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Tomorrow's Teachers and Artificial Intelligence: Exploring Attitudes and Perceptions of Turkish Prospective Social Studies Teachers

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Abstract

Over the past few years, artificial intelligence (AI) has become one of the prominent concepts closely associated with education. Despite this proximity, studies exploring the attitudes and perceptions of prospective teachers towards AI are still scarce. In this point, the current research aimed to investigate the attitudes and perceptions of prospective social studies teachers towards AI. The research adopted the convergent parallel design, one of the mixed research methods. The results revealed that prospective teachers' attitudes towards AI differed according to the variable of perceived AI knowledge. Accordingly, those who described their knowledge about AI as high exhibited significantly more positive attitudes compared to those with average and low knowledge. In addition, the study determined that the positive attitudes of male prospective teachers were significantly higher than female prospective teachers, and their negative attitudes were significantly lower. However, the results indicated that positive and negative attitudes did not differ significantly according to the variables of grade level and daily internet usage. Further, the qualitative findings highlighted a significant lack of understanding regarding the definition and scope of AI. The study observed that a significant number of prospective teachers' definitions of AI were theoretically baseless. Many of them highlighted that AI could become a major threat in the future. Despite their concerns, they struggled to identify a specific reason behind these potential threats. Moreover, most prospective teachers could not provide examples of AI technology other than dialog systems such as ChatGPT and Siri applications. Although they gave examples of different types of applications supported by AI, they could not sufficiently explain the AI systems on which these applications were based. All these results are evaluated as a situation that reveals the necessity of AI education for prospective teachers.

Keywords: Artificial intelligence, Prospective teachers, Social Studies

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Geleceğin Öğretmenleri ve Yapay Zekâ: Türk Sosyal Bilgiler Öğretmen Adaylarının Tutum ve Algılarının İncelenmesi

Öz

Yapay zekâ (YZ), özellikle son birkaç yılda eğitimle yakından ilişkilendirilen kavramlardan birisi haline gelmiştir. Tüm bu yakınlığa karşın öğretmen adaylarının YZ'ye yönelik tutum ve algılarını araştıran çalışmaların oldukça sınırlı olduğu görülmektedir. Bu noktada, ilgili araştırmanın amacı Sosyal Bilgiler öğretmen adaylarının YZ'ye yönelik tutum ve algılarının incelenmesidir. Karma araştırma yaklaşımlarından birisi olan yakınsayan paralel desen kapsamında yürütülen çalışma sonucunda öğretmen adaylarının tutumlarının algılanan YZ bilgisi değişkenine göre farklılaştığı belirlenmiştir. Bu noktada YZ'ye yönelik bilgi düzeyini yüksek olarak nitelendiren öğretmen adaylarının pozitif tutumlarının bilgi düzeyini ortalama ve düşük olarak nitelendiren öğretmen adaylarına göre anlamlı düzeyde yüksek olduğu bulgulanmıştır. Bununla birlikte erkek öğretmen adaylarının pozitif tutumlarının kadın öğretmen adaylarına göre anlamlı düzeyde yüksek, negatif tutumlarının ise anlamlı olarak düşük olduğu belirlenmiştir. Pozitif ve negatif tutumlar ile sınıf düzeyi ve günlük internet kullanımı değişkenleri arasında ise anlamlı ilişkiler gözlenmemiştir. Sosyal bilgiler öğretmen adaylarının nitel sorulara verdiği yanıtlar ise YZ'nin tanımı ve kapsamı üzerine önemli bir kavrayış eksikliğine sahip olduklarını göstermiştir. Nitekim öğretmen adaylarının önemli bir kısmının YZ üzerine gerçekleştirdiği tanımlamaların teorik açıdan temelsiz olduğu görülmüştür. Öğretmen adaylarının önemli bir kısmı YZ ile ilişkili tehditlerden söz etmiş, ancak bu tehditleri belirgin bir sebebe bağlayamamıştır. Dahası öğretmen adaylarının önemli bölümü ChatGPT ve Siri uygulamaları gibi diyalog sistemleri dışında herhangi bir YZ teknolojisi örneği verememiş, farklı türdeki YZ destekli uygulamalardan söz etseler de bu uygulamaların alt yapısını oluşturan YZ sistemlerini ifade edememişlerdir. Tüm bu sonuçlar ise öğretmen adaylarına yönelik YZ eğitiminin gerekliliğini ortaya koyan bir durum olarak değerlendirilmiştir.

Anahtar Kelimeler: Öğretmen adayları, Sosyal bilgiler, yapay zekâ

Introduction

The widespread adoption of AI technologies in recent years has affected people's lifestyles and led to significant changes in their daily lives. The concept of AI, which was once confined to the realm of science fiction, has integrated into our daily routines, becoming ubiquitous across society – from autonomous vehicles and smart homes to digital assistants (Southworth, et al., 2023). Currently, AI applications impact nearly all fields of activity, especially industry, banking, insurance, health, and defense fields (Ganascia, 2018). Education is among the fields where AI technologies are extensively employed. Studies in this field have led to the emergence AI in education (AIED) and, in time, AI has evolved into one of the crucial concepts of contemporary educational technology (Martín Núñez et al., 2023).

Today, AI technologies are actively involved in crucial aspects of the education, including "Learning", "Teaching", "Assessment", and "Administration" (Chiu et al., 2023). Baker et al. (2019) state that AI tools in education serve across three categories: "Learner-facing", "Teacher-facing", and "System-facing". "Learner-facing" tools cover the roles of AI in enhancing students' learning processes, while "Teacher-facing" tools encompass the functions of AI in supporting teachers during the teaching process. "System-facing" tools encompass the functions of AI in providing information to education administrators and aiding them in making effective decisions. Further, Hwang et al. (2020) classified the roles of AI in education based on studies conducted in the field. According to their research, AI in education serves roles such as intelligent tutor, intelligent tutee, intelligent learning tool/partner, and policy-making advisor.

The relevant literature indicates that different AI technologies such as intelligent tutoring systems, adaptive/personalized learning systems, facial recognition software, chatbots, automated assessment systems, recommendation systems, and intelligent tutees are used in education (Akgun & Greenhow, 2021; Hwang et al., 2020). In the educational landscape, these technologies provide teachers with numerous new tools and intelligent services to facilitate

students' learning (Adams et al., 2023). Thanks to these tools, teachers have the opportunity to provide students with personalized learning experiences and real-time feedback. In addition, by automating the tasks performed by the teacher, they liberate teachers from time-consuming tasks, allowing them to focus on higher-level responsibilities such as curriculum development and student mentoring (Chan & Tsi, 2023). Moreover, while increasingly used by educators at all levels of education (Chen et al., 2020), these technologies encourage a learning process that can be adapted to students' competencies and activate rich learning experiences where interaction is more intense (Annamalai et al., 2023; Rizvi et al., 2023).

In summary, AI-assisted technologies make their presence felt in every aspect of education. While aiding teachers to improve their teaching efficacy by providing novel opportunities, they possess substantial potential to enhance students' learning by promoting autonomous, personalized, and rich learning experiences. In addition, they promise to take over routine tasks performed by teachers, analyze student performance and provide essential insights into students' interests and needs. All these aspects bring about a range of advantages for teachers that would be challenging to obtain otherwise (Hwang et al., 2020). However, today, most teachers lack a fundamental understanding of AI. Additionally, they struggle to effectively employ AI technologies in educational processes (Kim & Kwon, 2023). A body of research confirms this situation. Lindler and Berges (2020) revealed that German teachers had superficial knowledge about AI, and their knowledge did not contain technical depth. Similarly, Chounta et al. (2022) conducted a study with Estonian K-12 teachers and found that teachers had limited knowledge about AI and a significant lack of understanding regarding the use and potential of AI in education.

This deficiency in teachers' knowledge could result in vague perceptions and negative attitudes towards the use of AI in education. This could potentially hinder teachers from effectively incorporating AI technologies into their learning and teaching processes (Chiu et al., 2023). In order to overcome this situation, fostering positive attitudes and perceptions towards AI among teachers could have a significant impact on integrating AI technologies into their classrooms (Celik et al., 2022). This situation has also been supported by various studies. For example, Wang et al. (2021) found that teachers' attitudes towards AI had a significantly positive effect on their behavioral intention to use AI technologies in teaching. Similarly, Al Darayseh (2023) determined that science teachers' attitude towards AI applications positively and significantly predicted their behavioral intention to use AI applications in science teaching. Given that perceptions are closely related to attitudes (Pickens, 2005), and may play a role in shaping the attitudes towards AI (Sindermann et al., 2022), it can be argued that equipping prospective teachers, who will play pivotal roles in future education processes, with positive attitudes and perceptions towards AI is an essential requirement.

Beside this, understanding attitudes and perceptions towards AI and machine learning is crucial for guiding AI's adoption (Grassini, 2023; Hopcan et al., 2023). Given that education systems worldwide have transitioned to learning-teaching processes enriched with AI, understanding perceptions of prospective teachers and examining the factors influencing their attitudes may help in transforming potential negative attitudes and perceptions into positive ones. This transformation, in turn, can motivate prospective teachers to adopt AI technologies in their future teaching careers. Further, considering that social studies, with its aim to prepare young people as active citizens of today and the future, occupies a significant role within the education systems, it becomes crucial to assess the attitudes of prospective social studies teachers towards AI, along with their perceptions that can directly influence these attitudes. Moreover, technological tools have a central role in social studies (Lee & Friedman, 2009), and in its current form, AI holds great promise for transforming the practice and pedagogy of social studies education (Berson & Berson, 2023; Stuckart & Berson, 2009). Additionally, there is a growing interest in teaching students about AI within the social studies classes (Yetişensoy & Rapoport, 2023). It can be argued that, to effectively respond to the new needs shaped by AI in social studies education, it is imperative for social studies teachers to maintain positive attitudes towards AI and base their AI perceptions on accurate and reliable information. For this reason, it can be said

that there is a need for studies aimed at determining the perceptions and attitudes of prospective social studies teachers towards AI.

In this point, this research aims to investigate the attitudes and perceptions of prospective social studies teachers towards AI. In the continuation of the study, a comprehensive literature review was presented based on studies that examine the relationship between AI and prospective teachers. Subsequently, attitudes and perceptions towards AI were assessed, and research questions were detailed based on identified gaps in the literature.

Literature Review and Study Questions

AI and Prospective Teachers

In-service teachers are traditionally considered one of the primary stakeholders in AI-enriched education processes (Celik et al., 2022). The relevant literature indicates that there is significant research concerning the relationship between in-service teachers and AI (Sanusi et al., 2022; Yau et al., 2023). Recently, prospective teachers, who will play a pivotal role in future educational processes, have also become subjects of comprehensive studies in the field of AIED. Prospective teachers being the subjects of these studies, on the other hand, have heightened the emphasis on providing them with the necessary pedagogical knowledge and practical skills to incorporate AI into their lessons (Tate et al., 2023). However, there exists a significant global deficiency when it comes to the integration of AI into teacher education programs (Frimpong, 2022; Karsenti, 2019). Sanusi et al. (2022), who evaluated this situation, stated that teacher education programs could not keep up with the increasing impact of AI in K-12 education and emphasized the necessity of integrating AI education into teacher education programs. One of the comprehensive assessments on the relationship between teacher education and AI technologies was made by Trust et al. (2023). The relevant study emphasized the advantages and disadvantages that advanced AI technologies such as ChatGPT might cause in the field of education and the necessity of organizing teacher training programs to help teachers adapt to these new conditions. At this point, they recommended to teacher educators that prospective teachers should be encouraged to incorporate AI tools into their teaching practices. They also suggested that prospective teachers should be given opportunities to think critically about and interact with AI technologies. Additionally, they recommended that teacher educators should adopt the role of becoming role models in critically evaluating the information and teaching materials produced by AI tools. Finally, they emphasized "Teaching about AI", and recommended that prospective teachers should be encouraged to incorporate AI education into their practices (Trust et al., 2023).

When the literature is examined, it is seen that there are studies addressing the development of AI education programs for prospective teachers (Kim, 2021; Jun et al., 2022). Park (2023), who carried out one of these studies, prepared a 15-week AI training program for Korean prospective teachers consisting of "AI Literacy Education," "AI-Linked Subject Education," and "Micro-teaching" sections and examined the effect of the program. Park (2023) observed that there were positive changes in the prospective teachers' awareness and perceptions towards both AI and its practical use in education. A very comprehensive study on this subject was conducted by Frimpong (2022) as part of a master's thesis. Emphasizing that most prospective teachers today lacked a general understanding of AI, Frimpong (2022) prepared a 4-week AI training program for Ghanaian prospective teachers. Within the program's scope, it was provided prospective teachers with an understanding of AI's basic structure and concepts. As a result, it was observed that prospective teachers' perceptions of AI became more conscious and theoretically supported. Moreover, the study found that this training significantly and positively affected the prospective teachers' AI readiness and confidence in AI. In addition, the study determined that this course increased the attitude and intrinsic motivation towards AI and reduced AI anxiety. Still, these differences were not found to be significant.

The current literature also reveals several studies examining teacher candidates' understanding of AI through short-term activities. For example, Farris and Kim (2022) designed activities that included hands-on experiences on machine learning and AI for 23 prospective

teachersfrom different fields. At the end of the activities, the study observed that there were improvements in the prospective teachers' understanding of machine learning, as well as their ability to establish connections between machine learning and the disciplines they would teach. Lozano and Blanco-Fantao (2023) conducted an activity with 118 Spanish prospective teachers using the ChatGPT application. Prospective teachers, whose knowledge level about ChatGPT was low before the application, pointed out after the relevant activity that their perceptions about the ChatGPT and its use in education were positive. Mike and Rosenberg-Kima (2021) designed a machine learning module for Computer Science Prospective Teachers. After teaching the basics of machine learning, prospective teachers were asked to identify similarities between human learning theories and machine learning algorithms.

In addition to all these, there are qualitative studies addressing prospective teachers' perceptions of AI (Haseski, 2019) and its use in education (Chee & Hong, 2023). Furthermore, it is observed that there has been an increase in studies recently pointing to the perceptions of prospective teachers towards AI-related technologies. Ballantyne (2021), who conducted one of these studies, examined perceptions of prospective teachers on the use of an intelligent tutoring system for English language proficiency. Moreover, Yang (2022) examined perceptions of prospective teachers on AI-powered chatbots in education. While Incerti (2020) examined prospective teachers' perceptions of AI tutors for learning, Sumakul et al. (2022) investigated prospective teachers' perceptions of the use of AI in a writing class.

Although there are qualitative studies on the relationship between teacher candidates and AI, there is a lack of studies examining the AI-related attitudes of prospective teachers and the variables that influence these attitudes. Indeed, the few studies in the literature that examine attitudes of educators towards AI-related technologies have all focused on in-service teachers without considering the variables that affected these attitudes (Cojean, et al., 2023; Kuleto, et al., 2022; Nazaretsky, et al., 2021). The only study related to this subject in the literature was conducted by Hopcan et al. (2023). The related study, which was based on prospective teachers' anxiety about AI and their attitudes towards machine learning, included two research questions regarding whether attitudes towards machine learning differed according to the department and gender. The results indicated that the general attitudes of prospective teachers did not differ according to gender. However, significant differences were observed according to the department studied.

In addition to all these, there are also studies that deal with the AI and prospective teacher relationship within the framework of technology acceptance. Zhang et al. (2023), who conducted one of these studies, examined the relationship between AI and prospective teachers within the framework of the Technology Acceptance Model (TAM). The results highlighted complex factors affecting prospective teachers' intentions to use AI-based educational applications. Cojean and Martin (2022) conducted a study with 406 French prospective teachers studying in master's degrees using the Unified Theory of Acceptance and Use of Technology (UTAUT) model. As a result, they found that prospective elementary school teachers expected higher performance from technology involving AI, but primarily for the purpose of content generation. However, prospective middle-school teachers were more inclined to accept technology involving AI for tasks with higher-added value.

Research on the relevant subject indicates an increasing interest in the relationship between prospective teachers and AI. At this point, research highlights that AI education for prospective teachers has become an important issue, and theoretical and practical studies on training prospective teachers about AI and its applications in education are increasing. The studies on AI training for prospective teachers indicates that most of them are carried out through detailed program designs or short-term activities, and the relevant practices aim to provide prospective teachers with a basic understanding of AI, the ability to use AI as a supporting power in teaching, and the competency to teach AI to students when necessary. Moreover, although limited in number, there are also studies addressing the acceptance of prospective teachers towards technologies related to AI. In addition to all these, the literature suggests that there are

studies that examine the perceptions of prospective teachers regarding AI, and these studies generally focus on a specific AI technology.

On the other hand, there is a notable absence of studies that investigate the attitudes of prospective teachers towards AI, particularly within the framework of the influencing variables, along with the studies addressing prospective teachers' general perceptions on AI. At this point, there is a requirement for studies that simultaneously examine the attitudes and perceptions towards AI, which are closely interconnected concepts in the context of AI-teacher education and discuss them through associations in the light of current literature. The current study will contribute to the literature in terms of evaluating the attitudes and perceptions of teacher candidates towards AI in a process where quantitative and qualitative processes are employed as well as discussing the combined results in the context of current debates in education.

Attitudes and Perceptions towards AI

Attitudes towards AI

One of the concepts that the current study investigated was "Attitudes towards AI." Various studies conducted in the literature demonstrate that there are different views about AI in the society, and people's attitudes towards AI can vary considerably (Neudert et al., 2020; Zhang & Dafoe, 2019). It is believed that individuals' general attitudes towards AI are likely to play a role in their acceptance of AI technologies (Schepman & Rodway, 2020). However, the factors affecting attitudes towards AI have not been sufficiently researched in the literature (Sinderman et al., 2022). In this point, investigating the factors affecting these attitudes can be considered as a necessity (Schepman & Rodway, 2023). When reviewing the literature, no study was found that examines the factors affecting the attitudes of educators, such as in-service teachers, prospective teachers, and educational administrators, towards AI from a quantitative perspective. Therefore, this study is expected to play a crucial role in filling this relevant gap. In this regard, the first research question for which an answer is sought is as follows.

- *1. What are the attitudes of prospective social studies teachers towards AI?*

Although the relevant research question aims to reveal the general situation regarding the attitudes of prospective teachers, it includes four sub-questions that investigate the attitudes of prospective teachers towards AI concerning different variables. In this context, the variables to be investigated for their impact on the attitudes of prospective teachers towards AI were identified as "Gender", "AI knowledge", "Class level", and "Daily internet usage time".

The current literature indicates that the influence of the gender factor on attitudes towards technology has been frequently studied. A common finding in these studies is that men are more likely to embrace technology than women, often due to their greater interest in technology (Cai et al., 2017). However, studies on the relationship between gender and AI technologies are still scarce. Zhang et al. (2023), who conducted a comprehensive evaluation of this subject, discussed the reasons why men might be more inclined to accept AI than women. The results indicated that women had less experience with technology and fewer opportunities for exposure to STEM fields compared to men. In addition, the stereotype that men are better than women at using AI may cause women to feel a sense of inadequacy regarding AI. Additionally, the fact that women are often more risk-averse and cautious than men may lead them to develop distrust and negative attitudes towards AI. Despite these insights, studies addressing the effect of gender on attitudes towards AI remain relatively scarce. Furthermore, the impact of gender on the attitudes of educators, including prospective teachers, towards AI has not yet been investigated. At this point, another question of the research is as follows:

- *1.1. Does gender make a significant difference in the attitudes of prospective teachers towards AI?*

The second variable examined within the scope of the study was perceived AI knowledge. It is a well-known fact that today, a significant portion of society lacks a basic understanding of AI, and unrealistic scenarios such as science fiction elements and conspiracy theories significantly

influence individuals' thoughts about AI (Branuer et al., 2023). Furthermore, this lack of knowledge in society about AI and the necessity of educational initiatives to address this deficiency are also subjects of discussion (Kaya et al., 2022). When considering this situation in the context of education, it is evident that there is a significant deficiency in AI training for prospective teachers (Sanusi et al., 2022). Considering that prospective teachers, unlike the general population, will be active users and instructors of AI in educational environments in the future, it can be essential for them to acquire a basic understanding of AI. However, no study has been found that examines whether AI knowledge significantly affects prospective teachers' attitudes towards AI. In this regard, another question of the research is as follows:

- *1.2. Does perceived AI knowledge make a significant difference in the attitudes of prospective teachers towards AI?*

The third variable of the study was “Class level". The relevant literature indicates that there are studies investigating whether age factor has an effect on attitudes towards AI (Eurobarometer, 2017; Gillespie et al., 2021; Kaya et al., 2022). However, there are no studies indicating the effect of the grade level. As the class level of university students increases, it can be thought that their experiences such as academic discussions and research projects, as well as their daily experiences with technology, may lead to an improvement in their understanding of AI. Moreover, when the social studies teacher education program implemented in Türkiye is examined (CoHE, 2018), it is seen that as the grade level increases, students take many courses closely related to technology. These courses include "Information Technologies", "Instructional Technologies", "Science, Technology, and Society", "Open and distance learning”, "Material design in social studies teaching", and "Information technologies in social studies". These courses, which are not directly related to AI but aim to improve the student's perspective on technology, can have the potential to change the attitudes of prospective teachers towards AI. At this point, the grade level variable was also included in the study to examine whether it had a significant effect on attitudes towards AI. In this context, the subsequent question of the research is as follows:

- *1.3. Does grade level make a significant difference in the attitudes of prospective teachers towards AI?*

The last variable examined in the study to determine its significant effect on attitudes was "Daily internet usage time." The research on the subject highlights that studies investigating the impact of daily internet use on attitudes towards AI are limited. One study on this subject revealed that as the time of internet usage increases, attitudes towards AI becomes more favorable (Eurobarometer, 2017). Another study found that individuals with more experience using smartphones held more positive attitudes towards various AI-supported applications (Martin et al., 2020). However, the existing studies are at an insufficient level. Furthermore, there has been a significant increase in AI-related content on social media, especially in light of recent advancements in AI. It is conceivable that the amount of time prospective teachers spend on the internet may influence their exposure to relevant AI-related content, and this exposure is likely to shape their attitudes towards AI. Hence, there is a need for the current and new studies examining whether daily internet usage can make a significant difference in prospective teachers' attitudes towards AI. For this reason, the variable of daily internet usage was also included in the study as another variable. The research question aimed at examining the impact of this variable is as follows:

- *1.4. Does daily internet usage time make a significant difference in the attitudes of prospective teachers towards AI?*

Perceptions towards AI

Another essential concept examined within the scope of this study is "Perceptions towards AI." The relevant literature highlights those studies addressing individuals' perceptions of AI in various fields, such as health, education, and banking, have increased in recent years (Albarrán Lozano et al., 2021). Branuer et al. (2023), who drew attention to the growing academic interest

in perceptions towards AI, stated that various factors, such as thoughts concerning the advantages of AI, elements from science fiction, uncertainties about the technology, potential threats, and fears, played essential roles in shaping these perceptions. They also highlighted the necessity of providing individuals with a basic understanding of the potential and limitations of AI. Hick and Ziefle (2022) stated that perceptions towards AI were important since they could play a crucial role in integrating AI into society and daily life. Robb et al. (2020) highlighted the potential impact of perceptions towards AI on technology usage. They argued that negative perceptions about AI could create resistance against its adoption and utilization. This resistance, in turn, could have adverse effects on the development and realization of the potential benefits that AI systems could offer. Evaluating this situation in the context of education, Kim and Kim (2023) stated that educators' perceptions towards AI could affect their willingness to adopt new educational technologies. In addition, they pointed out that initiatives aimed at transforming teachers' current negative perceptions of AI into positive ones might positively affect the acceptance of AI in educational environments.

As pointed out in related studies, educators' perceptions of AI are crucial, as these perceptions can influence their decisions to use and adopt AI technologies. Moreover, the perceptions of prospective teachers, who will play a significant role in shaping future education practices, towards AI can be considered equally important. Thus, there is a need for studies that investigate the AI perceptions of prospective teachers. When examining the studies mentioned under the heading "Artificial Intelligence and Prospective Teachers" it becomes apparent that research on prospective teachers' perceptions of AI often focus on specific technologies used in education. Furthermore, there is a noticeable lack of comprehensive studies that provide insights into the general perceptions of prospective teachers towards AI. Additionally, the release of ChatGPT in November 2022, which is considered a significant game changer in the field of education, has led to increased discussions and awareness about AI technologies in society. In light of this development, there is a need for studies to reveal the current and latest perceptions of prospective teachers towards AI. In this regard, the second research question for which an answer is sought is as follows:

- *2. What are the perceptions of prospective social studies teachers regarding AI?*

Method

Research model

The research was carried out using the convergent parallel design, one of the mixed research methods. In this design, qualitative and quantitative data are collected, analyzed and the results are combined to create a more holistic picture (Creswell, 2021). In this study, a group of participants from those involved in the quantitative part of the research volunteered to take part in the qualitative aspect, and qualitative data were collected from these participants. By integrating the quantitative and qualitative data, the research made an attempt to reveal meaningful results. At this point, while the quantitative part of the research was conducted using the basic survey design, which involve large samples to determine individuals' characteristics such as interests and attitudes (Büyüköztürk et al., 2017), the qualitative part was designed following the basic qualitative research pattern (Merriam, 2009).

Participants

The participants of this research consisted of 342 prospective social studies teachers studying in the social studies teaching programs at four different universities in Türkiye. The convenience sampling method was used in selecting the participants. In this method, participants are asked whether they are suitable to participate in the study or a group of participants who are easy to participate in the study is formed (Christensen et al., 2015). In this study, prospective teachers who volunteered to participate were reached, and the application process was conducted based on their willingness to take part in the research. The demographic characteristics of the study group are presented in Table 1.

Table 1.
Demographic characteristics of the study group

Demographic characteristics		f	%
Gender	Female	250	73.1
	Male	92	26.9
Grade level	First grade	82	24.0
	Second grade	93	27.2
	Third grade	88	25.7
	Fourth grade	79	23.1
Total		342	100

Table 1 showed that 250 of the participants were female prospective teachers and the number of prospective male teachers was 92. Table 1 further highlighted that 82 of the prospective teachers were at the first grade, 93 at the second grade, 88 at the third grade and 79 at the fourth-grade level. This revealed that the distribution of the participants according to their grade levels displayed a balanced representation. In addition, 128 prospective teachers in the quantitative dimension of the research also participated in the qualitative part of the research and expressed their perceptions regarding AI.

Data Collection Tools

The Attitude Scale towards AI, developed by Schepman and Rodway (2020, 2023) and adapted to Turkish culture by Kaya et al. (2022), was used to collect data for the first research question. The scale follows a 5-point Likert-type format and consists of 20 items. The first 12 items assess positive attitudes towards AI, while the remaining eight items reveal negative attitudes towards it. The internal consistency reliability of the Turkish version of the scale is satisfactory, with a= .82 for the positive attitude dimension and a= .84 for the negative attitude dimension. Furthermore, the researcher also designed a personal information form as an additional data collection tool for the first research question. This form contains closed-ended questions regarding participants' gender, grade level, level of knowledge about AI, and daily internet usage time. For the second research question, the primary data collection tool is an open-ended qualitative questionnaire, developed in accordance with expert opinions. In this questionnaire, participants were asked several questions to provide their own definitions of AI, express their general thoughts about it with specific reasons, and give examples of AI technologies they were familiar with.

Data Collection Process

The data for the research was initially planned to be collected in face-to-face interviews. However, due to an earthquake that led universities transitioning to online education nationwide, the data was collected online during the summer of 2023. In this regard, a form consisting of two sections, was formed using Google Forms. The first part of the form included the personal information form and the Attitude Scale towards AI. The second part of the form was designed as a questionnaire containing open-ended questions. The first part was filled out by 345 prospective teachers. However, the response forms of 3 prospective teachers were excluded from the study due to incomplete filling out of some scale items and random markings, leaving a total of 342 prospective teachers included for data analysis. Out of the 342 prospective teachers, 128 of them responded to the open-ended questions and participated in the qualitative part of the research. Throughout the entire process, voluntarism was emphasized, and the relevant form included explanations and instructions to ensure the smooth running of the data collection process.

Data Analysis

For the first question of the study, quantitative data analysis was utilized. Initially, the researcher planned to conduct a multivariate analysis of variance (MANOVA) to examine the prospective teachers' attitudes towards AI in terms of various variables. However, due to the violation of the normal distribution assumption for MANOVA, the researcher conducted separate comparison tests for each variable instead. To determine the appropriate analysis type to be used, normality tests were conducted. The normality of the scores in the positive and negative attitude dimensions for each categorical variable was examined. The Kolmogorov-Smirnov test, recommended for sample sizes of 50 and above (Büyüköztürk, 2007), and the kurtosis and skewness values suggested to be between +1 and -1 (Şencan, 2005) were taken into consideration when deciding on normality.

The analysis revealed that the group scores were far from normal distribution both in the positive and negative attitude dimensions towards AI. Therefore, a non-parametric test, the Mann-Whitney U test, was employed to examine the relationship between prospective teachers' attitudes towards AI and the gender variable. The attitudes of prospective teachers towards AI were examined in relation to their AI knowledge level, internet usage time, and grade variable using the Kruskal-Wallis test. Post-hoc Mann-Whitney U tests were conducted to determine which specific groups showed significant differences after obtaining significant results from the Kruskal-Wallis test. To control the probability of Type I error that could arise from multiple comparison tests, a Bonferroni correction was applied before conducting these tests, and the significance level of 0.05 was divided by the number of multiple comparison tests. The Statistical Package for the Social Sciences (SPSS) 28 was employed in all these processes.

The qualitative data of the research, on the other hand, were analyzed using inductive analysis approach. Inductive analysis involves uncovering hidden patterns, categories, and themes within the data, and presenting them as a meaningful whole (Patton, 2002). Accordingly, the data were analyzed using the inductive analysis approach, and codes were generated based on the identified patterns. These codes were then grouped into sub-themes (categories), and sub-themes were further grouped into main themes. To ensure the credibility of the research, peer debriefing was employed as a method (Yıldırım & Şimşek, 2016). For this, approximately 30% of the qualitative data, which were analyzed with the inductive approach, were re-analyzed by a social studies educator experienced in qualitative research. The researcher and the expert compared their analysis results and engaged in discussions until reaching a consensus on the analyses.

Findings

Findings Regarding the Attitudes of Prospective Social Studies Teachers towards AI

The descriptive statistics results regarding the positive and negative attitudes of prospective social studies teachers towards AI are presented in Table 2.

Table 2.
Descriptive statistics results about the attitudes of social studies teacher candidates towards AI

Attitudes towards AI	N	x̄	Sd	Min	Max
Positive Attitudes	342	44.43	7.10	12.00	60.00
Negative Attitudes	342	24.1	5.47	10.00	40

Table 2 indicated that the mean of the positive attitudes was 44.43. Considering that the lowest score that could be obtained from the positive attitude dimension of the scale was 12, and the highest score was 60, the prospective teachers' positive attitudes were relatively above average. On the other hand, the negative attitudes of prospective teachers indicated that the mean attitude was 24.1. Considering that the lowest score that could be obtained from the negative

attitude dimension was 8, and the highest score was 40, the prospective teachers had an average negative attitude. However, considering the minimum and maximum values for positive and negative attitudes, it became evident that prospective teachers' attitudes exhibited a variable structure.

Findings on Examining the Attitudes of Prospective Social Studies Teachers towards AI According to the Gender Variable

The results obtained from the Mann-Whitney U test, which was conducted to determine whether the attitudes of prospective social studies teachers towards AI differed according to the gender variable, are presented below.

Table 3.
Mann Whitney U test results on the relationship between prospective social studies teachers' attitudes towards AI and gender variable

Dimensions of Attitude	Groups	Mean Rank	Sum of Ranks	U	Z	p
Positive Attitudes	Male	198.88	18296.50	8981.500	-3.111	.002
	Female	161.43	40356.50			
Negative Attitudes	Male	151.85	13970.00	9692.000	-2.234	.026
	Female	178.73	44683.00			

Table 3 indicated that there was a statistically significant difference between the positive attitudes of male prospective teachers and female prospective teachers towards AI (U=8981.500, p= 0.002). Upon analyzing the mean ranks, it became apparent that this difference was in favor of male prospective teachers. The negative attitudes of prospective teachers towards AI, on the other hand, highlighted that their negative attitudes differed significantly in favor of female prospective teachers (U=8981.500, p= 0.026). This result indicated that female prospective teachers' negative attitudes towards AI were significantly higher than those of male prospective teachers.

Findings on Examining the Attitudes of Prospective Social Studies Teachers towards AI According to the Variable of Perceived AI Knowledge Level

The Kruskall-Wallis test was used to determine whether the attitudes of prospective social studies teachers towards AI differed according to the variable of AI knowledge level. The relevant test results are presented below.

Table 4.
Kruskal Wallis test results for the relationship between prospective social studies teachers' attitudes towards AI and the variable of AI knowledge level

Dimensions of Attitude	Groups	Mean Rank	Sd	X^2	p	Significant Difference
Positive Attitudes	High (A)	249.84	2	12.515	.001	A-B
	Average (B)	169.84	2			A-C
	Low (C)	144.00	2			
Negative Attitudes	High (A)	168.98	2	4.149	.091	
	Average (B)	164.92	2			

Low (C)	193.62	2

Table 4 indicated that the positive attitudes of prospective teachers towards AI differed significantly according to the variable of AI knowledge level, $X^2(sd=2, n=342) = 12.515$, p=.001. However, no significant difference was found between negative attitudes and AI knowledge level ($X^2(sd=2, n=342) = 4.149$, $p = 0.091$).

After determining that there was a significant difference in the positive attitudes of the prospective teachers, Mann Whitney U tests were conducted between the groups in order to determine between which groups this significant difference occured. Prior to conducting these multiple comparison tests, Bonferroni correction was applied, and the significance level was set at 0.0167 for all effects. The results of the multiple comparison tests observed that the difference in positive attitudes towards AI between the groups with high and average AI knowledge levels was significant, favoring the group with high knowledge level (U=1897.500, p=0.001). Similarly, the comparison between the groups with high and low levels of knowledge indicated a significant difference, favoring the group with high knowledge level (U=494.500, p=0.001). However, comparison regarding the group with average knowledge and the group with low knowledge indicated that the positive attitude towards AI differed in favor of the group with average knowledge, but this difference was not significant (U=7386.500, p=0.040).

Findings on Examining the Attitudes of Prospective Social Studies Teachers towards AI according to the Grade Level Variable

The Kruskall-Wallis test was used to determine whether the attitudes of prospective social studies teachers towards AI differed according to the grade level variable. The relevant test results are presented below.

Table 5.
Kruskal Wallis test results for the relationship between prospective social studies teachers' attitudes towards AI and the grade level variable

Dimensions of Attitude	Groups	Mean Rank	Sd	X^2	p
Positive Attitudes	First grade	167.12	2	2.529	.548
	Second grade	164.21	2		
	Third grade	171.28	2		
	Fourth grade	184.87	2		
Negative Attitudes	First grade	179.19	2	.021	.863
	Second grade	169.63	2		
	Third grade	170.86	2		
	Fourth grade	166.43	2		

Table 5 highlighted that the positive attitudes of prospective teachers towards AI did not differ significantly according to the grade level variable ($X^2(sd=2, n=342) = 2.529$, p=0.548). Similarly, there was no significant difference between negative attitudes and grade level ($X^2(sd=2, n=342) = 0.021$, p=0.863). These results indicated that the grade level did not have a significant effect on attitudes towards AI.

Findings on Examining the Attitudes of Prospective Social Studies Teachers towards AI according to the Variable of Daily Internet Usage

The Kruskall-Wallis test was used to determine whether the attitudes of prospective social studies teachers towards AI differed according to the daily internet usage variable. The relevant test results are presented below.

Table 6.
Kruskal Wallis test results for the relationship between prospective social studies teachers' attitudes towards AI and the variable of daily internet usage

Dimensions of Attitude	Groups	Mean Rank	Sd	X^2	p
Positive Attitudes	0-1 hours	191.50	2	3.175	.371
	1-3 hours	161.28	2		
	3-6 hours	170.14	2		
	Above 6 hours	187.53	2		
Negative Attitudes	0-1 hours	48.25	2	1.610	.364
	1-3 hours	171.67	2		
	3-6 hours	172.78	2		
	Above 6 hours	169.41	2		

Table 6 highlighted that the positive attitudes of prospective teachers towards AI did not differ significantly according to the variable of daily internet usage time (X^2(sd=2, n=342) = 3.175, p=0.371). Similarly, no significant difference was found between negative attitudes and daily internet usage time (X^2(sd=2, n=342) = 1.610, p=0.364). These results indicated that daily internet usage did not have a significant effect on the attitudes towards AI.

Findings on Artificial Intelligence Perceptions of Prospective Social Studies Teachers

The answers given by the teacher candidates to the open-ended questions were analyzed using inductive analysis and certain themes were formed. The main themes that emerged from the analysis are presented below.

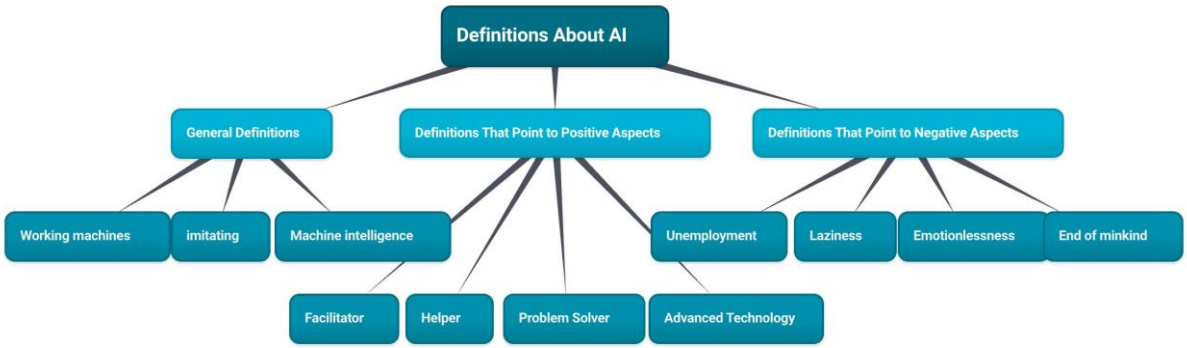
Figure 1.
Main themes related to AI perceptions of prospective social studies teachers

As shown in Figure 1, prospective teachers' perceptions of AI were categorized under three main themes: "Definitions about AI", "Thoughts on AI", and "AI examples". The qualitative findings obtained within the scope of these themes are presented in the continuation of the study.

Definitions about AI

Within the scope of the study, students were asked to provide their definitions of AI. The answers of the students were summarized into three categories: "General definitions", "Definitions that point to positive aspects", and "Definitions that point to negative aspects". The relevant theme and sub-categories within the scope of the theme are presented below.

Figure 2.
Prospective teachers' views in the scope of the theme "Definitions about AI"



General definitions: Prospective teachers provided various definitions for AI. One prominent element in their general definitions of AI was perceiving it as machines that perform human tasks. Some example definitions regarding this aspect are presented below:

Table 7.
Sample prospective teacher definitions 1.

Participants	Example definitions
P121	*It is the fulfillment of human tasks by machines or robots.*
P17	*I can define it as technological tools performing the duties of human beings for them.*
P111	*Artificial intelligence is machines doing human work.*
P73	*They are things developed by humans but mostly able to do human works.*
P3	*It is a technology in which a computer system performs tasks that would otherwise require human effort.*
P118	*It is the fulfillment of some human works and operations by robots or electronic devices through computer software prepared according to certain algorithms.*
P9	*A system that does things digitally that people do.*
P4	*A computer-controlled robot performing human activities with processors.*
P39	*Doing a job that a human can do with coding by an application or robot.*
P12	*It is the situation where a computer or a computer-controlled robot can do things that humans can do.*
P116	*It is the ability to do humane work by making machines more equipped.*
P65	*With the advancement of technology, robots have come to a level that can do most of the work that today's people do. We can call it artificial intelligence.*

The related definitions in general highlighted that a significant part of the participants perceived AI as machines, robots, applications, technological tools, and computer systems doing human work. This perception was clearly seen in participants' statements such as P121, P39, P3, and P17. However, different definitions also showed that AI was perceived as imitating human intelligence. Example definitions are presented below.

Table 8.
Sample prospective teacher definitions 2.

Participant	Example Definitions
P94	*It is doing things that a human can do by imitating human intelligence.*
P50	*Technologies that mimic human intelligence for specific tasks.*

P27	*Artificial intelligence is the name given to the system that processes and organizes information by imitating the intelligence of people.*
P87	*Artificial intelligence is something created with technology that imitates human intelligence.*
P45	*They are systems that imitate humans and sometimes constantly improve themselves like humans.*
P90	*Systems that mimic human intelligence.*
P59	*Artificial intelligence is a computer-assisted technological system. It has content that presents information to people by imitating human intelligence.*
P125	*A system that emerged with the development of technology and imitates human intelligence.*

Table 8 indicated that a significant portion of the participants perceived AI as a machine or technological tool imitating human intelligence. However, another prevalent perception in various definitions was considering AI as the display of intelligence by a machine. Sample definitions on this subject are presented below.

Table 9.

Sample prospective teacher definitions 3.

Participants	Example Definitions
P18	*Thinking machine.*
P23	*It is the transition of the human mind to technology.*
P24	*A computer system that can think like a human.*
P62	*It is the type of intelligence exhibited by machines and robots.*
P13	*As the name suggests, it is unnatural and artificial. It is intelligence developed by machines and systems.*
P105	*It is the interactive mind created by humans and dependent on the command system.*
P106	*Unlike natural intelligence, it is a type of intelligence developed for machines.*
P119	*A system that thinks instead of people at a certain level and acts according to those thoughts.*
P123	*Artificial intelligence is an internet-based system that can process and generate data. It is a thinking system that works mathematically just like the human brain.*

The definitions in Table 9 highlighted that a significant part of the participants perceived AI as a machine having intelligence. Accordingly, a machine's display of human-like intelligence can be defined as AI.

Definitions that point to positive aspects: In addition to the general definitions, the study observed that some definitions made by prospective teachers highlighted the positive aspects of AI. The most frequently emphasized positive aspect in these definitions was the role of AI in facilitating life. Participants such as P92, P55, P66, and P82 provided definitions in this direction. For instance, P82 defined AI as "Intelligent software that makes people's work easier", and P55 defined it as "Any kind of technological device that makes human life easier". P120 defined AI as "A system that is blended with high-level technology and makes human life easier," Similarly, according to P162, AI is a technology designed with human intelligence that facilitates lives and assists people.

The helper role of AI was also reflected in various definitions. For instance, P96 defined AI as "Electronic brains that provide people with more useful information in less time in their work or do things for them", and P2 defined it as "A robot that meets the needs of people". Some definitions pointed to the problem-solving role of AI. For example, P68 defined AI as a technology that solves people's problems by imitating human behavior, while P76 defined it as "A technology

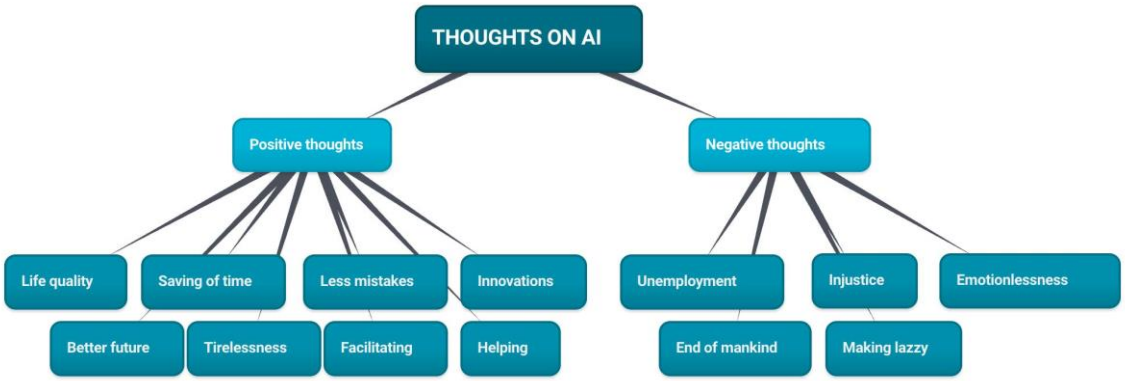
that solve problems faster and more practically than the human mind". In addition, the fact that AI is a highly advanced technology was reflected in various definitions. For example, P98 defines AI as today's most cutting-edge technology. Moreover, according to P8, AI is defined as "An innovation that can make the future of humanity more livable and easier with its superior features". Similarly, P33 defines AI as "A technology that will shed light on the future with its current level of development".

Definitions that point to negative aspects: The study observed that some definitions made by prospective teachers pointed to negative aspects of AI. One topic reflected in the definitions was the potential of AI to take away people's jobs. For example, P75 defined AI as "Robots that will take away people's jobs" while P112 defined AI as "A new system that imitates humans and could have negative effects such as an increase in unemployment issues in the future". Additionally, the perceptions of AI leading humanity towards laziness and being an emotionless technology were reflected in some definitions. For example, P7 defined AI as "A system that will lead people towards laziness" while P80 described it as a technology capable of imitating human intelligence but devoid of emotions. Furthermore, thoughts on the possibility of AI bringing about the end of humanity were reflected in the definitions. For example, the definition of P79 on this matter was "Artificial intelligence is the technology made by human hands but has an effect that can destroy human beings while helping them".

Thoughts on AI

Within the scope of the study, the participants were asked to provide their thoughts about AI. Their answers were summarized into two categories: "Positive thoughts" and "Negative thoughts" The relevant theme and sub-categories within the scope of the theme are presented below.

Figure 3.
Prospective teachers' views in the scope of the theme "Thoughts on AI"



Positive thoughts: Within the scope of the study, some prospective teachers shared thoughts pointing to positive perceptions towards AI. The first one was that AI made human life easier by taking on specific tasks of humans. This situation was expressed by the participants such as P81, P92, and P84. While P54 stated that he saw AI as a way that facilitated human life, P28 said that if AI was used correctly, it would make people's lives easier and make a difference in their lives. The thought of P20 on this issue was as follows: "When used professionally, it can be a magic wand that reduces the burden on people". In addition, the ability of AI to help people when needed was considered as a positive feature by P105, P115, and P124.

Another positive aspect was the potential of AI to improve people's quality of life. P11 and P8 expressed this situation. The advantage of AI in terms of timesaving was also a subject that had been mentioned. At this point, P41, P52, and P56 stated that AI enabled people to perform their daily tasks in a shorter time, thus saving people's time. P19 and P47 emphasized that AI technologies could do human work with less error rate. P44 and P64 noted that they welcomed AI technologies for bringing important innovations to human life. P6, P78, and P101 stated that

AI would shape the future and make the future more livable for people. P126 positively welcomed the ability of AI technologies to work tirelessly, unlike humans.

Negative thoughts: The participants also expressed negative thoughts about AI. Thirty-seven prospective teachers stated that their perceptions of AI were negative. However, a significant number of these prospective teachers did not provide specific reasons for their negative perceptions. Sample statements on this subject are presented below.

Table 10.
Statements pointing to negative perceptions

Participant	Statement
P70	*I think that if it is not used in a controlled manner, it can have bad consequences for humanity, it should definitely be used under the control of the state.*
P36	*I see artificial intelligence as an element that threatens our future.*
P61	*Artificial intelligence can work better than many brains. But it is a technology that will get things out of hand if used maliciously.*
P26	*Artificial intelligence has many benefits, but it is also a technology that is likely to be harmful.*
P31	*While machine intelligence makes human life easier, it can take a very dangerous form.*
P51	*In my opinion, artificial intelligence is an excellent technology when used correctly. However, no technology can be used properly today. The development of artificial intelligence in the future is uncertain. So it can be a little scary.*
P53	*It is useful but dangerous.*
P57	*AI is incredible, exciting, but also very terrifying.*
P107	*AI can be useful to humans, but I think it can have bad consequences if it doesn't get into good hands.*
P59	*If used systematically and wisely, it can be a good thing, but if used incorrectly, it can cause very bad things.*
P21	*It was produced by people to help people. However, it cannot be ignored that artificial intelligence can harm people and the world as a result of misuse.*

Table 10 highlighted that a significant number of the participants perceived AI as a threat. However, as seen in the relevant statements, the prospective teachers did not provide detailed explanations for the sources of these threats. Although the possibility of AI being used for malicious purposes was a frequently mentioned issue, what these misuses might be was not explained. On the other hand, some prospective teachers elaborated on the reasons behind their negative perceptions about AI. One major concern was the potential of AI to cause unemployment by taking away human jobs, which was expressed by P37, P106, P109, and P117. Further, some participants stated that the reason behind this unemployment was that AI would exacerbate inequality. For example, P30 and P88 believed that the unemployment caused by AI would deepen the gap between the rich and the poor, thus exacerbating existing injustices.

Furthermore, some participants expressed concerns about AI making people lazy by relying too much on convenience. This view was shared by P6, P7, P48, P95, and P102. P6 provided an example: "Artificial intelligence may appear useful, but it provides answers quickly, leading people to ignorance. For example, in routine project work, we can immediately find answers without the need to study". Moreover, several prospective teachers pointed out that their negative thoughts about AI stemmed from the possibility that AI might become more powerful than humans and eventually would bring about the end of humanity. For instance, P16 stated that "Artificial intelligence can actually be very useful in the modern world, but it also sounds a bit scary. It is really creepy that the balance of power shifts from human beings to robots". Similarly, P58 highlighted the concern that AI might gain control over humanity in the future, while P72 argued that AI should not surpass human power, and P79 emphasized that if AI became more powerful than humans, it could spell the end of humanity. Besides all these, P22 and P107

mentioned that their negative perceptions of AI were based on the fact that it was an emotionless entity.

AI Examples

Within the scope of the study, prospective teachers were asked to express the AI technologies they knew. Examples of AI technology/application given by prospective teachers are presented in Table 11.

Table 11.
AI technology/application examples expressed by the prospective teachers

AI Technology/Application	F	AI Technology/Application	F
ChatGPT	56	Google Maps	4
Digital assistants	22	Navigation	3
Face recognition system	17	Soundraw	3
Smart home systems	16	Midjourney	3
Siri	13	Timely	2
Google Assistant	10	Amazon Alexa	2
Autonomous cars	10	Bing AI Chatbot	2
Robots	9	Discord	2
Chatbot	7	Chatsonic	2
Snapchat my AI	5	Natural language processing	2
Hotpot AI	5	Google Bard	2
Search engines	5	Canva AI	1
Robot vacuum cleaner	4	YouChat	1
Translation programs	4	Krisp	1
Image processing	4	Socratic	1
Dall-e	4	Age estimation systems	1
Unmanned aerial vehicles	4	Compose AI	1
Total			228

Table 11 indicated that the most frequently cited AI technologies/applications by prospective teachers were related to dialogue systems. In this regard, ChatGPT was mentioned by 56 prospective teachers as the most common example of AI. Additionally, prospective teachers mentioned digital assistants 22 times, Siri 13 times, Google Assistant 10 times, Chatbot 7 times, Snapchat My AI 5 times, Alexa 2 times, Chatsonic 2 times, Google Bard 2 times, Bing AI Chatbot 2 times, and YouChat 1 time. Out of the 228 technology examples provided by prospective teachers, the fact that 122 of them were related to dialogue systems demonstrated that the most familiar AI-supported technologies for prospective teachers were AI-powered dialogue applications. However, despite their familiarity with these dialogue applications, prospective teachers fell short in expressing the fundamental AI technologies underlying these applications. In fact, natural language processing was only mentioned by P24 and P56.

Following dialogue systems, the most frequently mentioned AI technology by prospective teachers was facial recognition systems. While this technology was mentioned by 17 prospective teachers, similar to dialogue systems, prospective teachers were insufficient in expressing the underlying fundamental technologies of this technology. Indeed, image processing used in facial recognition was only mentioned by P24, P25, P81, and P94. Another technology example frequently mentioned by prospective teachers was applications capable of generating/editing images using AI. In this context, Hotpot AI was mentioned by 5, Dall-e by 4, Midijourney by 3, and Canva AI by 1 prospective teachers. Furthermore, smart home systems were mentioned by 16, robots by 9, robotic vacuums by 4, and smartwatches by 1 prospective teachers. On the other

hand, autonomous cars were mentioned by 10, and drones by 4 prospective teachers. In addition to all of these, search engines were mentioned by 5, translation programs by 4, Google Maps by 4, navigation by 3, and age estimation applications by 1 prospective teachers. The AI-powered music generation application Soundraw was mentioned by 3 prospective teachers, while Timely was mentioned by 2, Discord by 2, Krisp by 1, Socratic by 1, and Compose AI by 1 prospective teachers.

Discussion

Discussions on the Study's First Question

The study determined that prospective social studies teachers had a positive attitude towards AI above the average. The statements of the prospective teachers suggest that these positive attitudes might be related to the fact that AI makes things more accurately, saves time, helps people, facilitates human life, brings about innovations, increases the quality of life, and promises a better future. However, the study observed that prospective teachers also had negative attitudes towards AI at an average level. The statements of prospective teachers indicate that these negative attitudes might be influenced by the potential of AI to increase unemployment and injustice, make people lazy, and pose a significant threat to the future of humanity. The related literature supports that both in-service teachers and prospective teachers hold positive and negative views of AI (Chan & Hu, 2023; Chounta et al., 2022; Haseski, 2019). This situation can be attributed to the very nature of AI, which presents both essential advantages and challenges.

Moreover, the study revealed that male prospective teachers' positive attitudes towards AI were significantly higher than those of female. Conversely, female prospective teachers' negative attitudes were significantly higher than those of male. The finding that male participants had more positive attitudes towards AI than female participants aligns with the results of various studies in the literature (Schepman & Rodway, 2023; Sindermann et al., 2021; Sindermann et al., 2022; Zhang & Defoe, 2019). Zhang et al. (2023) found that female prospective teachers were more likely to experience anxiety about AI-based educational tools than male prospective teachers. They pointed out that this situation may be due to the fact that female prospective teachers were less exposed to STEM fields and were more risk-averse and cautious than male prospective teachers. One possible explanation for this significant difference observed in this study can be that male prospective teachers may have a greater interest in technology, in addition to the explanations outlined by Zhang et al (2023). Beside all these, it can be argued that the influence of social media may also be connected to this outcome. In fact, individuals who produce AI-related content on social media are predominantly men. Given that men and women often have distinct interests, the higher engagement of men with this content produced by their male peers may have contributed to developing their understanding on AI. This understanding may have positively affected men's attitudes by removing the uncertainties that cause anxiety about AI and by showing the opportunities offered by AI.

In addition, the study determined that the variable of AI knowledge significantly affected positive attitudes towards AI. Accordingly, prospective teachers who described their AI knowledge level as high showed a significantly higher positive attitude than those describing it as average or low. Similarly, various studies found that people with a high level of knowledge about AI exhibited more positive attitudes towards AI (Eurobarometer, 2017; Gillespie et al., 2021). Evaluating this situation, Belanche et al. (2019) state that individuals who are more familiar with technological innovations will be more aware of the benefits and value of related technologies, leading to more positive attitudes. At this point, the relevant finding can be seen as a result of this situation. In addition, given that uncertainties about AI bring about substantial negative concerns (Schmelzer, 2019), this result can also be attributed to the fact that AI knowledge eliminates existing uncertainties about AI and mitigates individuals' tendency to believe in dystopias associated with AI.

The results found no significant relationship between attitudes towards AI and the grade level of the prospective teachers. However, various research results indicate that younger individuals have a more positive attitude towards AI than older individuals (Eurobarometer,

2017; Gillespie et al., 2021; Kaya et al., 2022). It can be thought that the finding revealing that grade level does not have a significant effect on attitudes towards AI may stem from the small age difference between prospective teachers. In addition, it may suggest that the six technology-related courses in the Turkish social studies teacher education program, taught progressively across grade levels and unrelated to AI but designed to enhance students' technology competencies (CoHE, 2018), do not effectively impact attitudes towards AI. At this point, adding courses directly related to AI to teacher education programs may be seen as a more appropriate approach. Similarly, the study revealed that attitudes towards AI did not differ significantly according to daily internet usage time. This finding contradicts with the previous research that suggested a positive correlation between increased internet usage and more positive attitudes towards AI (Eurobarometer, 2017). Additionally, another study showed that individuals with higher smartphone usage experience tended to have more positive attitudes towards various AI-supported applications (Martin et al., 2020). The fact that attitudes towards AI did not change significantly based on daily internet usage among prospective teachers may be attributed to university students' frequent and similar internet usage patterns.

Discussions on the Study's Second Question

The qualitative part of the study asked prospective teachers to express their own definitions regarding AI. The findings observed that some of the definitions provided by prospective social studies teachers highlighted the positive aspects of AI, such as helping people and facilitating human activities. However, some prospective teachers' definitions indicated negative perceptions, such as AI's potential to cause unemployment and make people lazy. These findings demonstrated that prospective teachers' positive or negative perceptions were reflected in their definitions of AI. Additionally, there were general definitions provided by prospective teachers that did not explicitly indicate positive or negative perceptions. The predominant ideas in these general definitions were "machines/technology doing human work", "machines imitating humans", and "machines having human-like intelligence". However, considering various definitions of AI from the literature (IEEE, 2017; Kaplan & Haenlein, 2019), it can be said that a significant part of the prospective teachers' definitions about AI was relatively shallow. This may be attributed to prospective teachers' limited theoretical knowledge about AI. When the literature is examined, similar findings are observed (Baigi et al., 2023). For example, Lozano and Blanco Fantao (2023) conducted a study with 118 Spanish prospective teacher to assess their familiarity with the ChatGPT application and their perceptions regarding its potential use in education. The study's findings revealed a significant lack of knowledge about the ChatGPT application. In fact, 14% of the participants stated that they had heard of the ChatGPT application but had not used it, while 10% stated that they had used it before. Despite this, 76% of the participants were not aware of the application. In another study, Theng et al. (2022) conducted a study with 2167 Canadian university students studying in health-related departments, and the results observed that more than half of the participants could not explain what AI was. Bewersdorff et al. (2023) conducted a comprehensive literature review to examine myths, mis- and preconceptions on AI in the context of education. The results indicated that the learners had a limited understanding about AI at the technical level, and their views on the scope of AI were relatively limited. In this respect, it can be said that the relevant finding of this study overlaps with different study findings in the literature.

As a part of the study, prospective teachers expressed some positive perceptions. These positive perceptions about AI included its ability to help people and make their lives easier, improve the quality of life, save time, perform tasks with fewer errors and less fatigue, bring about innovations, and promise a better future. Similar perceptions were also revealed in Haseski's (2019) study with prospective teachers, where they defined AI as a technology that helps people, increases efficiency, makes life easier, and shows promise in fields such as the economy, health, science, and education. Moreover, it is evident that the relevant positive perceptions held by teacher candidates are shared by a large number of people. Indeed, many sources emphasize that

AI facilitates human life, promotes general welfare, and holds the promise of a better future (Edwards, 2021; Koch, 2022; OECD, 2019).

In addition to all of this, prospective teachers expressed specific statements indicating negative perceptions. A significant portion of prospective teachers frequently addressed the potential threats of AI, mentioning that if not used carefully, it could lead to negative consequences for humanity and the world. Furthermore, some prospective teachers described AI as dangerous, frightening, and unsettling technology. However, the reasons underlying these negative perceptions were not sufficiently articulated by prospective teachers. Bewersdorff et al. (2023) also determined that learners had unspecific views about the threats and dangers of AI. The existence of these negative perceptions, which cannot be fully explained, may be attributed to the lack of knowledge about AI and the influence of science fiction elements portraying doomsday scenarios like "Matrix" or "Terminator". Such unfamiliarity and negative perceptions based on science fiction elements are widely observed in society (Hick & Ziefle, 2022), including educators (Kim & Kim, 2022), and have been emphasized in various studies. For instance, Schmelzer (2019) highlights that uncertainties about AI lead to significant concerns, while Carillo (2020) points out that elements from mythology, literature, and science fiction influence perceptions of AI. Similarly, Salles et al. (2020) underline that the misleading tendency to perceive AI solely as human-like robotic entities leads to limited understanding, false expectations, and baseless fears about the meaning and capabilities of AI in society. At this point, it can be assumed that the negative expressions made by prospective teachers without specifying reasons might be influenced to some extent by these elements mentioned above.

Some prospective teachers elaborated on the underlying reasons for these negative perceptions. One of the concerns that prospective teachers expressed was the potential of AI to take over human jobs and leave people unemployed. In addition, some participants stated that this unemployment could deepen the problem of injustice in society. When the literature is examined, it is seen that there are negative perceptions and fears regarding the possibility of AI replacing human jobs (Schlögl et al., 2019; Van Noort, 2022) and thus exacerbating injustice even more (Bersin, 2023). In this regard, it can be said that the fears held by prospective teachers are shared by the broader public. Prospective teachers also expressed concerns about the potential of AI leading people towards laziness. Grigoras (2023) provides an assessment of the reasons behind this situation and emphasizes that AI automates tasks, provides easy access to information and services, and thereby reduces the need for effort and critical thinking, leading to people becoming lazy. He states that as the effectiveness of AI systems increases, individuals may become dependent on them, and this may lead to a decrease in motivation and certain cognitive abilities. Similarly, it is frequently emphasized in various studies that AI can lead to intellectual laziness and a decrease in creativity (Aiken & Epstein, 2000; Nalbant, 2021). At this point, it can be said that the relevant negative perceptions of prospective teachers are also a subject that is frequently discussed in the literature.

Participants also expressed concerns about the potential of AI to become so powerful that it could bring about the end of humanity. Loops (2021) states that this fear is a classic concern often addressed in science fiction. At this point, it can be said that these negative perceptions of prospective teachers are related to this classic fear associated with AI. Despite all these reasons pointing to the negative perceptions of prospective teachers, common ethical problems that result in significant negative perceptions in society within the context of AI were not expressed by prospective teachers. In a similar study conducted by Chan and Hu (2023) involving 399 undergraduate and postgraduate students from various department in Hong Kong, students expressed significant ethical concerns that lead to negative perceptions about AI. The fact that important AI-related ethical issues such as bias, discrimination, data privacy violations, lack of accountability, and transparency (Remian, 2019; Stahl, et al., 2022) are not voiced by prospective teachers in this study may suggests that Turkish prospective teachers have a limited understanding of the current debates on AI. It can be argued that this situation may stem from the fact that academic studies and initiatives on AI education in Türkiye are still scarce.

In addition to all of these, prospective teachers were asked to provide examples of AI technologies they knew, and a total of 228 examples of AI technology were expressed by 128 prospective teachers. When comparing the number of technology examples with the number of participants, it is evident that the average number of AI technologies expressed by a prospective teacher is below 2. This indicates a significant lack of knowledge on AI technologies among prospective teachers. However, the vast majority of prospective teachers could only provide examples of chatbot applications/dialog systems such as ChatGPT, Siri, and Google Assistant. The fact that more than half of the AI technology examples given by prospective teachers were related to dialogue systems supports the conclusion that prospective social studies teachers lack awareness of AI technologies.

Although dialogue systems were the most commonly mentioned AI technology, natural language processing, which is frequently utilized by dialog systems, was only mentioned twice. After dialogue systems, the most commonly mentioned AI technology by prospective teachers was facial recognition systems. However, the technologies behind facial recognition applications, such as deep learning and machine learning, were not mentioned by the participants. Another technology example frequently mentioned by the participants was image-generating/editing applications using AI. However, the underlying technologies of these applications, such as deep learning and neural networks, were not among the AI technologies/applications expressed by them. All of these observations support the finding that prospective social studies teachers had a limited level of knowledge on AI. In addition, this situation may suggest that the technology examples, such as autonomous systems, smart home systems, and robots were associated with AI by prospective social studies teachers due to the presence of AI-related terms like "smart" and "robot".

When this lack of understanding is considered from the very perspective of "Prospective social studies teachers", it can be thought that this situation may cause some challenges for social studies learning-teaching processes. While Fontana (1997) states that the competencies of social studies teachers are essential in adopting technology in educational environments, Doolittle and Hicks (2003) point out that for a powerful and transformative social studies education, social studies educators need a more advanced understanding of technology, and this is achievable when they are familiar with current and newly developing technology. In addition, considering that social studies course encompasses various technology-related topics from daily life and that one of its primary learning domains is "Science, Technology, and Society" (MoNE, 2018), it can be asserted that there is a necessity for initiatives aimed at enhancing the understanding of social studies teachers in the context of AI technologies.

Conclusion, and Suggestions

Evaluating the research findings as a whole, prospective teachers have a significant lack of understanding of AI. It can be argued that expecting prospective teachers to be successful in integrating AI into education, a more specialized field, without first gaining a general understanding of AI would not be a correct approach. This lack of understanding among prospective teachers about AI may limit their awareness of AI's educational potential, thereby creating a significant barrier to the integration of AI technologies into their future teaching careers. At this point, it can be said that basing prospective teachers' perceptions of AI on accurate information, free from misconceptions, might be beneficial in equipping them with more positive attitudes and perceptions towards AI. While Rainie et al. (2021) point out that the lack of knowledge about AI plays an important role in the formation of negative perceptions towards AI, Hornberger et al. (2023) argue that there is a significant and positive relationship between university students' AI literacy and their positive attitudes towards AI. Frimpong (2022) observed that AI training for prospective teachers had positive effects on their understanding towards AI. Both these results and this study's finding that prospective teachers with a high level of perceived AI knowledge have more positive attitudes towards AI, suggest that improving the understanding of prospective teachers about AI might lead to more positive attitudes towards AI. These positive

attitudes, and perceptions supported by accurate and reliable information, can direct prospective teachers to use AI applications as tools to improve their teaching processes in their future careers.

Moreover, considering that "Teaching about AI" is an increasingly important aspect in the field of AIED, alongside "Teaching with AI" (Mertala et al., 2022), it can be asserted that these positive attitudes, and perceptions grounded in trustworthy information, might also be advantageous for prospective teachers in educating students about using AI effectively and ethically. At this point, taking initiatives to provide both in- and pre-service teachers with a basic understanding of AI can be seen as a crucial matter. This important requirement is also highlighted in various studies (Zhang et al., 2023). While Phillips (2023) states that teachers need professional development specifically on AI and its productive applications, Luan et al. (2020) emphasize that embracing AI in today's world and preparing teachers for future education processes enriched with AI is a necessity. At this point, it can be argued that teacher education programs will play an essential role in addressing these needs.

Based on the study results, some recommendations can be offered, which are as follows:

Considering that even the prospective teachers, who are the focus of the relevant research, exhibit a significant lack of understanding of AI, it can be thought that educating individuals about AI from early stages is an essential requirement. In this point, from an early age, individuals can be provided with AI education through formal educational institutions. All of these educational efforts can be organized under the umbrella of AI literacy. In this point, AI literacy can be taught starting from preschool, and this competency can be included in the curriculum of different subjects. Social studies, on the other hand, can be a pioneering subject with its interdisciplinary structure that includes topics from the life itself.

AI-related courses can be added to teacher education programs, including social studies teacher education program. Through these courses, teacher candidates can gain knowledge and awareness concerning both the fundamental concepts of AI and its practical applications in the field of education. This knowledge and awareness can provide significant contributions to teacher candidates in the two distinct dimensions of AIED, namely “Teaching with AI” and “Teaching about AI".

University and faculty administrations can prepare projects aimed at enhancing the understanding of AI among teacher candidates. Encouraging teacher candidates to actively participate in these projects can help them improve their practical AI knowledge.

In-service AI training programs can be organized for teachers. These programs can provide teachers with the necessary skills and knowledge for effectively integrating AI into their teaching practices. Furthermore, these programs can encourage teachers to utilize AI technologies more frequently in education.

Studies addressing the relationship between teacher education and AI from the perspectives of teachers, education administrators, and university-level teacher educators, can be conducted. Through these studies, existing deficiencies and needs can be revealed. All of these initiatives can contribute to the elimination of existing deficiencies and, ultimately, to the training of teachers who can harness the power of AI in education.

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Extended Abstract

Giriş

Yapay zekâ (YZ), günümüzde çağdaş eğitim teknolojisinin önemli kavramlarından birisi hâline gelmiştir (Martín Núñez vd., 2023). Bu noktada, çeşitli tiplerdeki birçok YZ teknolojisi eğitimin "Öğrenme", "Öğretme", "Değerlendirme" ve "Yönetim" süreçlerinde aktif olarak kullanılmaktadır (Chiu vd., 2023). Buna karşın, çoğu öğretmen YZ'ye yönelik temel bir anlayıştan yoksundur (Kim & Kwon, 2023). Bu durum alanyazındaki çeşitli çalışma sonuçlarıyla da doğrulanmaktadır (Chounta et al., 2022; Lindler & Berges, 2020). Öğretmenlerin sahip olduğu bu anlayış eksikliği, yapay zekânın eğitim alanındaki kullanımına yönelik belirsiz algılara ve olumsuz tutumlara neden olabilir. Bu ise potansiyel olarak öğretmenlerin ilgili teknolojileri öğrenme ve öğretme süreçlerine etkili bir şekilde dâhil etmelerini engelleyebilir (Chiu vd., 2023). Bu durumun üstesinden gelmek için öğretmenler arasında YZ'ye yönelik olumlu tutum ve algıların geliştirilmesi, YZ teknolojilerinin sınıf ortamlarına entegrasyonunda önemli bir etkiye sahip olabilir (Çelik vd., 2022). Bu nedenle, geleceğin eğitim süreçlerinde önemli rol oynayacak öğretmen adaylarının da YZ'ye yönelik olumlu tutum ve algılarla donatılmasının önemli bir gereklilik olduğu düşünülebilir. Dahası, teknolojik araçlar Sosyal Bilgilerde merkezi bir role sahiptir (Lee & Friedman, 2009) ve mevcut haliyle yapay zekâ, Sosyal Bilgiler eğitimine yönelik uygulama ve pedagojileri dönüştürme konusunda umut vaat etmektedir (Berson & Berson, 2023; Stuckart & Berson, 2009). Bununla birlikte günümüzde Sosyal Bilgiler derslerinde öğrencilere yapay zekânın öğretilmesine yönelik de artan bir ilgi bulunmaktadır (Yetişensoy & Rapoport, 2023). Bütün bunlardan hareketle, yapay zekânın Sosyal Bilgiler eğitiminde oluşturduğu yeni ihtiyaçlara etkili bir şekilde cevap verebilmek adına Sosyal Bilgiler öğretmen adaylarının YZ'ye yönelik olumlu tutumlarla donatılmaları ve YZ algılarını doğru ve güvenilir bilgiye dayandırmaları önemli bir gereklilik olarak görülebilir. Bu noktada, ilgili araştırmanın amacı Sosyal Bilgiler öğretmen adaylarının YZ'ye yönelik tutum ve algılarının incelenmesidir.

Yöntem

İlgili araştırma karma araştırma yaklaşımlarından birisi olan yakınsayan paralel desen kapsamında yürütülmüştür. Araştırmanın katılımcı grubunu Türkiye'deki dört farklı üniversitenin Türkçe ve Sosyal Bilimler Eğitimi Bölümü, Sosyal Bilgiler Eğitimi Anabilim dalında öğrenim gören 342 Sosyal Bilgiler öğretmen adayı oluşturmuştur. Araştırmanın verileri Schepman ve Rodway (2020, 2023) tarafından geliştirilen ve Kaya ve arkadaşları (2022) tarafından Türk kültürüne uyarlanan Yapay Zekâya Yönelik Tutum Ölçeği (2022), kişisel bilgi formu ve uzman görüşleri doğrultusunda geliştirilen açık uçlu nitel sorulardan oluşan bir anket yoluyla toplanmıştır. Araştırmanın nicel kısmında yer alan 342 öğretmen adayının 128'i araştırmanın nitel kısmında yer almış ve anketteki nitel sorulara yanıt vererek YZ'ye yönelik algılarını detaylandırmıştır. İlgili veriler ise karşılaştırma testleri ve tümevarımsal içerik analizi ile çözümlenmiştir.

Bulgular

Analizler sonucunda öğretmen adaylarının tutumlarının algılanan YZ bilgisi değişkenine göre farklılaştığı belirlenmiştir. Bu noktada, YZ'ye yönelik bilgi düzeyini yüksek olarak nitelendiren öğretmen adaylarının pozitif tutumlarının bilgi düzeyini ortalama ve düşük olarak nitelendiren öğretmen adaylarına göre anlamlı düzeyde yüksek olduğu bulgulanmıştır. Bununla birlikte erkek öğretmen adaylarının pozitif tutumlarının kadın öğretmen adaylarına göre anlamlı düzeyde

yüksek, negatif tutumlarının ise anlamlı olarak düşük olduğu belirlenmiştir. Pozitif ve negatif tutumlar ile sınıf düzeyi ve günlük internet kullanımı değişkenleri arasında ise anlamlı ilişkiler gözlemlenmemiştir. Sosyal Bilgiler öğretmen adaylarının nitel sorulara verdiği yanıtlar ise YZ'nin tanımı ve kapsamı üzerine önemli bir kavrayış eksikliğine sahip olduklarını göstermiştir. Nitekim öğretmen adaylarının önemli bir kısmının YZ üzerine gerçekleştirdiği tanımlamaların teorik açıdan temelsiz olduğu görülmüştür. Öğretmen adaylarının önemli bir kısmı YZ ile ilişkili tehditlerden söz etmiş, ancak bu tehditleri belirgin bir sebebe bağlayamamıştır. Dahası öğretmen adaylarının önemli bölümü ChatGPT ve Siri uygulamaları gibi diyalog sistemleri dışında herhangi bir YZ teknolojisi örneği verememiş, farklı türdeki YZ destekli uygulamalardan söz etseler de bu uygulamaların alt yapısını oluşturan YZ sistemlerini detaylandıramamıştır.

Sonuç ve Tartışma

Araştırma bulguları genel olarak değerlendirildiğinde öğretmen adaylarının YZ'ye yönelik önemli bir anlayış eksikliğine sahip olduğu görülmektedir. Rainie ve arkadaşları (2021) YZ'ye ilişkin bilgi eksikliğinin yapay zekâya yönelik olumsuz algıların oluşmasında önemli bir rol oynadığına dikkat çekerken, Hornberger ve arkadaşları (2023), üniversite öğrencilerinin YZ okuryazarlığı ile YZ'ye yönelik olumlu tutumları arasında anlamlı ve pozitif bir ilişki olduğunu bulgulamıştır. Frimpong (2022) ise öğretmen adaylarına yönelik yapay zekâ eğitiminin, onların yapay zekâya yönelik anlayışları üzerinde olumlu etkileri olduğunu gözlemlemiştir. Gerek farklı çalışmalarla elde edilen söz konusu bulgular gerekse de ilgili çalışmanın algılanan YZ bilgisi düzeyi yüksek olan öğretmen adaylarının YZ'ye yönelik daha olumlu tutumlara sahip olduğunu göstermesi, öğretmen adaylarının YZ anlayışlarının geliştirilmesinin daha olumlu tutumlara yol açabileceğini düşündürmektedir. Doğru ve güvenilir bilgilerle desteklenen bu olumlu tutum ve algıların ise öğretmen adaylarını gelecekteki kariyerlerinde öğretim süreçlerini iyileştirmek için YZ uygulamalarını araç olarak kullanmaya teşvik edeceği söylenebilir. Bütün bunların yanında, "YZ ile Öğretim'in" yanı sıra, "YZ Hakkında Öğretim'in" de eğitimde YZ alanında önemi giderek artan bir konu olduğu göz önüne alındığında (Mertala vd., 2022), bu olumlu tutum ve algıların öğretmenlere öğrencilerini YZ'yi etkili ve etik bir şekilde kullanan bireyler olarak yetiştirmeleri konusunda fayda sağlayacağı söylenebilir. Bu noktada öğretmen adaylarına yapay zekâ konusunda temel bir anlayış kazandırmaya yönelik girişimlerde bulunmak önemli bir konu olarak görülebilir. Bu noktada, Sosyal Bilgiler öğretmenliği lisans programları da dâhil olmak üzere öğretmen yetiştirme programlarına YZ ile ilgili dersler eklenebilir. Öğretmen adayları bu dersler aracılığıyla hem YZ'nin temel kavramlarına hem de eğitim alanındaki pratik uygulamalarına ilişkin bilgi ve farkındalık kazanabilirler. Bu bilgi ve farkındalık ise öğretmen adaylarına eğitimde yapay zekânın iki ayrı boyutunda, yani "Yapay Zekâ ile Öğretim" ve "Yapay Zekâ Hakkında Öğretim" konusunda önemli katkılar sağlayabilir.

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Investigation of The Efficiency of the In-Service Training Course Designed for Algebra Teaching: An Experimental Research

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Abstract

The study aimed to examine the effect of the in-service training course designed for teaching algebra on the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra and their material design self-efficacy beliefs. Within the scope of the study, a 30-hour in-service training course was designed for mathematics teachers, and the study examined the effectiveness of this in-service training course. In this context, the study was carried out using the experimental research method. The participants consisted of 36 mathematics teachers who volunteered to work in public schools in aprovince in the northeast of Türkiye in the 2021-2022 academic years. The study's experimental group consisted of 16 mathematics teachers who attended the algebra teaching in-service training course. In comparison, the control group consisted of 20 mathematics teachers who received no intervention. "Awareness Scale for the Nature of Transition from Arithmetic to Algebra" and "Material Design Self-Efficacy Belief Scale "were used to collect the data for the study. Descriptive and predictive statistics were used in the analysis of the data. The results showed that the designed in-service training course did not create significant mean difference between the experimental and control groups.

Keywords: Arithmetic, Algebra, Algebraic thinking, Teaching material, Teacher training.

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Ethics Declaration:

This study followed all the rules stated to be followed within the “Higher Education Institutions Scientific Research and Publication Ethics Directive” scope. None of the actions specified under the title of “Actions Contrary to Scientific Research and Publication Ethics,” which is the second part of the directive, were not carried out.

Ethics committee permission information

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Cebir Öğretimine Yönelik Düzenlenen Hizmet İçi Eğitim Kursunun Verimliliğinin İncelenmesi: Deneysel Bir Araştırma

Öz

Araştırmanın amacı cebir öğretimine yönelik düzenlenen hizmet içi eğitim kursunun matematik öğretmenlerinin aritmetikten cebire geçişin doğası hakkındaki farkındalıklarına ve materyal tasarımı öz-yeterlik inançlarına etkisini incelemektir. Çalışma kapsamında matematik öğretmenlerine yönelik 30 saatlik bir hizmet içi eğitim kursu tasarlanmış olup, çalışmada bu hizmet içi eğitim kursunun etkililiği incelenmiştir. Bu bağlamda çalışma deneysel araştırma yöntemi kullanılarak gerçekleştirilmiştir. Katılımcılar, 2021-2022 eğitim-öğretim yılında Türkiye'nin kuzeydoğusundaki bir ildeki devlet okullarında gönüllü olarak görev yapan 36 matematik öğretmeninden oluşmuştur. Araştırmanın deney grubunu cebir öğretimi hizmet içi eğitim kursuna katılan 16 matematik öğretmeni oluşturmuştur. Karşılaştırıldığında, kontrol grubu hiçbir müdahale almayan 20 matematik öğretmeninden oluşuyordu. Araştırmanın verilerinin toplanmasında "Aritmetikten Cebire Geçişin Doğasına İlişkin Farkındalık Ölçeği" ve "Materyal Tasarımı Öz-Yeterlik İnancı Ölçeği" kullanılmıştır. Verilerin analizinde tanımlayıcı ve yordayıcı istatistiklerden yararlanılmıştır. Sonuçlar, tasarlanan hizmet içi eğitim kursunun deney ve kontrol grupları arasında anlamlı bir ortalama fark yaratmadığını gösterdi.

Anahtar Kelimeler: Aritmetik, cebir, cebirsel düşünme, öğretim materyali, öğretmen eğitimi.

Introduction

Mathematics education is of great importance in raising students towards determined goals. Because mathematics is one of these sential tools developed for one's thinking and understanding and one of the critical building blocks of primary education (Koçlar, 2019). According to the research, students form their ideas about algebra by structuring their experiences with arithmetic (Akkan et al., 2017). For this reason, students should have a good knowledge of arithmetic in order to be able to learn algebra well. This reason strongly links algebra and arithmetic (Kieran, 1992; Akkan, 2011).

The first step of a person learning mathematics is to learn arithmetic. They then begin to learn advanced mathematics. Arithmetic takes its roots from numbers and deals with arithmetic numbers themselves. According to Akkan (2009), arithmetic, the largest and most well-known branch of mathematics, includes four basic operations with numbers, all calculations based on these four operations, finding the unknown from the known, and the relationships between numbers. In other words, the first step of learning mathematics starts with arithmetic because to learn mathematics, you need to know arithmetic.

While the formation of arithmetic came from numbers, the formation of algebra was from arithmetic. While arithmetic takes roots from number concepts, algebra takes roots from arithmetic. This situation shows a reciprocal and robust relationship between arithmetic and algebra (Koçlar, 2019), and arithmetic and algebra cannot be considered separately. Students from the foundations of algebra by making generalizations with the given concepts (Carpenter & Levi, 2000).

The abstraction of the arithmetic concept, which includes operations such as operations with numbers, comparison, and counting, has influenced the birth of algebra (Gürbüz & Toprak, 2014). Algebra has emerged as a branch of mathematics that generalizes the relationship or relationships between the data by examining the data at hand with numbers and symbols and transforming them into equations (Öztürk, 2021). Algebra has its own rules that form the main language of mathematics (Çelik, 2007). Algebra has formed an essential field of mathematics, and in order to do algebra, it is necessary to do abstraction first (Yenilmez & Teke, 2008). Baki (2008) explained algebra by classifying it as setting equations, solving equations, generalizing, and working with functions. Thorpe (1999), on the other hand, stated that teaching algebra should be planned in a way that makes students understand the concepts and encourages them to think. In addition, Thor Peex plained the general purposes of algebra teaching as follows:

1. Algebra develops students' equation-solving skills.
2. Algebra enables students to use symbol to resolve properly real-life problems.
3. Algebra prepares students to follow and gain insight into physics and engineering subjects.
4. It enables them to be sufficient about algebraic relations.

Algebra and algebra-related achievements, which have an important place in mathematics teaching, appear in every aspect of our daily life, making it necessary to use algebraic knowledge effectively (Konak, 2009). Algebraic thinking develops with the subject of algebra. In other words, all developments in the field of algebra also impress algebraic thinking.

First, students must understand what algebraic sentences mean, why algebraic transformations remade, and the structural features of the relationships between mathematical operations (Öner, 2009). Teachers should give importance to algebra teaching and give students algebraic relations, operations, and relations between concepts by giving meaning to them.

It is accepted that the development of algebraic thinking begins with arithmetic thinking in preschool and primary school years (National Council of Teachers of Mathematics [NCTM], 2000). However, from preschool to 5th grade, students only deal with arithmetic operations. In the 6th grade, the transition to algebra, including symbols, begins (The Ministry of National Education [MoNE], 2018). The learning area of algebra, which is one of the five essential learning are as in the middle school mathematics curriculum, is between 6th and8th grades. By finding the pattern rule in the classroom program, expressing it with letters, and associating it with equations with two unknowns, in which one variable change depending on another variable, with generalizations, concepts are learned in a more meaning full way (MoNE, 2018).

Algebraic thinking is necessary in every field, from solving problems in daily life to solving problems indifferent disciplines (Türkoğlu, 2017). According to Kriegler (2008), algebraic thinking is a structure consisting of algebraic ideas, mathematical thinking, and the generalizations of arithmetic as a tool of functions and mathematical models.

According to Çelik (2007), algebraic thinking skills are made up of a repetitive pattern of three actions by making generalizations with real life by making sense of algebraic expressions. These patterns are using algebra in relations and symbols, benefiting from multiple representations such as figures, tables, and graphics and expressing generalizations with formulas.

A project called "Concepts in Secondary Mathematics and Science" examined the students' understanding levels of algebraic expressions in four stages (Çağdaşer, 2008). These stages are given below in order.

1. Level 1: It is the level at which questions such as finding the value of a letter as a result of arithmetic operations, solving a problem by taking the letters as the name of an object, or concluding this operation without giving value to these letters although there are letters in them, can be solved.
2. Level 2: It is the same as the first level in terms of abstraction, and the questions are more complex at this level.
3. Level 3: Letters are used and interpreted as an unknown at this level.
4. Level 4: Unlike the third level, student's cans on clued these operations by making sense of more complex expressions at this stage.

Algebra education is critical to develop students' algebraic thinking and not to create misconceptions about algebra. For this reason, it will be challenging for students who have just moved from the substantial period to the abstract period to understand an abstract subject such as algebra without memorizing it. According to Ainsworth (2006), using different teaching

techniques and strategies in teaching mathematical expression is necessary for teaching mathematical concepts and methods. This situation has led us to different teaching methods in the teaching of mathematics lessons and concrete materials in mathematics education. For students to achieve permanent learning, teachers should prepare environments where they can realize their learning by visualizing abstract topics to establish meaning full relationships between concepts and learn more information in less time (Şahin, 2012). Since concrete materials appeal to more than one sense of the student, they will affect the effective and meaningful learning of the students. In algebra teaching, materials, and virtual learning objects should increase active participation in the course and provide better learning (Karakaş & Bahadır, 2018). Studies have shown that concrete materials (Şahin, 2012; Turan, 2013) and virtual learning objects (Öztürk, et al., 2016) are successful in teaching mathematics in general and algebra in particular. Instead of pushing the students to memorize the information by giving them abstract algebra knowledge directly, teachers should give the information to students by understanding them with the help of concrete objects and virtual learning objects and even by allowing them to discover it themselves. For these reasons, teachers' use of materials is vital in teaching algebra. Akkan (2016) mentioned the necessity of using materials by stating that students would achieve better learning by appealing to various sensory organs with pictorial representations and concrete materials that would participate in algebra teaching.

It is essential to investigate the level of self-efficacy beliefs of teachers in preparing material and using the prepared material effectively. Bandura (1997) defines self-efficacy as an individual's belief in himself/herself that he/she can plan activities on any subject and conclude them successfully. In other words, it is the individual's thoughts about himself/herself. The higher the individual's self-efficacy belief regarding a subject, the higher the belief he/she has to overcome the difficulties he/she faces. The lower the individual's self-efficacy belief, the lower the belief he/she has to overcome the difficulties he/she faces (Avcı, 2019).

Self-efficacy belief has many effects on education (Ertekin & Dilmaç, 2021). One of them is teacher self-efficacy. Teacher self-efficacy is the teacher's belief in teaching the knowledge (Schunk, 2012). In other words, teacher self-efficacy is the belief in organizing and realizing educational activities that are effective and needed for successful teaching (Avcı,2019). Teachers' self-efficacy in teaching algebra can be explained as the teacher's self-belief in preparing concrete material on the subject of algebra and incorporating the concrete material he/she has prepared into teaching. The higher the teacher's self-efficacy in teaching algebra, the more successful he/she is expected to be in teaching algebra because the teacher's high self-efficacy in teaching algebra will contribute to the teacher's effort on not giving up easily and to produce alternative teaching methods, in this context, for students to be successful in algebra, their teachers should have high self-efficacy in algebra.

This research aims to provide an answer to the "Does the in-service training course designed for teaching algebra affect the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra and their material design self-efficacy beliefs?" problem and the following questions:

1. Does the in-service training course designed for algebra teaching significantly affect mathematics teachers' perceptions of material design self-efficacy?
2. Does the in-service training course designed for teaching algebra significantly affect mathematics teachers' awareness of the nature of the transition from arithmetic to algebra?

Method

Research Model

An experimental research model, one of the quantitative research designs, was used in this study. Experimental research models are conducted to test the cause-effect relationship between variables (Büyüköztürk, 2018). This research design, after creating the experimental and control

groups, including both groups in the research and processing the experimental group, is a method in which the two groups are compared again (Ekiz, 2015). This study's design was preferred since it aimed to compare the group that received and did not receive in-service training for teaching algebra.

Participants

The participants were formed according to purposive sampling method, which is one of the non-random sampling types. Mathematics teachers who volunteered to work in public schools in province in the northeast of Türkiye in the 2021-2022 academic year voluntarily participated in the study. The experimental group of the research consisted of 16 mathematics teachers who volunteered to participate in the in-service training course for teaching algebra, and the control group consisted of 20 mathematics teachers who could not attend the training.

Instruments

Quantitative data to be obtained within the scope of this study were collected with the "Personal Information Form," "Material Design Self-Efficacy Belief Scale," and "Awareness Scale for the Nature of Transition from Arithmetic to Algebra."

Personal Information Form

The researcher prepared this form. Information about the participants' gender, seniority, age, education level, region of employment, and whether they had participated in such a study before were collected.

Material Design Self-Efficacy Belief Scale

The material design self-efficacy belief scale developed by Bakaç and Özen (2015) for pre-service teachers was used to examine the material design self-efficacy perceptions of mathematics teachers. Scale consists of three sub-dimensions: "Preparing material on the computer", "Preparing three-dimensional material", and "Preparing a two-dimensional material.". The validity coefficient of all the items on the scale is. 814, which is greater than .6 and is significant. So it is valid for doing factor analysis. While the Cronbach Alpha internal consistency coefficient for the total scale was .92, Cronbach Alpha values for the sub-dimensions were calculated for material preparations .89, three-dimensional material preparations .82, and two-dimensional material preparations .79, respectively. A Cronbach Alpha value of .70 and above in scientific studies shows that the scale is reliable (Şencan, 2005). Accordingly, the results showed that the scale was reliable for the whole scale and its sub-dimensions.

Awareness Scale for The Nature of Transition from Arithmetic to Algebra

To determine the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra, the "Awareness Scale for the Nature of Transition from Arithmetic to Algebra" developed by Polat et al. (2023) was used. Researchers determined that the scale consisted of eight items and two dimensions. The smallest item factor load value in the scale was calculated as .47. The first dimension of the scale is called the differences between arithmetic and algebra, and the second is the relationship between arithmetic and algebra. The total variance rate explained by the scale was determined as 50%. As result of the reliability analysis, the Cronbach Alpha internal consistency coefficient was calculated as .72. Two examples of items in the scale are as follows: "I see arithmetic as a subset of algebra." and "While arithmetic deals with numbers, algebra deals with unknowns."

Data Collection Process

To collect the data of the study before starting the study, the material design self-efficacy belief scale and the awareness scale about the nature of the transition from arithmetic to algebra were applied to the participating teachers before the in-service training course. Thus, pretest data were collected from the experimental and control groups. Then, the experimental process was started with in the scope of the in-service training program for the experimental group teachers. In this

process, the mathematics teachers who participated in the study were taken to the in-service training course: “The effect of the in-service training course designed for teaching algebra on material design and the perception of the nature of the transition from arithmetic to algebra". The control group followed no treatment. Then, after this in-service training course was given to the experimental group, the data were collected applying the post-test data collection tools to the experimental and control groups again.

On the first day of the course, material preparation activities were held regarding the problems that may be encountered in daily life related to algebra. On the first day of the event, a six-hour program was organized. In the first of these programs, "Finding a result by choosing five random numbers and performing four operations with these numbers", "There is as pare storage in the shape of a cube inside a cube-shaped storage. What is the volume of the constantly used part of this warehouse?", " Complete the square by adding 1 $(x+1)^2$ to any length (x) and find its area” and “Subtract 1 $(x-1)^2$ from any length (x) and complete the square and find its area” activities were carried out.

A six-hour program was organized on the second day of the course. These programs were "regular four-sided, regular eight-sided, regular dodecahedron open and closed", "magic squares", "Getting a triangle with Pythagorean relation", "Prime numbers", and "Creating a pattern by painting visible faces of a given figure".

On the third day of the course, a six-hour program was organized. In these programs, the researchers explained how one should attend the "Research and Inquiry-Based Approach" modeling mathematics lessons. The researchers explained with examples of how the "Argumentation-Based Science Learning" approach should be included in algebra teaching. Moreover, the activity "Studies on real-life applications of algebra” washeld.

A six-hour program was organized on the fourth day of this course. This day included the following activities: "What is mathematical modeling and how is it done?" and "Five basic steps of mathematical modeling". Modeling activities were carried out in algebra teaching.

On the fifth day of this course, a six-hour program was organized. In the first program, the researchers analyzed the algebra topics in LGS. The researchers mentioned where the questions mostly came from, what level of questions came from, which process steps, and the students needed to be more successful. Furthermore, the researchers stated where students made misconceptions. In the study, in which more analyzes were made, in order to increase success, it was mentioned what teachers should pay attention to and how the objectives should be given. In the second program, the researchers taught the use of the “Geogebra” program, and the quadrilaterals were drawn by making equations to make drawings with the “Geogebra” program. In the third program, the researchers showed some daily life examples for the transition from arithmetic to algebra. In addition, a pattern-making activity was carried out by showing the towers of Hanoi.

Data Analysis

In the analysis of the data obtained in study, descriptive and predictive statistics were used to achieve the objectives. In order to achieve the objectives, descriptive statistics were first applied. Thus, the suitability of the data for analysis was evaluated and the researchers checked whether the data showed a normal distribution. The data showed normal distribution. With descriptive statistics, the awareness of mathematics teachers about material design and the nature of the transition from arithmetic to algebra was determined. Central tendency and distribution measures were used in descriptive statistics.

For predictive statistics, the pre-test scores of the groups were controlled, and their post-test scores were compared. For this, analysis of covariance (ANCOVA) was used. ANCOVA is used in cases where the number of variables in the study is high and is used to measure the changes in the dependent variable due to the interactions of the dependent Variations in the dependent variables due to the interaction of the dependent variables. Büyüköztürk (2018) stated that the

reason for using this method was that it should be used to eliminate the effect of any variable in the study on the study and stated that it was used to measure the difference between the pre-test and post-tests of the experimental group and control group.

The Reliability Analysis for material design self-efficacy and awareness of the nature of the transition from arithmetic to algebra in the study is presented in Table 1.

Table 1.

Table of reliability analysis for material design self-efficacy and awareness of the nature of the transition from arithmetic to algebra

Experiment			Control	
	Pre-test	post-test	Pre-test	post-test
Material Design Self-Efficacy Perception	.846	.855	.962	.934
Awareness of the Nature of the Transition from Arithmetic to Algebra	.624	.641	.539	.694

When Table 1 is examined, there liability values of both material design self-efficacy scores and awareness scores about the nature of the transition from arithmetic to algebra were appropriate.

The histogram graph for normality values showed that the skewness in the ∓1 for the material design experimental group pre-test graph was 0.648, kurtosis was 0.464, meaning that the data showed normal distribution because it was in the range. The skewness (0.355) and kurtosis (-0.988) values were in the range of ∓1 for the post-test graph. For this reason, the post-test data of the experimental group collected for material design showed a normal distribution.

From the pre-test data of the control group collected for material design in the study, skewness (-0.838) and kurtosis (-0.444) were in the range of ∓1. For this reason, the pre-test data of the control group collected for material design showed normal distribution. When the normality analys is of the control group post-test data is examined, the skewness (-0.245) and kurtosis (-0.688) values were in the range of ∓1. Therefore, the control group post-test data collected for material design showed a normal distribution.

Data regarding the self-efficacy scores for material design met the normal distribution conditions. In the study, ANCOVA analysis was used to check whether there was a mean difference between the post-tests controlling the pre-tests.

First assumption of the covariance analysis is that the data should be normally distributed (Shavleson, 1988). The data met the normal distribution conditions. Another assumption for ANCOVA is the homogeneity of variances (Shavleson, 1988, p. 558). The homogeneity of the variances was tested, and it was determined that ($F1{,}34 = 3.976$, $p > .05$) the variances were homogeneously distributed. Another of the assumptions of ANCOVA is the homogeneity of their gression slopes (Shavleson, 1988, p. 559). The analysis found that the regression slopes were homogeneous ($F1{,}32 = 2.166$, $p > .05$). Since all assumptions were met, ANCOVA was conducted to examine whether the intervention applied affected material design self-efficacy perception scores.

When the awareness scores for the transition from arithmetic to algebra are examined, all of the data met the normal distribution conditions. In the study, the covariance (ANCOVA) analysis was used to check whether there was a mean difference between the post-tests by controlling the pre-tests. The first of the assumptions of the covariance analysis is to provide the normality assumptions of the data (Shavleson, 1988, p. 558). The data meet the normal distribution conditions. Another assumption for ANCOVA is the homogeneity of variances (Shavleson, 1988). The homogeneity of the variances was tested, and it was determined that the variances were homogeneously distributed ($F1{,}34 = 0.140$, $p > .05$). Another assumption is the homogeneity of the regression slopes (Shavleson, 1988, p .559). In the analysis, the regression slopes were

homogeneous ($F1,32 = 0.826, p > .05$). Since all assumptions were met, ANCOVA was conducted to examine whether the intervention applied had an effect on the awareness scores for the transition from arithmetic to algebra.

Results

Findings Regarding the Effect of In-Service Training Courses on Mathematics Teachers' Perceptions of Material Design Self-Efficacy

The findings regarding the ANCOVA analysis on whether the post-test scores differed when the pre-test scores were controlled are given in Table 2.

Table 2.
Findings of material design post-test analysis of covariance

	Experiment			Control		
	N	M	SE	N	M	SE
Pre-test	16	98.25	8.76	20	103.90	12.10
Adjusted Post-test	16	104.22	2.61	20	102.62	2.32

When Table 2 was examined, it was determined that the material design post-test scores did not differ significantly when the pre-tests were controlled ($F1,33=.20, p>.05$).

The in-service training course designed for algebra teaching did not significantly affect the mathematics teachers' material design self-efficacy perceptions.

Findings Regarding the Effect of In-Service Training Courses on Mathematics Teachers' Perceptions of Computer Material Design Self-Efficacy

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled are presented in Table 3.

Table 3.
Findings of covariance analysis of self-efficacy in material design in computer

	Experiment			Control		
	N	M	SE	N	M	SE
Pre-test	16	45.06	1.04	20	46.88	1.82
Adjusted Post-test	16	45.41	1.27	20	46.92	1.13

When Table 3 was examined, it was determined that the material design post-test scores did not differ significantly when the pre-tests were controlled ($F1,33 = .77, p > .05$). In other words, when the material design self-efficacy perception on the computer material design pre-test scores of the experimental and control group were controlled, it was seen that the post-test scores of the material design self-efficacy perception on computer did not differ significantly.

Findings on the Effect of In-Service Training Course on Mathematics Teachers' Perceptions of Three-Dimensional Material Design Self-Efficacy

The ANCOVA analysis findings regarding whether the post-test scores differed when the pre-test scores were controlled are presented in Table 4.

Table 4.
Three-dimensional material design self-efficacy perception findings of covariance analysis

	Experiment			Control		
	N	M	SE	N	M	SE
Pre-test	16	24.63	.97	20	27.94	1.11
Adjusted Post-test	16	27.38	1.18	20	25.34	1.08

When Table 4 was examined, it was determined that the material design post-test scores did not differ significantly when the pre-tests were taken under control ($F1,33= 1.523, p > .05$). In other words, when the three-dimensional material design self-efficacy perception pre-test scores of the experimental and control group were controlled, it was observed that the three-dimensional material design self-efficacy perception post-test scores did not differ significantly.

Findings Regarding the Effect of In-Service Training Course on Mathematics Teachers' Perceptions of Two-Dimensional Material Design Self-Efficacy

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled are presented inTable5.

Table 5.
Findings of two-dimensional material design self-efficacy perception covariance analysis

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	24.50	.59	20	25.31	1.19
Adjusted Post-test	16	25.80	.66	20	24.81	.59

When Table 5 was examined, the material design post-test scores did not differ significantly when the pre-tests were taken under control ($F1,33= 1.253, p > .05$). When the two-dimensional material design self-efficacy pre-test scores of the experimental and control group were controlled, it was seen that the two-dimensional material design self-efficacy perception post-test scores did not differ significantly.

The Effect of Awareness of the In-Service Training Course on the Transition of Mathematics Teachers from Arithmetic to Algebra

The ANCOVA analysis findings on whether the post-test scores differed or not when the pre-test scores were controlled are presented in Table 6.

Table 6.
Findings of awareness score covariance analysis for transition from arithmetic to algebra

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	30.13	1.12	20	32.63	.95
Adjusted Post-test	16	30.93	1.042	20	33.16	.93

When Table 6 was examined, the awareness post-test scores for the transition from arithmetic to algebra did not differ significantly when the pre-tests were controlled ($F1,33 = 2.466, p > .05$). In other words, the in-service training course designed for algebra teaching did not have a significant effect on the awareness of mathematics teachers about the nature of the

transition from arithmetic to algebra.

The Effect of Awareness of the In-Service Training Course on the Relationship of Mathematics Teachers with Arithmetic and Algebra

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled are presented in Table 7.

Table 7.
Findings of covariance analysis for arithmetic and algebra relationship

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	11.63	.56	20	12.71	.52
Adjusted Post-test	16	11.82	.62	20	11.99	.57

When Table 7 is examined, the awareness post-test scores for the relationship between arithmetic and algebra did not differ significantly when the pre-tests were taken under control ($F1,33= .041$, $p > .05$). In other words, when the awareness pre-test scores of the participants in the experimental and control groups regarding the relationship between arithmetic and algebra were checked, it was seen that the participants' post-test scores on awareness about the relationship between arithmetic and algebra did not differ significantly.

Findings on the Effect of In-Service Training Courses on Mathematics Teachers' Awareness of the Differences Between Arithmetic and Algebra

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled represented in Table 8.

Table 8.
Findings of covariance analysis on the differences of arithmetic and algebra

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	18.50	.68	20	19.67	.63
Adjusted Post-test	16	19.29	.70	20	21.18	.64

When Table 8 is examined, the awareness post-test scores for the transition from arithmetic to algebra did not differ significantly when the pre-tests were taken under control ($F1,33= 3.891$, $p > .05$). In other words, when the awareness pre-test scores of the participants in the experimental and control groups about the nature of the transition from arithmetic to algebra were controlled, it was seen that the awareness post-test scores about the nature of the transition from arithmetic to algebra did not differ significantly.

Conclusion and Discussion

The study aimed to examine the effect of in-service training course on teaching algebra on the perception of material design and the nature of the transition from arithmetic to algebra. The most important result of the study was that the in-service training course designed for algebra teaching did not significantly affect the mathematics teachers' awareness about the transition from arithmetic to algebra and their perceptions of material design self-efficacy. This result constitutes one of the original results of the study. It coincides with the results of the study of Görgün and Eken (2020), in which the effect of Hands-on Activities on success was examined. Çelik (2007) examined the algebraic thinking skills of pre-service teachers and concluded that pre-service teachers' algebraic thinking skills were similar. This situation supports the absence of a significant difference in teachers' awareness of the transition from arithmetic to algebra in

our study. The results of the study determined that there was a negative relationship between teacher candidates' self-efficacy against using materials and their use of materials. This situation is similar to the results of the study conducted by İskenderoğlu et al. (2016), in which their self-efficacy for recognizing and using concrete materials was examined. Bakaç and Özen (2015) stated in their study that they examined teachers' material design self-efficacy and that teachers' self-efficacy towards material design did not have significant effect. These results are in parallel with our results.

The results obtained in the study showed that when the pre-test scores of the experiment and control groups were controlled, there was no significant mean difference between the awareness scores of the nature of the transition from arithmetic to algebra. When the scores for the between arithmetic and algebra were examined, there was no significant mean difference relationship between the experiment and control groups. According to the results obtained by Çekirdekçi and Toptaş (2011) from the opinions of the classroom teachers about the rates of using materials in mathematics lessons, the rates of using materials did not differ according to the ages and seniority of the teachers. This situation appears to be similar to our results. Charitaki et al. (2022) stated, who looked at the impact of teachers' demographic characteristics on their opinions with the analysis carried out with parametric and non-parametric controls which were based on the age of the teachers, their field of expertise and whether there was a situation that would affect the environment, that there was no significant effect in the study. This situation appears to be parallel to our study.

According to the results obtained from the analysis made in this study, the in-service training course designed for teaching algebra did not have a good effect on the perception of mathematics teachers about the nature of the transition from arithmetic to algebra and on designing materials. As the reason for this, some planned events could not be held due to the pandemic. The teachers who would participate in the study due to the pandemic were also affected; therefore, the sample was affected. In addition, the change in the time of the in-service training course due to the pandemic and the official disruptions caused by this wholly affected both the teachers who would participate in the study, the teachers who would provide training, and the activities to be done. In addition, it is used as a reason why research conducted outside of these reasons does not yield the desired results. Vogiatzi et al. (2022) argued that teachers' competence and individual capacity to maintain motivation, as well as the teacher's feelings, attitudes and concerns, were also effective. In order to maintain motivation, it should be used in obtaining social support and developing teacher training programs (Vogiatzi et al., 2022).

Suggestions

The experimental research model, one of the quantitative research models, was used in the study, and only quantitative data were obtained. For this reason, the reasons why there was no significant mean difference between the teachers who participated in the in-service training course and the teachers who did not participate in the in-service training course could not be explained. Future researchers can make more in-depth evaluations of the in-service training course using mixed research methods to evaluate in-service training courses design for teaching algebra.

The results obtained in the research show that the designed in-service training course does not give effective results. There could be many reasons for this situation. In this context, organizing the in-service training course should be planned in line with the expectations and needs of teachers.

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Genişletilmiş Özet

Giriş

Öğretim materyallerinin öğrenci başarısına etkisi düşünülürse öğretmenlerin materyal hazırlama ve hazırlanan materyali etkili kullanma konusunda özyeterlik inançlarının ne düzeyde olduğunu araştırmak önemlidir. Bandura (1997) özyeterliği bireyin herhangi bir konuda etkinlikleri planlayarak başarılı bir şekilde sonuçlandırabilmesine yönelik kendine olan inancı şeklinde tanımlamıştır. Başka bir ifadeyle bireyin kendisi hakkındaki düşünceleridir. Bireyin bir konu ile ilgili olarak özyeterlik inancı ne kadar yüksek olursa, karşılaştığı zorlukları aşmak için sahip olduğu inancı da o derecede yüksek olur. Bireyin özyeterlik inancı ne kadar düşük olursa karşılaştığı zorlukları aşmak için sahip olduğu inancı da o derece düşük olur (Avcı, 2019).

Özyeterlik inancının eğitime bir çok etkisi vardır (Ertekin, & Dilmaç, 2021). Bunlardan birisi de öğretmen özyeterliğidir. Öğretmen özyeterliği, öğretmenin bir konuda sahip olduğu bilgileri öğretmeye yönelik inancıdır (Schunk, 2012). Başka bir deyişle öğretmen özyeterliği, başarılı bir öğretim için etkili olan ve ihtiyaç duyulan eğitim etkinliklerini organize ederek gerçekleştirmeye olan inancıdır (Avcı, 2019). Öğretmenlerin cebir öğretimi özyeterliği ise öğretmenin cebir konusuna ait somut materyal hazırlamada ve hazırladığı somut materyali öğretime katmada kendine olan inancı olarak açıklanabilir. Öğretmenin cebir öğretimi özyeterliği ne kadar yüksek olursa cebir öğretimide o denli başarılı olması beklenir. Çünkü öğretmenin cebir öğretimi özyeterliğinin yüksek olması öğretmenin kolay yılmamasını daha fazla çaba göstermesini ve öğretim için alternatif yöntemler üretilmesine katkı sağlayacaktır. Bu bağlamda öğrencilerin cebir konularında başarılı olması için öncelikle öğretmelerinince bir konusunda özyeterliklerinin yüksek olması gerektiği söylenebilir.

Bu araştırmada "Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun, matematik öğretmenlerinin aritmetikten cebire geçişin doğasına yönelik farkındalıkları ve materiyal tasarımı özyeterlik inançlarına bir etkisi var mıdır?" problemine yanıt aranmıştır.

1. Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun matematik öğretmenlerinin materyal tasarımı özyeterlik algıları üzerinde anlamlı etkisi var mıdır?
2. Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun matematik öğretmenlerinin aritmetikten cebire geçişin doğasına yönelik farkındalıkları üzerinde anlamlı etkisi var mıdır?

Yöntem

Bu çalışmada nicel araştırma yöntemlerinden deneysel araştırma deseni kullanılmıştır. Yapılan çalışma deneysel araştırma türlerinden çok denekli desenler araştırmasıdır. Ve çok denekli deneysel araştırmalardan da gerçek deneysel desen araştırmasıdır. Gerçek deneysel araştırmalar içinden ise öntest-sontest kontrol gruplu seçkisiz desen çalışmasıdır. Yapılan deneysel çalışmanın yapılış süreci aşağıdaki şekil 1'de gösterilmiştir.

Araştırmanın çalışma grubu seçkisiz olmayan örnekleme çeşitlerinden amaçsal örnekleme yöntemine göre oluşturulmuştur. 2021-2022 eğitim öğretim döneminde Türkiye'nin kuzey doğusundaki bir ilde görev yapan gönüllü olarak çalışmaya katılan matematik öğretmenleri oluşturmuştur. Araştırmanın deney grubunu cebir öğretimine yönelik hizmetiçi eğitim kursuna katılmaya gönüllü olan 16 matematik öğretmeni ve kontrol grubunu ise eğitimlere katılamayan 20 matematik öğretmeni oluşturmuştur.

Bu çalışma kapsamında elde edilecek nicel veriler "Kişisel Bilgi Formu", "Materyal Tasarımı

Özyeterlik İnancı Ölçeği" ve "Aritmetikten Cebire Geçişin Doğasına Yönelik Farkındalık Ölçeği" ile toplanmıştır. Çalışmada elde edilen verilerin analizinde hedefleri gerçekleştirebilmek için betimsel ve kestirimsel istatistikten yararlanılmıştır. Hedefleri gerçekleştirmek için ilk olarak toplanan verilere betimsel istatistik yapılmıştır. Böylece verilerin analizi için uygunluğu değerlendirilmiş ve normal dağılım gösterip göstermediğine bakılmıştır. Yapılan analizler sonucunda elde edilen veriler normal dağılım gösterdiği görülmüştür. Betimsel istatistik ile matematik öğretmenlerinin materyal tasarımı ve aritmetikten cebire geçişin doğasına ilişkin farkındalıkları belirlenmiştir. Betimsel istatistikte merkezi eğilim ve dağılım ölçülerinden yararlanılmıştır. Kestirimsel istatistik için grupların öntest puanları kontrol altına alınarak sontest puanları karşılaştırılmıştır. Bunun için kovaryans analizi (ANCOVA) kullanılmıştır.

Sonuç ve Tartışma

Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun, materyal tasarlamaya ve aritmetikten cebire geçişin doğasına yönelik algıya etkisini incelemek için yapılan çalışmada matematik öğretmenlerinin öntest–sontest sonuçlarına göre elde edilen sonuçlar bulgulara gore değerlendirilmiştir. Yapılan çalışmada ulaşılan en önemli sonucu cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun matematik öğretmenlerinin aritmetikten cebire geçişe yönelik farkındalıkları ve materyal tasarımı özyeterlik algıları üzerinde anlamlı etki oluşturmadığıdır.