıf öğretmeni adaylarının ölçme ve değerlendirme tekniklerine yönelik tercihlerinin ders planları ile incelenmesi. *Uluslararası Eğitim Araştırmacıları Dergisi*, *3*(2), 199-212.

Williams-McBean, C. T. (2022). Assessment tools and strategies used by Jamaican secondary school teachers. *International Journal of Assessment Tools in Education, 9*(4), 883–905.

Yıldız, M. & Yıldız, Ö. (2019) Beden eğitimi öğretmenlerinin alternatif ölçme ve değerlendirme yöntemlerini kullanma düzeyleri. *Türk Spor Bilimleri Dergisi, 2*(1), 60-73.

Yıldırım, S. (2023). Coğrafya öğretmenleri ve öğretmen adaylarının web 2.0 araçları kullanım yetkinliklerinin değerlendirilmesi. *Ahmet Keleşoğlu Eğitim Fakültesi Dergisi (AKEF) Dergisi, 5*(2), 359-373.

Yıldırım, A. & Şimşek, H. (2018). *Nitel araştırma yöntemleri*, 11. Baskı, Seçkin Yayıncılık.

Yunus, Ö. (2018). *Alternatif ölçme ve değerlendirme tekniklerinin 6. sınıf "bitki ve hayvanlarda üreme, büyüme ve gelişme" ünitesinde kullanılmasının öğrencilerin akademik başarılarına etkisinin incelenmesi*. [Yüksek Lisans Tezi]. Hatay Mustafa Kemal Üniversitesi Fen Bilimleri Enstitüsü, Hatay.

Investigation of Postgraduate Theses on the Effects of STEM/STEAM and Robotic Coding Applications on 21st-Century Learning and Innovation Skills

Muhammed İkbal İRFANOĞLU[1*] Fatma AKGÜN[2]

[1] Trakya University, Institute of Natural and Applied Sciences, Edirne, Türkiye

[2] Trakya University, Faculty of Education, Edirne, Türkiye

Article Info	ABSTRACT
	The aim of this study is to analyse the postgraduate theses that investigated the relationship between STEM/STEAM (STEM+Art) and robotic coding practices and 21st-century learning and innovation skills. For this purpose, the postgraduate theses in the YÖK National Thesis Centre database were classified according to criteria such as thesis type, year, university, institute, research topic, 21st-century learning and innovation skill types, sample type and size, sampling method, research approach, data analysis and findings, and examined within a thematic framework. Out of 237 theses in the sample, 112 (83 master's and 29 doctoral) were identified as suitable for the purpose of the research. They were investigated through systematic analysis, and the data were analysed with descriptive analysis. According to the findings, the studies were most frequently completed in 2019 and 2023, with the majority of the topics focusing on STEM, and problem-solving skills being the most researched. The participants were predominantly secondary school students, and the most commonly used sampling method was convenience sampling. Additionally, the sample size was found to be between 31-100. The study also found that the mixed research design was most preferred methodologically, the effect of STEM/STEAM and robotic coding applications was mostly in the area of problem-solving and creativity, and it also provided positive contributions in terms of cooperation, communication, critical thinking and innovation skills to the learning process. Based on the results obtained from the analysis of the graduate theses, several proposals for new research to be carried out in the future were presented.

STEM/STEAM ve Robotik Kodlama Uygulamalarının 21. Yüzyıl Öğrenme ve Yenilenme Becerilerine Etkisini İçeren Lisansüstü Tezlerin İncelenmesi

ÖZET

Gerçekleştirilen çalışmada STEM/STEAM (STEM+Art) ve robotik kodlama uygulamalarının 21. Yüzyıl öğrenme ve yenilenme becerileri ile ilişkisini inceleyen lisansüstü tezleri analiz etmek amaçlanmıştır. Bu amaçla, YÖK Ulusal Tez Merkezi veri tabanında yer alan lisansüstü tezler; tez türü, yılı, üniversite, enstitü, araştırma alanı, 21.yüzyıl öğrenme ve yenilenme beceri türü, örneklem türü ve sayısı, örneklem seçimi, araştırma yaklaşımı, veri analizi ve bulgular gibi kriterler temelinde sınıflandırılarak tematik bir çerçevede incelenmiştir. Örneklem kapsamında 237 tez çalışmasından araştırmanın amacına uygun olan 83 yüksek lisans ve 29 doktora olmak üzere toplam 112 tez çalışması sistematik analizle incelenmiş ve veriler betimsel analizle çözümlenmiştir. Bulgulara göre, çalışmaların en fazla 2019 ve 2023 yılında tamamlandığı, konuların en yoğun olarak STEM alanında ele alındığı ve problem çözme becerisinin araştırıldığı, katılımcıların çoğunlukla ortaokul öğrencilerinden oluştuğu, örneklem seçiminde en çok uygun örnekleme metodunun kullanıldığı ve örneklem büyüklüğünün 31-100 arasında olduğu belirlenmiştir. Çalışmada ayrıca yöntemsel olarak çoğunlukla karma araştırma deseninin tercih edildiği, STEM/STEAM ve robotik kodlama uygulamalarının etkisinin en fazla problem çözme ve yaratıcılık alanında olduğu, bununla birlikte öğrenme sürecine yönelik iş birliği, iletişim, eleştirel düşünme ve yenilikçilik becerileri açısından da olumlu katkılar sağladığı belirlenmiştir. Tez çalışmaların analizi kapsamında ulaşılan sonuçlara göre gelecekte yapılması planlanan yeni araştırmalara yönelik çeşitli öneriler sunulmuştur.

*Corresponding Author: Muhammed İkbal İrfanoğlu, *ikbalirfanoglu@gmail.com*

INTRODUCTION

The 21st-century is recognized as an era of rapidly evolving digital technologies, including smart devices, the Internet, cloud computing, social media, artificial intelligence applications, the Internet of Things, and similar advancements. In this dynamic environment, individuals are expected to possess highly developed skills such as information access, problem-solving, and critical thinking. Therefore, it is crucial for education systems to adopt innovative methods and approaches that align with contemporary needs. Among these innovative approaches, STEM (Science, Technology, Engineering, and Mathematics) and STEAM (STEM integrated with the arts), along with robotics and coding education, stand out as essential practices. These approaches contribute to the development of key 21st-century skills such as analytical thinking, creativity, collaboration, communication, and digital literacy. In fact, technological advancements have led to the widespread use of digital technologies across various fields, accelerating their integration into educational processes (Imaniah, 2023; Özdamar & Aydın, 2022; Qashou, 2021; Talan, 2022; Valverde-Berrocoso et al., 2020). As part of the innovations brought about by digital transformation, many technological tools and resources have become integral to learning activities. However, digital transformation in education is not merely about incorporating digital tools into the process; it is a transformative approach aimed at equipping both learners and educators with national and international competencies, preparing them to be future-ready individuals (Bozkurt et al., 2021). In this regard, learning environments and curricula have been restructured to meet contemporary demands, integrating innovative practices into educational programs. One such educational approach is STEM education, which encompasses interdisciplinary teaching practices from preschool to higher education, fostering the acquisition of 21st-century skills (Fındık et al., 2023). STEM education is recognized for enhancing various competencies, including academic success, problem-solving, creativity, and communication (İdin & Dönmez, 2020). Particularly, robotic coding applications within the STEM framework support the development of creative and systematic thinking, help students understand relationships between events (Güleryüz et al., 2020), and facilitate the acquisition of essential 21st-century skills such as problem-solving, critical thinking, creativity, and collaboration (Arafat et al., 2024). To support these objectives, the Partnership for 21st Century Skills (P21) advocates for educational support systems that involve all stakeholders. These systems include 21st-century standards, assessments, curriculum design, teacher professional development, and learning environments, all aimed at fostering and ensuring the development of essential 21st-century skills in students (Aksoy & Taşkın, 2019; Zhou, 2023).

21st Century Skills

Information and communication technologies continue to develop rapidly in recent years. Especially the widespread use of mass media together with the internet has facilitated data sharing and access. Rapid developments in information and communication technologies require the formation of a social structure that can adapt to this progress at a parallel speed (Aktan & Vural, 2016). In line with this necessity, various skills such as creativity, problem-solving, critical thinking, cooperation, communication, learning to learn, entrepreneurship should be effectively taught and learned in order to adapt and contribute to the development process (Önal & Erişen, 2019). These skills are considered within the framework of 21st-century skills (Thornhill-Miller et al., 2023).

Although 21st-century skills do not have a fixed and unchanging definition in the conceptual framework, it refers to the competencies that individuals should have in this century (Coşkun, 2022; Sayın & Seferlioğlu, 2016). In Turkey, Ministry of National Education-MoNE (2023) published the 'Research Report on 21st Century Skills and Values', which contains a systematic analysis and results of national and international research conducted within the framework of 21st-century skills. The report states that 21st-century skills, which are addressed in different frameworks and overlap in many models,

are generally defined as the competencies students need to be successful in their personal, academic and professional lives and include skills such as access to information, critical thinking, problem-solving, effective communication and collaboration. However, in the same report, MoNE (2023) categorised the basic 21st-century skills that students should have under seven main headings: social and emotional skills, language and communication skills, higher-order thinking skills, personal skills, learning skills, study skills and digital skills. This classification suggests that 21st-century skills are addressed in a broad framework. On the other hand, many institutions and organisations at the international level address 21st-century skills with different definitions and classifications (Kuru, 2021). The Partnership for 21st Century Learning (P21) project, which is one of these organisations, provides a comprehensive framework that is well known to the global public and accepted as valid by the authorities (Kılıç, 2022a). For this purpose, a framework for the implementation of 21st-century skills in curriculum and instruction has been developed within the scope of a strategic education project 'Partnership for 21st Century Learning (P21)' implemented in 21 states in the United States and supported by 33 institutions (Gelen, 2017). This framework is organised to ensure that students are ready to work in a more competitive global economy in the 21st- century (Bozkurt, 2021). The education project also offers a broad approach to learning, including areas such as digital literacy, media and technology literacy.

The P21 framework consists of three main components. These are learning and regeneration skills, life and career skills, information, media and technology skills (P21, 2019). Learning and innovation skills, which include creativity, innovation, critical thinking, problem-solving, communication and collaboration skills, are considered to be among the most important skills that individuals should have in academic and daily life (Orak & İnözü, 2021). In the 21st-century, it is emphasized the development of creativity and innovation skills has become increasingly important for success in both academic and business environments (Adeoye & Jimoh, 2023; Akarsu, 2024) and that learning that supports problem-solving skills is effective in the development of creativity skills (Güven & Kavuncuoğlu, 2020; Kashani-Vahid et al., 2017). Life and career skills, which include competencies such as flexibility and adaptability, entrepreneurship and self-direction, leadership and responsibility, social and intercultural skills, productivity and accountability, are also recognised as necessary skills to equip individuals in the 21st-century to anticipate and solve complex problems in living and working environments (Zuwanda et al., 2021). Information, media and technology skills are generally referred to as digital competence, ICT literacy, digital literacy or skills and competences related to the use of digital technologies (Hazar et al., 2021). It is stated that these skills are necessary for personal development and success as well as for social progress as a whole (Zhou, 2023) and that they are necessary for the individual to keep up with the age and to be productive and effective (Özer & Tekin Bozkurt, 2024). The P21 framework has been accepted by the education systems of many countries around the world and has been put into practice through various projects (Gelen, 2017). The P21 framework overlaps with the 21st-century skills in the "21st Century Skills and Values Research Report" published by the MoNE (2023). STEM/STEAM activities, which is a learning approach used to develop these skills in learning environments (Fajrina et al., 2020). STEM and STEAM practices include practices that are put forward to develop various skills such as creativity, critical thinking, collaboration, and communication.

STEM and STEAM Education

STEM is an abbreviation formed by combining the initials of the English words science, technology, engineering and mathematics. While it was previously referred to as SMET, it was reorganised as STEM in 2001 by the National Science Foundation of the United States of America and aimed to develop students' interests and competencies by integrating these disciplines into education (Britannica, 2024). STEAM emerged with the inclusion of artistic activities in STEM practices

(Aguilera & Ortiz-Revilla, 2021; Costantino, 2018; Kahya & Özdilek, 2021). It is aimed to develop students' 21st-century skills with the activities carried out by combining STEM and art (Watson, 2020). In addition, STEAM education, which supports STEM education in fields such as art (STEAM), design and humanities, is expressed as an approach that can be used to model learners' innovation, creativity, critical thinking, effective communication and collaboration within the scope of 21st-century skills (Quigley & Herro, 2016). However, STEAM education, which is considered a popular interdisciplinary pedagogical approach to develop students' creativity, problem-solving skills and interest in STEM (Perignat & Katz-Buonincontro, 2019), is being addressed in many countries to develop subjects such as entrepreneurship, critical thinking, interdisciplinary integration and creativity (Chang et al., 2024). In addition, STEM education is also a very effective process in this context, and the interdisciplinary approach to teaching and learning that it offers increases the adaptability to this concept over time (Tytler, 2020). It is stated that this approach improves individuals' personal information literacy, increases competitiveness in the global economy, and forms the basis for conscious and responsible citizenship, including the ethical protection of our world (Maass et al., 2019). In addition, STEM activities help children develop problem-solving skills and scientific thinking processes by awakening their natural curiosity and desire to explore (Erol & İvrendi, 2021; Tippett & Milford, 2017). In particular, STEM-based robotic coding applications can contribute to creative thinking skills by enabling children to apply these skills in concrete projects.

Robotic Coding

In the 21st-century, coding, which is accepted as a new literacy, is the process of creating the commands needed for computer programs to work (Sayın & Seferoğlu, 2016). Robotic coding is a type of coding expressed by the combination of mechanical objects and coding (Karataş, 2021). Robotic coding, which gives mobility to objects, is a field of technology used to increase efficiency and productivity in various sectors. Some systems developed in this field offer user-friendly, easy-to-understand interfaces and tools to facilitate the programming of robots. These systems allow robots to be programmed without dealing with complex code-writing processes. Block-based programmes are generally used for robot programming without writing code. With this system, the desired result can be achieved by dragging and dropping predefined code blocks together. With these methods used in robotic coding education, students can actively participate in the process and experience creating a product these applications, especially in the robotic coding process in the primary and secondary school education curriculum, can facilitate the development of students' cooperation, communication and leadership skills (Gratani & Giannandrea, 2022). On the other hand, it is concluded that robotic coding practices support the development of creativity, critical thinking, problem-solving, communication and computational thinking skills, which are among the 21st-century learning and innovation skills (Erdoğan et al., 2020; Kılıç, 2022b).

Purpose and Problem of the Research

There are studies in the literature that STEM/STEAM education and robotic coding applications have an impact on the acquisition of 21st-century skills (Eguchi, 2016; Graffin et al., 2022; Güleryüz, 2020; Krüger & Chiappe, 2021; Metin et al., 2023). For example, a meta-analysis study conducted by Saltan and Korkmaz (2024) found that educational robot kits had positive effects on students' problem-solving, academic achievement, and scientific process skills. Similarly, Nazifah and Asrizal (2022) emphasised in their study that STEM-integrated physics e-modules prepared for the development of students' 21st-century skills are used in the learning process. Based on the findings of the studies, it can be stated that STEM/STEAM and robotics coding applications contribute to the development of 21st-century skills. However, it is felt that a comprehensive review of postgraduate dissertations on how these practices work in different contexts and what variables make them more effective will contribute to the

field. To this end, a systematic review of the type, year, university, institute, research topic, 21st-century learning and innovation skill types, sample type and size, sampling method, research approach, data analysis and findings of postgraduate these studies and how they are shaped within the data analysis and findings and what kind of academic tendency they show in this context was undertaken. The main research question of the study is expressed as follows:

What variables are prominent in postgraduate thesis studies examining the effects of STEM/STEAM and robotics coding practices on 21st-century learning and innovation skills such as creativity, innovation, critical thinking, problem-solving, collaboration and communication, and how are these variables distributed? In this context, the following research questions were investigated.

1. What is the distribution of graduate theses on STEM/STEAM and robotic coding applications in terms of type of thesis (master's/doctoral), year, university and institute?

2. What is the distribution of theses on STEM/STEAM and robotic coding applications?

3. What is the distribution of theses incorporating STEM/STEAM and robotic coding applications in relation to 21st-century learning and innovation skills?

4. What is the distribution of the sample types and sample sizes in the theses?

5. What are the sampling methods and research approaches used in the theses?

6. What are the data analysis methods used in the theses?

7. What are the findings of the theses including STEM/STEAM and robotic coding applications on the impact of 21st-century learning and innovation skills?

METHOD

Research Model

In this study, the document review method was used to determine the analysis of doctoral and master's theses that examine the effects of robotic coding, STEM and STEAM applications on 21st-century learning and innovation skills. Document review is a research method that is carried out to obtain data by analysing written documents containing information about the facts and events related to the subject of the research (Yıldırım & Şimşek, 2008).

Population and Sampling

In this study, master's and doctoral theses that were conducted between 2017 and 2024 and found in the YÖK National Thesis Centre database were investigated. As the Ministry of National Education published a framework roadmap for STEM education in 2016 (MoNE, 2016), postgraduate theses conducted since 2017 were included in the study. The search using the keywords "STEM", "STEAM", "FETEMM" and "21st-century skills" retrieved 237 studies and 112 theses (83 master's, 29 doctoral) that met the research criteria formed the sample of the study. "The Impact of STEM/STEAM and Robotics Coding Applications on 21st Century Learning and Innovation Skills" were taken into consideration as criteria in the sample selection of the study and the process progressed according to these criteria.

Data Collection Process

In this study, a publication classification form containing the relevant themes was used as a data collection tool, using the relevant literature. In developing the publication classification form, the 'Educational Technologies Publication Classification Form' developed by Göktaş et al. (2012) was

revised and used by the researchers according to the scope and objectives of the research.

In the data collection process of the study, searches were conducted using keywords in order to access thesis studies suitable for the research topic from the master's and doctoral theses in the YÖK Thesis Center database. After searching with the keywords "STEM and 21st-century skills", "STEM and creativity", "STEM and innovation", "STEM and collaboration", "STEM and critical thinking", and "STEM and problem solving" in the advanced search section of the YÖK Thesis Center database, the terms "STEAM", "FeTeMM" and "Robotic Coding" were written instead of "STEM" and the master's and doctoral theses were reached. During the data collection process, it was taken into account that the studies accessed as a result of the scan included one of the STEM, STEAM, FeTeMM, robotic coding practices and their impact on 21st-century learning and innovation skills, or one of the sub-dimensions of learning and innovation skills (creativity, innovation, critical thinking, problem-solving, collaboration, communication). The sampling process is shown in Figure 1.
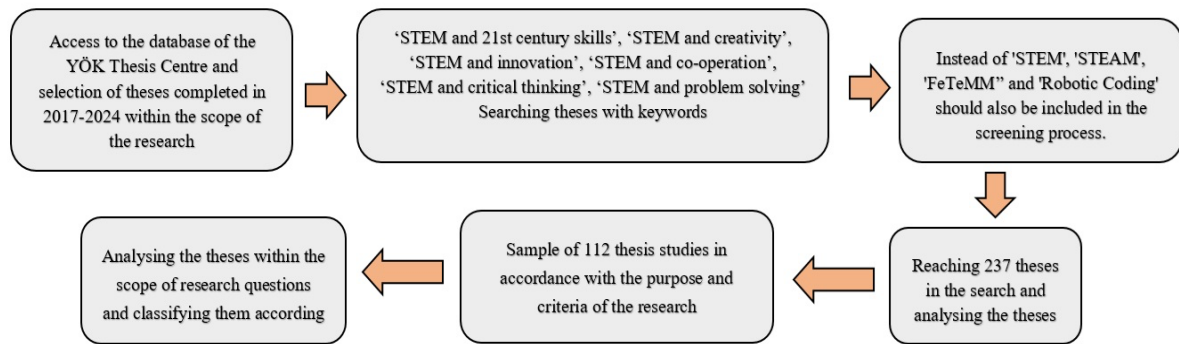
Figure 1. Sampling and data collection process

Analysing the Data

The data of the study were analysed by descriptive analysis method. The aim of descriptive analysis is to reach concepts and relationships that can explain the collected data. Within the scope of descriptive analysis, a framework is created for the analysis, and the data are processed according to the thematic framework, which further illuminates the findings and their interpretations (Yıldırım & Şimşek, 2008). In the study process, master's and doctoral theses were examined one by one and discussed within the scope of publication year, thesis type, university and institute, research topic, 21st-century learning and innovation skill types, sample type and size, sampling method, research approach, data analysis and findings. An example of a thesis analysis is shown in Table 1.

Table 1
Analysis of a sample thesis

Thesis No	Year	University Name	Thesis Types	Institute	STEM/STEAM/ Robotic Coding Research Topic	Subject Area of 21st Century Learning and Innovation Skills	Sample Type	Sample Size	Sampling Method	Research Approach	Analysis Methods	The Effect of STEM, STEAM and Robotic Coding Applications on 21st Century Skills
1	2019	Ondokuz Mayıs University	PhD	Institute of Educational Sciences	STEM	Creativity, Innovation, Critical Thinking, Problem Solving, Collaboration, Communication	Primary School	34	Convenience Sampling Maximum Variation Sampling	Mixed Method	Quantitative Analysis: ANOVA and t-testi Qualitative Analysis: Descriptive Analysis, Content Analysis	**Positive Effect** Creativity, Innovation, Critical Thinking, Problem Solving, Collaboration, Communication

The data obtained from the studies were coded and grouped under the themes in the classification form. In order to ensure the consistency of the coding process in the study, a coding study was carried out for the theses analysed with the participation of two researchers. The codes were compared with each other for internal consistency. The reliability formula proposed by Miles and Huberman (1994) was used for comparison. If the result of the reliability formula is above 70%, the study is considered to be reliable. As a result of the coding study, it was seen that the researchers presented consistent codings and the agreement between the codings was 94%. For the codings for which there was no consensus, the researchers came together again and discussed the codings until they reach a consensus.The findings obtained from the study are presented in tables and explanations with frequency values.

FINDINGS

In this section, the findings obtained as a result of the study are presented. As a result of the research, the information obtained within the framework of the type of postgraduate theses, year of publication, universities and institutes, distribution according to research topic, distribution according to learning and innovation skill types, sample type, sample size, sampling method, research approach, data analysis and findings are presented in tables.

Table 2
Distribution of Thesis Studies by University, Year of Publication, and Thesis Type

University	Year								Total	Thesis Type
	2017	2018	2019	2020	2021	2022	2023	2024		
Afyon Kocatepe University		1				1			2	MSc
Akdeniz University					1				1	MSc
Alanya Alaaddin Keykubat University		1			1				2	MSc
Amasya University		1				1			2	MSc
Atatürk University		1	2						3	1 MSc/2 PhD
Aydın Adnan Menderes University	1	2							3	2 MSc/1 PhD
Bahçeşehir University		2				1			3	MSc
Bayburt University		1							1	MSc
Bolu Abant İzzet Baysal University		1							1	MSc
Çanakkale Onsekiz Mart University						1			1	MSc
Çukurova University			1		1				2	PhD
Dokuz Eylül University						1	1		1	1 MSc/1 PhD
Düzce University				2					2	MSc
Ege University					1				1	MSc
Erciyes University			1	2		1			4	2 MSc/2 PhD
Erzincan Binali Yıldırım University		3		1		1			5	MSc
Eskişehir Anadolu University						1			1	MSc
Eskişehir Osmangazi University									1	MSc
Fırat University		1	2		1		3		7	6 MSc/1 PhD
Gazi University	1	2	1	1	1		2	1	9	3 MSc/6 PhD
Giresun University							2		2	MSc
Hacettepe University				1		1			2	PhD
Hatay Mustafa Kemal		1	1	1					3	MSc

University									Total	Degree
University										
İnönü University						1			1	MSc
İstanbul Aydın University	1			1					2	MSc
İstanbul University		1	1						2	1 MSc/1 PhD
Kafkas University							1		1	MSc
Kahramanmaraş Sütçü İmam University							1		1	MSc
Karamanoğlu Mehmetbey University						2			2	MSc
Kastamonu University					1				1	MSc
Kırıkkale University		1				1			2	MSc
Kırşehir Ahi Evran University			1		1				2	MSc
Kütahya Dumlupınar University			1						1	MSc
Marmara University	1	1	2			1			5	MSc
Mersin University				1		1			2	1 MSc/1 PhD
Muğla Sıtkı Koçman University							2		2	MSc
Muş Alparslan University		1							1	MSc
Necmettin Erbakan University			2				1		3	2 MSc/1 PhD
Nevşehir Hacı Bektaş Veli University							1		1	PhD
Niğde Ömer Halisdemir University					1				1	MSc
Ondokuz Mayıs University		1	1		1				3	PhD
Ordu University							1		1	PhD
Pamukkale University				1					1	PhD
Recep Tayyip Erdoğan University		1		1					2	MSc
Sakarya University							1		1	PhD
Siirt University							1		1	MSc
Sivas Cumhuriyet University							1		1	MSc
Süleyman Demirel University								1	1	MSc
Tokat Gaziosmanpaşa University			1						1	MSc
Trabzon University					1				1	PhD
Trakya University					2				2	MSc
Uşak University		1							1	MSc
Van Yüzüncüyıl University					1				1	MSc
Yıldız Teknik University			2		1	1			4	3 MSc/1 PhD
Zonguldak Bülent Ecevit University			1				1		2	MSc
Toplam	3	15	26	11	14	14	26	3	112	83 MSc 29 PhD

MSc: Master's Degree   **PhD:** Doctorate

Table 2 shows the distribution of master's (f=83, 74.11%) and doctoral (f=29, 24.89%) thesis studies conducted in 55 universities between 2017-2024. Gazi University (f=9, 8.04%) is the university with the highest number of thesis studies, followed by Fırat University (f=7, 6.25%), Erzincan Binali Yıldırım University and Marmara University (f=5, 4.46%), and then Erciyes University and Yıldız

Technical University (f=4, 3.57%). When the distribution by years is analysed, the most studies were conducted in 2019 and 2023 (f=26, 23.21%), followed by 2018 (f=15, 13.40%) and 2021 and 2022 (f=14, 12.50%).

Table 3

Distribution of Thesis Studies by Institute and Thesis Type

Institutes	Thesis Type		Total
	Master's Degree	Doctorate	
Institute of Educational Sciences	44	23	67
Institute of Natural and Applied Sciences	27	3	30
Institute of Social Sciences	12	3	15
Total	83	29	112

When the distribution of thesis studies in Table 3 according to the institutes, the institutes where the most studies were conducted are Institutes of Educational Sciences (f=67, 59.82%), followed by Institutes of Natural and Applied Sciences (f=30, 26.79%) and Institutes of Social Sciences (f=15, 13.39%). 44 master's (f=44, 53.01%), 23 doctorate (f=23, 79.31%) thesis studies were conducted in Institutes of Educational Sciences, 27 master's (f=27, 32.53%), 3 doctorate (f=3, 10.34%) thesis studies were conducted in Institutes of Natural and Applied Sciences and 12 master's (f=12, 14.46%), 3 doctorate (f=3, 10.34%) thesis studies were conducted in Institutes of Social Sciences.

Table 4

Distribution of Thesis Studies by Subject Area

Theme	f	Master's Degree	Doctorate
STEM	90	67	23
STEAM	4	2	2
Robotic Coding	18	14	4
Total	112	83	29

When the distribution of studies according to their subject area is examined in Table 4, it is seen that the most studied theme is STEM (F=90, 80.36%), followed by robotic coding (f=18, 16.07%) and STEAM (f=4, 3.57%).

Table 5

Distribution of Thesis Studies by Subject Area of 21st-Century Learning and Innovation Skills

21st-Century Skills	STEM	STEAM	Robotic Coding	Total
Creativity	58	4	9	71
Innovation	21	1	6	28
Critical Thinking	45	2	7	54
Problem Solving	62	3	15	80
Collaboration	32	1	8	41
Communication	30	1	6	37
Total	248	12	51	311

Table 5 shows the distribution of 21st-century learning and innovation skills in the studies according to subject area. Accordingly, problem-solving skill (f=80, 71.43%) is the most commonly

used skill, followed by creativity skill (f=71, 63.39%) and critical thinking skill (f=54, 48.21%). When the studies are examined within their themes, problem-solving skill emerging in 80 theses is mostly handled with STEM applications (f=62, 77.50%), followed by robotic coding (f=15, 18.75%) and STEAM (f=3, 3.7.35%). Creativity skill, which was included in a total of 71 studies, was also studied mostly with STEM (f=58, 81.69%), and was included with robotic coding (f=9, 12.68%) and STEAM (f=4, 5.63%), respectively. Critical thinking skill was also addressed in a total of 54 studies and studied mostly with STEM (f=45, 83.33%), followed by robotic coding (f=7, 12.96%) and finally with STEAM (f=2, 3.70%).

Table 6

Distribution of Thesis Studies by Sample Type and Sample Size

Sample Type	f	Sample Size	f
Preschool	15	1-10	6
Primary School	21	11-30	28
Middle School	45	31-100	65
High School	2	101-300	7
Undergraduate	22	301-1000	5
Teacher	7	1001 and above	1
Total	112	Total	112

Table 6 shows the distribution of sample levels and sample sizes in thesis studies. The sample level was mostly taken from secondary school students (f=45, 41.16%), followed by sample groups consisting of undergraduate students (f=22, 19.64%). When the sample sizes are examined, it is seen that 31-100 (f=65, 58.04%) is preferred the most.

Table 7

Distribution of Thesis Studies by Sampling Method and Research Approach

Sampling Method	f	Research Approach	f
Criterion sampling	20	Mixed	61
Maximum variation sampling	10	Quantitative	37
Homogeneous sampling	8	Qualitative	14
Typical case sampling	1		
Convenience sampling	73		
Simple random sampling	8		
Total	124	Total	112

Table 7 shows the sampling method and research approach used in the studies. Convenience sampling stood out as the most preferred one (f=73, 65.18%). In addition, since some studies included more than one sample type due to their structure, it is seen that the total value (f=124) is more than the total of the research (f=112). When the research method is examined, it is seen that the most mixed research is (f=61, 54.46%).

Table 8

Distribution of Thesis Studies by Data Analysis Methods

Quantitative Data Analysis	f	Qualitative Data Analysis	f
t-test	66	Content analysis	60
ANOVA/ANCOVA	33	Descriptive analysis	40
MANOVA/MANCOVA	5		
Correlation	8		

Regression	2		
Mann Whitney U	27		
Kruskal Wallis	6		
Confirmatory Factor Analysis (CFA)	2		
Total	149	Total	100

In Table 8 the distribution of the data obtained in the studies according to their analysis is presented. The results revealed that in the analysis of quantitative data, the t-test was used the most (f=66, 58.93%) whereas the qualitative data was mostly analysed through the content analysis (f=60, 53.57%).

Table 9
Distribution of STEM, STEAM, and Robotic Coding Applications in Thesis Studies by Their Effects on 21st-Century Skills

21st-Century Skills	STEM		STEAM		Robotic Coding	
	Effective	No effect	Effective	No effect	Effective	No effect
Creativity	57	1	4	-	9	1
Innovation	20	1	1	-	6	-
Critical Thinking	44	1	2	-	7	-
Problem Solving	58	4	3	-	15	-
Collaboration	31	1	1	-	8	-
Communication	29	1	1	-	6	-

In Table 9, STEM, STEAM and robotic coding applications are generally effective in the development of 21st-century learning and innovation skills. According to the findings of the theses studies, STEM/STEAM and robotics coding training are particularly effective in developing creativity and problem-solving skills. In addition, many theses found that these courses contributed positively to the development of critical thinking, innovation, collaboration and communication skills. On the other hand, in addition to the finding that STEM education has no significant effect on problem- solving skills, there are also findings that it has no significant effect on creativity, innovation, critical thinking, cooperation and communication skills. Another study found that training in robotics programming had no significant effect on creativity skills.

DISCUSSION

In this study, 21st-century skills and their components, including learning and innovation skills along with STEM, STEAM and robotic coding concepts are discussed. By reviewing the literature on these concepts, definitions in line with the data obtained from many academic studies and various findings obtained in the studies were mentioned. For the purpose of this study, the studies on the effect of STEM, STEAM and robotic coding applications on 21st-century learning and innovation skills were analysed from the master's and doctoral theses conducted in Turkey between 2017 and 2024 in the YÖK National Thesis Centre database. According to the data obtained, there are 112 thesis studies in 55 universities, 83 of which are master's theses and 29 of which are doctoral theses. The findings that the studies were mainly conducted at the master's level overlap with the results of the meta-analysis study conducted by Kazu and Kaplan (2024) and Çavaş et al. (2020), which examined the impact of STEM education. An analysis of the distribution of postgraduate theses by year reveals that the highest number of studies was conducted in 2019 and 2023, with 26 theses in each year. In particular, the increase in the number of studies on STEM applications after 2018 is noteworthy. This finding aligns with the fact that STEM education has been included in the curricula in Turkey since 2018 (Uluyol & Pehlivan, 2019). Çavaş et al. (2020) also stated that there were no postgraduate theses on STEM in Turkey before 2014

and that this issue was addressed in the following years. Similarly, in the study conducted by Ecevit et al. (2022), which analysed research on STEM education in Turkey, it was found that the research was mostly concentrated in 2019.

The distribution of studies by university shows that Gazi University had the highest number of 9 studies, followed by Fırat University with 7 studies and then Erzincan Binali Yıldırım University and Marmara University, each with 5 studies, and Erciyes University and Yıldız Technical University, each with 4 studies. Kaya and Ok (2020), in their research on the graduate thesis studies carried out in the field of STEM education in Turkey, found that most of the dissertations in the field of STEM were carried out at Gazi University, and Erzincan Binali Yıldırım University was one of the higher education institutions with the highest number of dissertations in the field of STEM. This can be interpreted as an indication that the study has consistent findings with similar studies. When the distribution of thesis studies according to the institutes in which they were carried out was analyzed, it was found that the most studies were carried out in the Institutes of Educational Sciences with 67 studies, then in the Institutes of Natural and Applied Sciences with 30 studies and in the Institutes of Social Sciences with 15 studies, respectively. These studies are distributed as 44 master's and 23 doctoral theses in the Institutes of Educational Sciences, 27 master's and 3 doctoral theses in the Institutes of Natural and Applied Sciences, and 12 master's and 3 doctoral theses in the Institutes of Social Sciences. Similarly, in the content analysis study conducted by Çalışkan and Okuşuk (2021) on postgraduate theses conducted within the framework of STEM education, it was observed that most of the theses were conducted in the Institutes of Educational Sciences. The prevalence of studies conducted in the Institute of Educational Sciences can be attributed to the recognition of STEM as a contemporary and global educational approach. Looking at the distribution of theses studies on teaching activities, it can be seen that 90 studies mostly addressed the effect of STEM education on 21st-century skills. Ichsan et al. (2023) stated that STEM approach is especially important for 4C skills (Creativity, Colaboration, Critical Thinking and Communication) among 21st-century skills and emphasised the need for a STEM approach that will encourage these skills for Generation Z. This may be due to the fact that STEM education is a more general approach and educational policy that can be used at all levels of education (Akarsu et al., 2020; Arslan & Arastaman, 2021; Ay & Seferoğlu, 2021).

Among the STEM/STEAM and robotics coding applications, the effect of STEM activities on problem-solving, one of the 21st-century learning and innovation skills, was examined and a total of 62 studies were found to cover this area. Then, the relationship between STEM applications and creativity in 58 studies, critical thinking in 45 studies, collaboration in 32 studies, communication in 30 studies and innovation skills in 21 studies was investigated. Among the 51 studies addressing the theme of robotic coding, the impact on problem-solving skills was the most frequently explored, with 15 studies focusing on this aspect. Additionally, creativity was explored in 9 studies, collaboration in 8 studies, critical thinking in 7 studies, and communication and innovation skills in 6 studies. In studies focusing on the STEAM theme, creativity emerged as the most frequently addressed skill in four studies, followed by problem-solving in 3 studies, critical thinking in 2 studies, and innovation, collaboration, and communication skills in one study each. These findings highlight a predominant emphasis on problem-solving and creativity skills. Duran and Sarı (2021), in their research analyzing graduate thesis studies on STEM education in the 4th and 5th grades of primary education, found that problem-solving skills were the primary focus when examining the outcomes related to the acquisition of STEM education skills. Similarly, numerous national and international studies in the literature highlight the impact of STEM education on problem-solving skills (Acar et al., 2020; Astuti et al., 2021; Doğan et al., 2020; Shongwe, 2024).

In terms of sample types of the thesis studies in the study, it is observed that 45 studies included middle school students, 22 studies included undergraduate students, and 21 studies included primary

school students. Considering the findings obtained in similar studies conducted in Turkey in the literature, it is seen that secondary school level is generally preferred as the sample group (Çalışkan & Okuşuk, 2021; Çavaş et al., 2020; Daşdemir et al., 2018; Herdem & Ünal, 2018; Kazu & Kaplan, 2024). Regarding study group sizes, there are 65 thesis studies with a maximum size between 31-100. Similarly, Zağlı et al. (2022) found that the most common sample size used in their document analysis of character education theses was less than 100. The preference for a study group of less than 100 people may be due to concerns about keeping the sample under control (Özgür et al., 2018).

Within the scope of sample selection method, convenient/easily accessible sampling was preferred in 73 thesis studies, followed by criterion sampling in 20 studies, maximum variation sampling in 10 studies, affinity sampling and simple random sampling in 8 studies each, and typical case sampling in 1 study. The reason why convenient/easily accessible sampling type is mostly preferred in the studies may be due to the ease of access to the participants in the research and it's advantageous in terms of time (Evci & Yeşiltaş, 2023) and cost (Baltacı, 2018). When the distribution of the studies according to their methods was examined, the mixed method was preferred in 61 studies, followed by the quantitative method in 37 studies and the qualitative method in 14 studies. In a similar study conducted by Kaya and Ok (2020), the fact that the most preferred method was the mixed method is consistent with the results obtained. In the analysis of the data was evaluated, it was concluded that 60 content analyzes and 40 descriptive analyzes were used in qualitative research methods, while 66 t-tests and 33 ANOVA/ANCOVA tests were applied in quantitative research methods. It can be interpreted that content analysis is the most preferred method among qualitative research methods because it enables researchers to obtain in-depth information about a specific purpose or topic in their studies (Alanka, 2024). In addition, the preference for parametric tests such as t-test and ANOVA/ANCOVA in quantitative data is thought to be due to the normal distribution of study groups and the fact that these tests are effective and powerful statistical methods for assessing differences between group means.

When the thesis studies are analysed, according to the general findings on the effects of STEM, STEAM and robotic coding applications on 21st-century learning and innovation skills, it is concluded that STEM applications are effective in 58 studies in thesis studies where the effect of STEM applications on problem-solving skills is discussed, while there is no effect in 4 studies. In the literature, here are many studies demonstrating that STEM applications generally have a positive effect on students' problem-solving skills (Erden & Yalçın, 2021; Güven et al., 2021; Kartini et al., 2021; Muzana et al., 2021). However, some studies include findings STEM education has a low effect on problem-solving skills. For example; in the study conducted by Açışlı Çelik (2022), it was stated that STEM education integrated with the 5E learning model did not create a significant difference in students' problem-solving skills, but an increase was observed in general. In Asigigan and Samur (2021), the effect of gamified STEM applications on students' problem-solving skills was investigated and it was emphasized that there was no significant difference between the experimental and control groups. Upon reviewing theses on coding applications for robots, it was observed that all studies on problem-solving skills contributed to the development of these skills. Similarly, in the studies on STEAM activities, it was found that creativity skills were most often investigated and that STEAM activities contributed to 21st-century skills in all studies.

CONCLUSION AND SUGGESTIONS

As a result, within the scope of the findings obtained from master's and doctoral theses studies, it can be stated that STEM, STEAM and robotic coding education contributes to the development of students' 21st-century skills and these practices are more prevalent in secondary school education levels. There are many national and international studies conducted in this area in the literature (Arafat et al.,

2024; Bircan & Çalışıcı, 2022; Hadinugrahaningsih et al., 2017; Haymana & Özalp, 2020; Nazifah & Asrizal, 2022; Zainil et al., 2023) and their findings overlap with the findings of this study. Therefore, although the instructional activities conducted in the context of STEM/STEAM and robotics coding contribute to creativity, innovation, critical thinking, problem-solving, cooperation and communication skills among the 21st-century learning and innovation skills, it can be interpreted that the positive effect on especially problem-solving and creativity skills is predominant. In addition, in line with the findings of this study, which was carried out to analyse postgraduate theses, including the impact of these practices on 21st-century learning and innovation skills, various suggestions can be made for further studies to be carried out.

1. Since this study was conducted at the national level, future studies can examine global studies on the effects of STEM/STEAM and robotic coding practices on 21st-century skills. Comparisons can be made by considering the differences in implementation between countries.

2. Studies on the effects of STEM/STEAM and robotic coding practices on 21st-century life and career skills and information, media and technology skills can be addressed.

3. By comparing different new-generation educational approaches (e.g. project-based learning, flipped learning, game-based learning), the effects of these approaches on 21st-century skills can be examined.

4. Studies can be conducted on the effects of STEM/STEAM and robotic coding practices on 21st-century skills according to demographic differences.

5. As theses research tends to focus on problem-solving and creativity skills, the impact of the practices on innovation, critical thinking, collaboration and communication skills can be explored.

6. As the majority of the sample groups favoured in the thesis studies were middle school students, this situation can be taken into account in future studies and research can be conducted for different age groups and social contexts.

7. The number of studies on STEAM and the relationship between this subject and different teaching areas and skills can be increased in the graduate thesis studies to be carried out.

Author Contributions

Research Design (CRediT 1) Author 1 (%50) – Author 2 (%50)

Data Collection (CRediT 2) Author 1 (%50) – Author 2 (%50)

Research - Data analysis - Validation (CRediT 3-4-6-11) Author 1 (%50) – Author 2 (%50)

Writing the Article (CRediT 12-13) Author 1 (%50) – Author 2 (%50)

Revision and Improvement of the Text (CRediT 14) Author 1 (%50) – Author 2 (%50)

Conflict of Interest

There is no conflict of interest to declare.

REFERENCES

Acar, D., Tertemiz, N., & Taşdemir, A. (2020). STEM eğitimi ile öğrenim gören öğrencilerin matematik ve fen bilimleri problem çözme becerileri ve başarıları arasındaki ilişkinin incelenmesi. *Bartın Üniversitesi Eğitim Araştırmaları Dergisi*, *3*(2), 12-23. https://dergipark.org.tr/en/download/article-file/1094399

Adeoye, M. A., & Jimoh, H. A. (2023). Problem-solving skills among 21st-century learners toward creativity and innovation ideas. *Thinking Skills and Creativity Journal*, *6*(1), 52-58. https://doi.org/10.23887/tscj.v6i1.62708

Aguilera, D., & Ortiz-Revilla, J. (2021). STEM vs. STEAM education and student creativity: A systematic literature review. *Education Sciences*, *11*(7), 331. https://doi.org/10.3390/educsci11070331

Akarsu, M., Okur Akçay, N., & Elmas, R. (2020). STEM eğitimi yaklaşımının özellikleri ve değerlendirilmesi. *Bogazici University Journal of Education*, 37, 155-175. https://dergipark.org.tr/en/pub/buje/issue/58376/842413#article_cite

Akarsu, O. (2024). İş hayatında yaratıcılık ve yenilik yönetimi. *Yeni nesil teknolojiler ve yeni iş hayatı*, 57. Eğitim yayınevi.

Aksoy, G., & Taşkın, G. (2019). Öğretim programlarının değişmesini etkileyen faktörlerin, sosyal bilgiler ve fen bilimleri dersi müfredatlarını etkileme boyutu. *Milli Eğitim Dergisi*, *48*(224), 75-99. https://dergipark.org.tr/en/pub/milliegitim/issue/50252/648739#article_cite

Aktan, C. C., & Vural, İ. Y. (2016). Bilgi toplumu, yeni temel teknolojiler ve yeni ekonomi. *Yeni Türkiye*, *88*(1), 1-37.

Alanka, D. (2024). Nitel bir araştırma yöntemi olarak içerik analizi: Teorik bir çerçeve. *Kronotop İletişim Dergisi*, *1*(1), 64-84. https://dergipark.org.tr/en/pub/kronotop/issue/82784/1405579

Arafat, M. H., Budiyanto, C. W., Yuana, R. A., & Fenyvesi, K. (2024). Implementation of integrated STEM learning in educational robotics towards 21st century skills: A systematic review. *International Journal of Education in Mathematics, Science and Technology*, *12*(5), 1127-1141. https://files.eric.ed.gov/fulltext/EJ1452798.pdf

Arslan, S. Y., & Arastaman, G. (2021). Dünyada STEM politikaları: Türkiye için çıkarımlar ve öneriler. *Nevşehir Hacı Bektaş Veli Üniversitesi SBE Dergisi*, *11*(2), 894-910. https://doi.org/10.30783/nevsosbilen.903115

Asigigan, S. I. & Samur, Y. (2021). The effect of gamified STEM practices on students' intrinsic motivation, critical thinking disposition levels, and perception of problem-solving skills. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 9*(2), 332-352. https://doi.org/10.46328/ijemst.1157

Astuti, N. H., Rusilowati, A., & Subali, B. (2021). STEM-based learning analysis to improve students' problem solving abilities in science subject: A literature review. *Journal of Innovative Science Education, 10*(1), 79-86. doi:10.15294/jise.v9i2.38505

Ay, K., & Seferoğlu, S. S. (2021). Farklı ülkelerin stem eğitimi politikalarının incelenmesi ve türkiye için çıkarımlar. *Erzincan Üniversitesi Eğitim Fakültesi Dergisi*, *23*(1), 82-105. https://doi.org/10.17556/erziefd.669988

Baltacı, A. (2018). Nitel araştırmalarda örnekleme yöntemleri ve örnek hacmi sorunsalı üzerine kavramsal bir inceleme. *Bitlis Eren Üniversitesi Sosyal Bilimler Dergisi*, *7*(1), 231-274. https://dergipark.org.tr/en/pub/bitlissos/issue/38061/399955

Bircan, M. A., & Çalışıcı, H. (2022). STEM eğitimi etkinliklerinin ilkokul dördüncü sınıf öğrencilerinin STEM'e yönelik tutumlarına, 21. yüzyıl becerilerine ve matematik başarılarına etkisi. *Eğitim ve Bilim*, *47*(211). http://dx.doi.org/10.15390/EB.2022.10710

Bozkurt, A., Hamutoğlu, N. B., Kaban, A. L., Taşçı, G., & Aykul, M. (2021). Dijital bilgi çağı: Dijital toplum, dijital dönüşüm, dijital eğitim ve dijital yeterlilikler. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 7*(2), 35-63. https://doi.org/10.51948/auad.911584

Bozkurt, F. (2021). 21. yüzyıl becerileri açısından sosyal bilgiler öğretmenliği lisans programının değerlendirilmesi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 51*, 34-64. https://doi.org/10.9779/pauefd.688622

Britannica. (2024). *STEM education. Encyclopaedia Britannica.* https://www.britannica.com/topic/STEM-education

Chang, Y. S., Wang, Y. Y. & Ku, Y. T. (2024) Influence of online STEAM hands-on learning on AI learning, creativity, and creative emotions, *Interactive Learning Environments*, *32*(8), 4719-4738, doi: 10.1080/10494820.2023.2205898

Costantino, T. (2018). STEAM by another name: Transdisciplinary practice in art and design education. *Arts Education Policy Review*, *119*(2), 100-106. https://doi.org/10.1080/10632913.2017.1292973

Coşkun, F. (2022). Öğretmenlik mesleği ve 21. yüzyıl becerileri. *Alanyazın*, *3*(1), 31-38 http://dx.doi.org/10.22596/ cresjournal.0301.31.38

Çalışkan, A., & Okuşluk, F. (2021). Türkiye'de STEM alanında ve eğitim-öğretim konusunda yapılmış olan lisansüstü tezlerin içerik analizi. *Academia Eğitim Araştırmaları Dergisi*, *6*(1), 124-136. https://dergipark.org.tr/en/download/article-file/1455160

Çavaş, P., Ayar, A., & Gürcan, G. (2020). Türkiye'de STEM eğitimi üzerine yapılan araştırmaların durumu üzerine bir çalışma. *Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, *17*(1), 823-854. https://doi.org/10.33711/yyuefd.751853

Çelik, S.A. (2022). STEM etkinliklerinin ortaokul 6. sınıf öğrencilerinin problem çözme becerilerine, eleştirel düşünmelerine ve STEM'e yönelik tutumlarının etkisinin araştırılması. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi,* 1-27. https://dergipark.org.tr/en/download/article-file/2179933

Daşdemir, İ., Cengiz, E., & Aksoy, G. (2018). Türkiye'de FeTeMM (STEM) eğitimi eğilim araştırması. *Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, 15(1), 1161-1183. http://dx.doi.org/10.23891/efdyyu.2018.100

Doğan, A., Aydın, E., & Kahraman, E. (2020). STEM uygulamalarının ortaokul öğrencilerinin problem çözme becerilerine yönelik algılarına etkisinin incelenmesi. *Eskişehir Osmangazi Üniversitesi Türk Dünyası Uygulama ve Araştırma Merkezi Eğitim Dergisi*, *5*(2), 123-144. https://dergipark.org.tr/tr/download/article-file/1197604

Duran, M. ve Sarı, K. (2021). İlköğretim 4. ve 5.sınıflarda STEM eğitimi alanında yapılan tez çalışmalarının değerlendirilmesi. *Ihlara Eğitim Araştırmaları Dergisi*, *6*(2), 213-234. doi: 10.47479/ihead.934643

Ecevit, T., Yıldız, M., & Balcı, N. (2022). Türkiye'deki STEM eğitimi çalışmalarının içerik analizi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 22(1), 263-286. https://doi.org/10.17240/aibuefd.2022..-893198

Eguchi, A. (2016). RoboCupJunior for promoting STEM education, 21st century skills, and technological advancement through robotics competition. *Robotics and Autonomous Systems*, *75*, 692-699. https://doi.org/10.1016/j.robot.2015.05.013

Erden, S., & Yalçın, V. (2021). Probleme dayalı öğrenme yaklaşımına göre hazırlanan okul öncesi STEM etkinliklerinin çocukların problem çözme becerileri üzerindeki etkisinin incelenmesi. *Trakya Eğitim Dergisi*, *11*(3), 1239-1250. https://doi.org/10.24315/tred.789922

Erdoğan, Ö., Toy, M., & Kurt, M. (2020). Robotik uygulamaların fen bilgisi öğretmen adaylarının bazı 21. yüzyıl becerileri üzerindeki etkisinin incelenmesi. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi, 7*(4), 117-137. https://dergipark.org.tr/en/pub/asead/issue/54055/713508

Erol, A., & İvrendi, A. (2021). Erken çocuklukta STEM eğitimi. *Erken Çocukluk Çalışmaları Dergisi*, *5*(1), 255-284. https://doi.org/10.24130/eccd-jecs.1967202151265

Evci, N., & Yeşiltaş, E. (2023). Türkiye'de sosyal bilgiler eğitiminde drama üzerine yapılan akademik çalışmaların eğilimleri (2001-2021). *Iğdır Üniversitesi Sosyal Bilimler Dergisi*, 32, 220-238. https://doi.org/10.54600/igdirsosbilder.1193391

Fajrina, S., Lufri, L., & Ahda, Y. (2020). Science, technology, engineering, and mathematics (STEM) as a learning approach to improve 21st century skills: A review. *International Journal of Online & Biomedical Engineering*, *16*(7). https://doi.org/10.3991/ijoe.v16i07.14101

Fındık, N., Ültay, N., & Ültay, E. (2023). Türkiye'deki ilkokullarda yapılan STEM eğitimi uygulamaları betimsel içerik analizi. *Karadeniz Sosyal Bilimler Dergisi*, *15*(28), 163-176. https://doi.org/10.38155/ksbd.1241470

Gelen, İ. (2017). P21-program ve öğretimde 21. yüzyıl beceri çerçeveleri (ABD uygulamaları). *Disiplinlerarası Eğitim Araştırmaları Dergisi, 1*(2), 15-29. https://dergipark.org.tr/en/download/article-file/386403

Göktaş, Y., Küçük, S., Aydemir, M., Telli, E., Arpacık, Ö., Yıldırım, G., & Reisoğlu, İ. (2012). Türkiye'de eğitim teknolojileri araştırmalarındaki eğilimler: 2000-2009 dönemi makalelerinin içerik analizi. *Kuram ve Uygulamada Eğitim Bilimleri Dergisi*, *12*(1), 177-199.

Graffin, M., Sheffield, R., & Koul, R. (2022). 'More than Robots': Reviewing the impact of the FIRST® LEGO® league challenge robotics competition on school students' STEM attitudes, learning, and twenty-first century skill development. *Journal for STEM Education Research*, *5*(3), 322-343. https://doi.org/10.1007/s41979-022-00078-2

Gratani, F., & Giannandrea, L. (2022, July). Towards 2030. Enhancing 21st century skills through educational robotics. In *Frontiers in Education* (Vol. 7, p. 955285). Frontiers. https://doi.org/10.3389/feduc.2022.955285

Güleryüz, H. (2020). 3D yazıcı ve robotik kodlama uygulamalarının öğretmen adaylarının 21. yüzyıl öğrenen becerileri, STEM farkındalık ve STEM öğretmen öz yeterliğine etkisi. *Yayınlanmamış Doktora Tezi). Atatürk Üniversitesi Eğitim Bilimleri Enstitüsü. Erzurum.*

Güleryüz, H., Dilber, R., & Erdoğan, İ. (2020). STEM uygulamalarında öğretmen adaylarının kodlama eğitimi hakkındaki görüşleri. *Ağrı İbrahim Çeçen Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *6*(1), 71-83. https://dergipark.org.tr/en/download/article-file/1091428

Güven, H., Altun Yalçın, S., & Yalçın, P. (2021, August). *Investigation of the effects of STEM and STEM-based robotic activities on the problem solving and metacognition skills of secondary school students*. Nevsehir Hacı Bektas Veli University International Professional Education Conference (IPEC) (pp.87-89). Nevşehir, Türkey

Güven, Y., & Kavuncuoğlu, M. K. (2020). Okul öncesi dönem çocukların yaratıcılık düzeyleri ile problem çözme becerileri arasındaki ilişkinin incelenmesi. *Ahmet Keleşoğlu Eğitim Fakültesi Dergisi*, *2*(1), 37-53. https://dergipark.org.tr/en/pub/akef/issue/55203/757636

Hacıoğlu, Y., & Başpınar, A. (2020). Bir sınıf öğretmeni ve öğrencilerinin ilk STEM eğitimi deneyimleri. *Karadeniz Sosyal Bilimler Dergisi, 12*(22), 1-23. https://dergipark.org.tr/tr/pub/ksbd/issue/55048/690919

Hadinugrahaningsih, T., Rahmawati, Y., & Ridwan, A. (2017, August). *Developing 21st century skills in chemistry classrooms: Opportunities and challenges of STEAM integration*. In AIP Conference Proceedings (Vol. 1868, No. 1). AIP Publishing. https://doi.org/10.1063/1.4995107

Haymana, İ., & Özalp, D. (2020). Robotik ve kodlama eğitiminin ilkokul 4. sınıf öğrencilerinin yaratıcı düşünme becerilerine etkisi. *İstanbul Aydın Üniversitesi Eğitim Fakültesi Dergisi*, *6*(2), 247-274. https://dergipark.org.tr/tr/pub/iauefd/issue/57710/822431

Hazar, E., Akkutay, Ü., & Keser, H. (2021). Information, media and technology skills in terms of curricula, process and product in middle and high schools. *International Journal of Technology in Education and Science*, *5*(3), 288-310. https://eric.ed.gov/?id=EJ1311305

Herdem, K., & Ünal, İ. (2018). STEM eğitimi üzerine yapılan çalışmaların analizi: Bir meta-sentez çalışması. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi*, *48*(48). https://doi.org/10.15285/maruaebd.345486

Ichsan, I., Suharyat, Y., Santosa, T. A., & Satria, E. (2023). The effectiveness of STEM-based learning in teaching 21 st century skills in generation Z student in science learning: A meta-analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 150-166. https://jppipa.unram.ac.id/index.php/jppipa/article/view/2517

Imaniah, I. (2023, September). *The synergy of educational technology advancement and human capabilities in the era of society 5.0.* E3S Web of Conferences. https://doi.org/10.1051/e3sconf/202345207010

İdin, Ş., & Dönmez, İ. (2020). It is never too early to start STEM education. (Edt. Ünlü Çetin, Ş., Bilican, K., & Üçgül, M.) In *Key points for early childhood STEM education and involving parents*, 1. https://ddd.uab.cat/pub/llibres/2020/232604/ParentSTEM_Recommendations_Book_ISBN_v1.pdf#page=7

Kahya, V., & Özdilek, Z. (2021). Alan uzmanlarının STEAM eğitimi ile ilgili görüşleri. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi*, (42), 122-147. https://dergipark.org.tr/en/pub/ataunikkefd/issue/63299/862411

Karataş, H. (2021). 21. yy. becerilerinden robotik ve kodlama eğitiminin Türkiye ve dünyadaki yeri. *21. Yüzyılda Eğitim ve Toplum Eğitim Bilimleri ve Sosyal Araştırmalar Dergisi, 10*(30), 693-729. https://dergipark.org.tr/en/pub/egitimvetoplum/issue/68196/1059967

Karataş, Z. (2015). Sosyal bilimlerde nitel araştırma yöntemleri. *Manevi Temelli Sosyal Hizmet Araştırmaları Dergisi, 1*(1), 62-80. https://avys.omu.edu.tr/storage/app/public/kokdener/123091/13f.pdf

Kartini, F. S., Widodo, A., Winarno, N., & Astuti, L. (2021). Promoting student's problem-solving skills through stem project-based learning in earth layer and disasters topic. *Journal of Science Learning*, *4*(3), 257-266. https://eric.ed.gov/?id=EJ1307440

Kashani-Vahid, L., Afrooz, G., Shokoohi-Yekta, M., Kharrazi, K., & Ghobari, B. (2017). Can a creative interpersonal problem solving program improve creative thinking in gifted elementary students? *Thinking Skills and Creativity*, *24*, 175-185. https://doi.org/10.1016/j.tsc.2017.02.011

Kaya, D., & Ok, G. (2020, Aralık). *Türkiye'de STEM eğitimi alanında yapılan lisansüstü tezlerin içerik analizi*. 2. Uluslararası Eğitim Araştırmaları Kongresi, Nevşehir, Türkiye. http://hdl.handle.net/20.500.11787/8136

Kazu, İ. Y., & Kaplan, A. (2024). STEM uygulamalarının bilimsel süreç becerilerine etkisi: bir meta-analiz çalışması. *Elektronik Sosyal Bilimler Dergisi*, *23*(89), 234-255. https://doi.org/10.17755/esosder.1331946

Kılıç, A. (2022a). Türkiye Yükseköğretim yeterlilikler çerçevesi lisansüstü düzey tanımlarının P21'in 21. yüzyıl beceri tasnifi kapsamında değerlendirilmesi. *Eğitimde Yeni Yaklaşımlar Dergisi*, *5*(2), 66-83.

Kılıç, S. (2022b). Robotik programlamanın ön lisans öğrencilerinin bilgi işlemsel düşünme becerisi gelişimine etkisi. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 24*(2), 480-494. https://dergipark.org.tr/en/pub/akusosbil/article/919479

Krüger, W., & Chiappe, A. (2021). 21st-century skills and STEAM learning environments: a review. RED. *Revista Educación a Distancia*, *21*(67). http://dx.doi.org/10.6018/red.470461

Kuru, B. (2021). İş dünyasında 21. yüzyıl becerileri ve Maria Montessori. *Bayburt Üniversitesi İnsan ve Toplum Bilimleri Fakültesi Dergisi*, *4*(8), 19-38. https://dergipark.org.tr/tr/pub/butobid/issue/62281/833566

Maass, K., Geiger, V., Ariza, M. R., & Goos, M. (2019). The role of mathematics in interdisciplinary STEM education. *ZDM, 51*, 869-884. https://link.springer.com/article/10.1007/s11858-019-01100-5

MEB, (2023). 21. yüzyıl becerileri ve değerlere yönelik araştırma raporu. https://ttkb.meb.gov.tr/meb_iys_dosyalar/2023_05/11153521_21.yy_becerileri_ve_degerlere_y onelik_arastirma_raporu.pdf. Erişim tarihi: 18.02.2025

Metin, M., Güler, M. M., & Çevik, A. (2023). 21. yüzyıl becerileri hakkında STEM eğitimi almış fen bilimleri öğretmenlerinin görüşleri. *Studies in EducationalResearchand Development*, *7*(1). https://serd.artvin.edu.tr/en/download/article-file/2853182

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2. bs.). Thousand Oaks, California: Sage.

Muzana, S. R., Wilujeng, I., Yanto, B. E., & Mustamin, A. A. (2021). E-STEM project-based learning in teaching science to ıncrease ıct literacy and problem solving. *International Journal of Evaluation and Research in Education*, *10*(4), 1386-1394. doi: 10.11591/ijere.v10i4.21942

Nazifah, N., & Asrizal, A. (2022). Development of STEM integrated physics E-Modules to improve 21st century skills of students. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1783–1789. https://doi.org/10.29303/jppipa.v8i4.1820

Orak, S. D., & İnözü, J. (2021). Teachers' Awareness and actual practices of 21st century learning and innovation skills. *International Online Journal of Education and Teaching*, *8*(2), 975-997. https://eric.ed.gov/?id=EJ1294172

Önal, İ., & Erişen, Y. (2019). Öğretmen yetiştirme programlarında eleştirel düşünme becerilerinin kazandırılması ihtiyacı. *Akdeniz Üniversitesi Eğitim Fakültesi Dergisi, 2*(1), 62-78. https://dergipark.org.tr/en/pub/akuned/issue/48807/581460

Özdamar, N., & Aydın, O. (2020). Mobil öğrenme ve Türkiye'de açıköğretim faaliyeti yapan üniversitelerin mobil öğrenme uygulamalarının incelenmesi. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi*, *6*(4), 113-154. https://dergipark.org.tr/en/pub/auad/issue/57638/778664

Özer, İ., & Bozkurt, A. T. (2024). Türkiye'de öğretmenlerin 21. yüzyıl becerileri konusunda yayımlanan lisansüstü tezlerin incelenmesi. *Medeniyet Eğitim Araştırmaları Dergisi*, *8*(1), 28-41. https://dergipark.org.tr/en/download/article-file/3942734

Özgür, H., Çuhadar, C., & Akgün, F. (2018). Eğitimde oyunlaştırma araştırmalarında güncel eğilimler. *Kastamonu Education Journal*, *26*(5), 1479-1488. doi:10.24106/kefdergi.380982

Partnershipfor 21st Century Learning. (2019). *P21 resources*. https://www.battelleforkids.org/insights/p21-resources/

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity*, *31*, 31-43. https://doi.org/10.1016/j.tsc.2018.10.002

Qashou, A. (2021). Influencing factors in M-learning adoption in higher education. *Education and Information Technologies, 26*(2), 1755-1785. https://link.springer.com/article/10.1007/s10639-020-10323-z

Quigley, C. F., & Herro, D. (2016). "Finding the joy in the unknown": Implementation of STEAM teaching practices in middle school science and math classrooms. *Journal of Science Education and Technology*, *25*, 410-426. doi: 10.1007/s10956-016-9602-z

Saltan, Y., & Korkmaz, Ö. (2024). Eğitici robot setlerinin etkililiği: 2010-2021 yıllarını kapsayan bir meta analiz çalışması. *Eğitim Teknolojisi Kuram ve Uygulama*, 14(2), 176-197. https://doi.org/10.17943/etku.1358742

Sayın, Z., & Seferoğlu, S. S. (2016, Şubat). *Yeni bir 21. yüzyıl becerisi olarak kodlama eğitimi ve kodlamanın eğitim politikalarına etkisi*. Akademik Bilişim Konferansı, Adnan Menderes Üniversitesi, Aydın. https://yunus.hacettepe.edu.tr/~sadi/yayin/AB16_Sayin-Seferoglu_Kodlama.pdf

Shongwe, B. (2024). The effect of STEM problem-based learning on students' mathematical problem-solving beliefs. *EURASIA Journal of Mathematics, Science and Technology Education*, *20*(8), em2486. https://doi.org/10.29333/ejmste/14879

Talan, T. (2022). *Eğitimde dijitalleşme ve yeni yaklaşımlar*. Efe Akademi Yayınları.

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J.-M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, critical thinking, communication, and collaboration: Assessment, certification, and promotion of 21st century skills for the future of work and education. *Journal of Intelligence*, *11*(3), 54. https://doi.org/10.3390/jintelligence11030054.

Tippett, C. D., & Milford, T. M. (2017). Findings from a pre-kindergarten classroom: Making the case for STEM in early childhood education. *International Journal of Science and Mathematics Education, 15*, 67-86. https://doi.org/10.1007/s10763-017-9812-8

Tytler, R. (2020). STEM education for the twenty-first century. *Integrated Approaches to STEM Education: An International Perspective*, 21-43. https://doi.org/10.1007/978-3-030-52229-2_3

Uluyol, Ç., & Pehlivan, K. (2019). STEM ve eğitimde uygulama örneklerinin incelenmesi. *Türkiye Sosyal Araştırmalar Dergisi*, *23*(3), 848-861. https://dergipark.org.tr/en/download/article-file/907898

Valverde-Berrocoso, J., Garrido-Arroyo, M. D. C., Burgos-Videla, C., & Morales-Cevallos, M. B. (2020). Trends in educational research about e-learning: A systematic literature review (2009–2018). *Sustainability*, *12*(12), 5153. https://www.mdpi.com/2071-1050/12/12/5153

Watson, E. (2020). STEM or STEAM? The critical role of arts in technology education (and the critical role of art in technology). *Irish Journal of Academic Practice, 8*(1). https://doi.org/10.21427/EQZB-VB42

Yıldırım, A. & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri*. Ankara: Seçkin.

Zağlı, M. İ., Samur, M., Budak, İ., Yetişgin, K., & Aslan, M. (2022). Karakter eğitimi üzerine yapılmış lisansüstü çalışmaların incelenmesi: Bir içerik analizi çalışması. *International Journal of Social and Humanities Sciences Research (JSHSR)*, *9*(86), 1577-1583. https://jshsr.org/index.php/pub/article/view/147

Zhou, L. (2023). How to develop 21st century skills in students: The role of LEGO education. *Science Insights Education Frontier*, *15*(2). https://doi.org/10.15354/sief.23.co066

Zuwanda, M. E., Sumarni, S., & Sulistyaningrum, S. D. (2021). Designing life and career skills-integrated speaking syllabuses for English language education study program. *SAGA: Journal of English Language Teaching and Applied Linguistics*, *2*(2), 145-162. https://doi.org/10.21460/saga.2021.22.84