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The Effect of Artificial Intelligence-Supported Activities on Academic Achievement, Critical Thinking and Innovation Skills in Social Studies Classes

Yapay Zekâ Destekli Etkinliklerin Sosyal Bilgiler Dersinde Öğrencilerin Akademik Başarılarına, Eleştirel Düşünme ve İnovasyon Becerilerine Etkisi

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Abstract

This research investigated the effect of artificial intelligence-supported activities on academic achievement, critical thinking, and innovation skills. To this end, an explanatory sequential mixed-methods design was used. The quantitative phase utilised a quasi-experimental pretest-posttest control group design, while the qualitative phase adopted a case study approach. A total of 49 seventh-grade students from a public school were selected through simple random sampling, with 25 students in the experimental group and 24 in the control group. The experimental intervention lasted six weeks. The quantitative data were collected using the Academic Achievement Test, the Critical Thinking Disposition Scale, and the Innovation Skills Scale, while the qualitative data were collected through semi-structured interviews. The analysis showed that AI-supported activities significantly enhanced academic achievement and innovation skills but did not improve critical thinking compared to traditional textbook-based instruction. The analysis of interview responses revealed that students perceived the advantages of AI for learning and its disadvantages for critical thinking and misdirection. Based on these findings, it is recommended that classrooms be equipped with the essential technological infrastructure to help students benefit from AI, that large language models designed for educational use be fine-tuned with scientific and reliable sources, and that further research explore and exemplify the potential roles of AI tools in educational contexts.

Keywords: *Artificial intelligence, large language models, academic achievement, innovation, critical thinking*

Öz

Bu çalışmada yapay zekâ etkinliklerinin akademik başarı, eleştirel düşünme ve inovasyon becerisine etkisini ortaya koymak amaçlanmıştır. Araştırmada açıklayıcı sıralı karma desen kullanılmıştır. Çalışmanın nicel boyutunda ön test-son test kontrol gruplu yarı deneysel desen; nitel boyutunda ise durum çalışmasından yararlanılmıştır. Çalışmaya basit seçkisiz örnekleme tekniği ile belirlenen bir devlet okulunda 7. sınıfa devam eden 49 öğrenci dahil edilmiştir. Araştırmanın deney grubunda 25, kontrol grubunda 24 öğrenci yer almıştır. Deneysel müdahale 6 hafta sürmüştür. Nicel veriler, akademik başarı testi, Eleştirel Düşünme Eğilimi Ölçeği ve İnovasyon Becerileri Ölçeği ile nitel veriler ise yarı yapılandırılmış görüşme sorularıyla elde edilmiştir. Araştırma sonucunda yapay zekâ etkinliklerinin akademik başarıyı ve inovasyon becerilerini önemli ölçüde geliştirdiğini, ancak eleştirel düşünmeyi ders kitabı etkinliklerine kıyasla geliştiremediğini göstermiştir. Görüşmelerde öğrencilerin yapay zekânın öğrenme için algılanan avantajlarını, eleştirel düşünme ve yanlış yönlendirmelere dönük dezavantajlarını vurguladıkları belirlenmiştir. Araştırma sonucunda; öğrenme ortamlarında yapay zekâdan öğrencilerin faydalanabilmesi için sınıflarının gerekli teknolojik cihazlarla donatılması, eğitim için kullanılacak yapay zekâ büyük dil modellerinin daha bilimsel ve güvenilir kaynaklar kullanılarak eğitilmesi için ince ayarlamaların yapılması ve yapay zekâ araçlarının öğrenme ortamında ne tür farklı eğitimsel rolleri üstlenebileceğine ilişkin çalışmaların yapılması ve örneklerin sunulması önerilmiştir.

Anahtar Kelimeler: *Yapay zekâ, büyük dil modeli, akademik başarı, inovasyon, eleştirel düşünme*

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INTRODUCTION

The 21st century is an age in which the impact of innovative information technologies (IT) and tools is most strongly felt. Undoubtedly, present technological changes and transformations are reflected in educational environments. Striking developments in the software world have increased the diversity of technologies that can be used in education. Such technologies have become tools that complement or transform classical teaching methods. Recent years have witnessed remarkable developments in AI technology. The integration of IT and AI tools into educational environments plays a critical role in supporting teaching methods and achieving targeted learning outcomes.

In educational settings, students are expected to achieve a number of goals. One of the most important goals is to ensure cognitive development. The concept of academic achievement comes to the fore at this point. Academic achievement also indicates the performance measures for the target behaviour throughout the learning process. Many factors, such as physical, mental, and socioeconomic levels, influence academic achievement, and technological developments are among these factors (Byrnes, 2011). Thus, academic achievement develops under the influence of various variables and is an important outcome in terms of the use of technology in education.

In addition to academic achievement, thinking skills are vital in educational practice. In modern education systems, curricula are focused on cultivating students who are capable of both critical thought and productive output (Seferoğlu & Akbıyık, 2006). The four fundamental essential 21st-century skills, i.e., critical thinking, creativity, communication, and collaboration, are central to this goal (Spector & Ma, 2019). The term ‘critical’ in critical thinking originates from the Latin ‘criticus’ derived from the Greek word ‘kriticos’ (Alkın-Şahin & Tunca, 2015; Şenşekerci & Bilgin, 2008). Critical thinking requires multi-dimensional thinking in the process of acquiring information and the ability to think mentally and emotionally effectively (Akınoğlu, 2001, p. 20). Ennis (1991) defines critical thinking as analysing arguments through basic thinking processes and logical reasoning by taking into account assumptions and prejudices. Similarly, Elçi et al. (2020) define critical thinking as the logical interpretation of complex events and situations based on evidence and accurate grounds, while recognising prejudices and stereotypes (p. 3318). Critical thinking is one of the *sine qua non* of scientific development, and by extension, education. However, traditional schooling often fails to foster the development of critical thinking (Spector & Ma, 2019). Thus, most researchers and educators advocate for the integration of critical thinking into educational curricula (Hatcher, 2013). Critical thinking skills also play a pivotal role in the adoption and dissemination of technological tools in educational settings. They have significantly contributed to the expansion of technology use in education (Evcim & Topsakal, 2019; Schooner et al., 2017). Nevertheless, the potential of technological innovations to enhance critical thinking in education has largely been overlooked. Rusandi et al. (2023) pointed out that today, one of the main focuses is on how AI can improve critical thinking skills while improving learning and research. Therefore, it is reasonable to assert that critical thinking is intricately linked to AI-supported educational activities, and this connection warrants further investigation.

Considering the use of AI technologies in education, the concept of innovation is also of great importance. Innovation is often associated with novelty and can be defined as a new idea, product, or service that provides societal benefits (Nakano & Wechsler, 2018). The term originates from the Latin ‘innovatus’, which means to renew (Kocabaşoğlu, 2023, p. 11). Innovation skills involve thinking outside the box, heightened awareness, authenticity, sociability, and openness to productivity (Aras, 2020, p. 9; Koyuncuoglu, 2021, pp. 105-106; Özmusul, 2012, p. 732). It can be argued that the concepts of education and innovation are inherently connected, as innovation plays a critical role in transforming educational environments in terms of processes, opportunities, and curriculum (Keleşoğlu & Kalaycı, 2017). Contemporary frameworks such as Industry 4.0 and Education 4.0 are indicative of the effectiveness of innovation skills (Gonzalez-Perez & Ramirez-Montoya, 2022). The Ministry of National Education Social Studies Curriculum also emphasises innovative thinking skills (MEB, 2018a). In particular, the learning outcomes in the 'Global Connections' and 'Science, Technology and Society' units focus on fostering innovative thinking. Similarly, creative thinking is also featured in the Science Curriculum, and from an interdisciplinary perspective, promoting innovation skills in educational settings is essential (MEB, 2018b).

1.1. Historical Development of Artificial Intelligence

AI has undergone various transformations throughout history. According to some sources, an automaton chess player named 'The Turk' invented by Wolfgang von Kempelen in the 18th century is considered one of the first inventions using machine intelligence, although there is no conclusive evidence of whether it is an example of AI (Artut, 2019). During the Second World War, the British mathematician Alan Turing used the intelligence of machines to break the 'Enigma' code, an effective weapon of the German army. With his invention, Turing launched the first modern attempt to develop AI (Haenlein & Kaplan, 2019).

The term AI was first coined in 1956 by scientist John McCarthy, who was part of a research team funded by the Rockefeller Foundation (Andresen, 2002). McCarthy defined AI as the ability of computers to perform metacognitive skills such as reasoning, generalisation, problem-solving, and inference-making. In the 1960s, the natural language processing program 'ELIZA' that increased the functionality of computers was developed by Joseph Weizenbaum in the AI laboratories at the Massachusetts Institute of Technology (MIT) (Arslan, 2020). The "physical symbol system hypothesis (PSSH)" was introduced by Allen Newell and Herbert A. Simon in the 1970s constituted a philosophical milestone in the conceptualisation of AI (Yeşilkaya, 2022).

To date, ELIZA created by Joseph Weizenbaum at MIT in 1966, PARRY implemented by Kenneth Colby in 1972, ALICE developed by Richard Wallace, SmarterChild, developed by ActiveBuddy in 2001, IBM's Watson in 2011, and Google Duplex introduced in 2018, have marked key moments in the evolution of natural language processing and machine learning algorithms, which are the first examples of chatbots that provide human-like responses (Labadze et al., 2023). Large language models (LLM) such as Microsoft Copilot, ChatGPT, Claude, DeepSeek, Gemini, Grok, Llama, and Mistral have led a quiet revolution in AI. For example, ChatGPT reached more than 100 million users within two months of its release (Guo & Wang, 2023). AI technology has developed in many different areas. Today, traces of AI are visible in many social and digital fields, including medicine, industry, engineering, psychology, architecture, art, and education. Autonomous devices, smart software, and technologies that make human life easier in every sense are the reflections of AI.

It is possible to say that artificial intelligence technologies have an important place in today's educational environments. It is inevitable that the innovations brought about by this constantly evolving technology will permeate education. Roll and Wylie (2016, p. 583) draw attention to this situation and state that educational environments and applications must work together to keep pace with this transformation. However, artificial intelligence applications are changing and innovating every day. For educational integration, it is important for education stakeholders to learn about these changes and the basic use of artificial intelligence.

Artificial intelligence technologies, therefore, have significant potential for learning and teaching activities (Huang et al., 2021; Söllner et al., 2025). This situation has made it inevitable that AI will be used more frequently in educational environments to observe its effects (Qian et al., 2025). When considering artificial intelligence technologies in educational environments in the literature, they are generally grouped under three headings: Intelligent tutoring systems (İncemen & Öztürk, 2024), expert systems (Arslan, 2020), and chatbots, i.e., dialogue-based systems (Barış, 2020). The generative artificial intelligence (LLM) tools we focus on in this study are also included in dialogue-based systems. LLM tools incorporate individual and group contributions from the perspective of educators and learners in the learning process (Chu et al., 2025). Additionally, it can be said that LLM tools have made educators' roles easier and positively influenced design-oriented active learning processes (Bozkurt, 2023). LLMs have had a significant impact in the field of education. LLMs can recognise, classify, and summarise texts, make inferences, generate creative content, translate, write code, and provide informative answers to questions based on information from large data sets. LLMs use the dataset they were trained on to predict the most likely sequence of words that could resemble a human response, thereby answering questions (Crawford et al., 2023).

LLMs are a subset of generative AI technologies. Generative AI is not limited to text production; it can also generate new information from different modalities, such as visuals and sounds. Farrokhnia et al. (2024) conducted a SWOT analysis to explore the effects of such software in educational environments and highlighted that, despite its possible threats and weaknesses, the successful integration of AI in education is essential due to its many learning-enhancing features and the fact that today's students are digital natives. Similarly, Baidoo-Anu and Owusu-Ansah (2023) emphasised the necessity of AI integration into education, given the growing importance of internet-based remote access opportunities in education, especially since the COVID-19 pandemic. Thus, it is evident that LLMs occupy a key place in educational environments.

One of the most well-known LLM-based applications is ChatGPT. Developed by OpenAI, this software was released in 2020 under the name GPT-3, and a paid version called GPT-4 was launched in 2023. ChatGPT offers innovative opportunities in learning and teaching processes, providing students and teachers with an application environment that reduces potential risks through fast, effective, and activity-based learning (Rudolph et al., 2023).

The AI-powered chatbot within Microsoft's Bing search engine is based on large language models (LLMs) and includes several advanced features. Initially introduced as "Bing Chat," the tool was later rebranded as "Microsoft Copilot" as part of Microsoft's broader strategy to integrate AI across its platforms. Copilot became one of the most up-to-date implementations by incorporating additional layers on top of OpenAI's foundational GPT-4 model through its "Prometheus Model". This Prometheus system utilises a component called the "Orchestrator" to combine the Bing search index and results with the capabilities of GPT-4. Copilot distinguishes itself with key capabilities such as maintaining context in multi-turn conversations, the ability to analyse external content (e.g., an article), and providing responses with up-to-date information through real-time web access.

Considering that AI technologies have gained ground in many fields today, their use in educational environments has been studied from a diversity of perspectives. The volume of studies focusing on AI has significantly increased,with bibliometric analyses revealing a particularly sharp surge in publications since 2018 (Karaca & Kılcan, 2023). Tapan-Broutin (2023) conducted a qualitative study to explore the LLM user experiences of pre-service mathematics teachers. Celik (2023) developed a scale to measure teachers' knowledge of AI-based instruction in terms of technological, pedagogical, and content knowledge. In their quantitative study with 215 teachers, Choi et al. (2023) examined the pedagogical acceptance of educational AI tools using structural equation modelling. In their thematic qualitative study, Chiu and Chai (2020) explored teachers' opinions about the suitability of AI tools for the school curriculum. Perkins (2023) addressed the issue of generative AI software within the context of academic integrity. Apart from those stated above, the literature also includes empirical research (Chocarro et al., 2023; Dogan et al., 2021) and theoretical discussions (Akgun & Greenhow, 2022; Alharbi, 2023; Cooper, 2023; Crompton & Burke, 2023; Fraiwan & Khasawneh, 2023; Lim et al., 2023; Lo, 2023; Siegle, 2023; Yang, 2022). However, no mixed-methods research has been found that experimentally examines the effects of LLMs on academic achievement, innovation, and critical thinking in the educational environment.

Some scholars have pointed out that some teachers may become overdependent on LLMs, which could adversely impact students' creativity, critical thinking, and problem-solving skills (Kasneci et al., 2023). Apart from such assumptions, the questions of how teachers can use AI and how LLMs impact education have not been adequately investigated. Thus, there is a certain need for empirical research on this topic (Aşkun, 2023; Guo & Wang, 2023; İşler & Kılıç, 2021; Jeon & Lee, 2023; Labadze et al., 2023; Oksanen et al., 2020; Rahman & Watanobe, 2023; Williamson, 2020). In a report on AI and mobile learning, UNESCO (2019) also underlined the encouragement of experimental research on how to integrate educational technologies in school education within the framework of the 2030 goals in education.

1.2. Current Study

Fostering innovation skills in educational environments is of key importance to adapt to and manage the rapid advancements in technology. This is because different problems are likely to arise in this process. Wrahatnolo and Munoto (2018) pointed out the need to investigate the use and impact of innovation skills and other 21st-century skills in educational settings, together with educational strategies and technologies, and they emphasised that this is important for the proper management of the process. A recent study by IBM emphasised that many people need new skills, especially on a sectoral basis, and innovation skills soon come to the fore as a result of the effectiveness of AI (Solimano, 2023). Thus, it is of utmost importance to evaluate innovation in education and the requirements and outcomes of innovation skills. There is a need to explore how to use and improve innovative thinking in educational environments, which has evolved with the introduction of AI.

Several factors influence students' academic achievement. Özer and Sarı (2009) noted that academic achievement is affected by the quality of education, which is shaped by many variables such as environmental, cultural, socioeconomic, familial, and health factors, as well as by the increasing use of technological innovations. Digital and technological competences have a boosting effect on academic achievement. IT, especially AI technologies, contribute to academic achievement (İşler & Kılıç, 2021; Jiao et al., 2022; Ulum, 2022). Thus, the widespread, effective, and proper use of AI tools in educational environments can reduce shortcomings and deficiencies that hamper academic achievement.

Unlike the case with academic achievement, it is hard to ascertain that IT and AI tools positively affect critical thinking processes. Despite the ongoing controversy in the literature, the general belief is that the frequent use of AI tools in educational environments negatively affects students' critical thinking skills (Bozkurt, 2023; Sağın et al., 2023; Spector & Ma, 2019). Thus, it is important to carry out new research, especially in educational environments and integrate AI tools into the learning process. Zhai (2022) argued that AI software such as ChatGPT has positive effects in many ways; however, the integration of such tools should be well managed, especially in terms of critical and creative thinking skills. Although AI-supported tools make student-oriented teaching and assessment processes more systematic and efficient (Chassignol et al., 2018), they may create some disadvantages for creative, reflective, and critical thinking, which are the intellectual processes of the human mind (Coşkun & Gülleroğlu, 2021; Karakoç-Keskin, 2023). Therefore, the proper and effective use of AI is critical. Considering that traditional teaching methods have come to be inadequate in many aspects, developments in IT prove the necessity of using AI tools in education (Chen et al., 2020; Kouzov, 2019). Thus, it seems that AI technologies and AI-supported teaching activities will soon have an important position in education; thus, new research on these issues is of key importance.

This research aimed to explore the effects of AI-supported activities on middle school students' academic achievement, critical thinking, and innovation skills in social studies classes. As a mixed-methods study, it holds the potential to make a significant contribution to the literature by examining the impact of LLMs on the learning environment. In line with this aim, the following research sub-questions were formulated:

1. Is there a significant difference between the experimental group's pretest and posttest mean scores on the Academic Achievement Test (AAT)?

2. Is there a significant difference between the control group's pretest and posttest mean scores on the AAT?

3. Is there a significant difference between the experimental and control groups in their adjusted posttest means on the AAT?

4. Is there a significant difference between the experimental group's pretest and posttest mean scores on the Critical Thinking Disposition Scale (CTDS)?

5. Is there a significant difference between the control group students' pretest and posttest mean scores on the CTDS?

6. Is there a significant difference between the experimental and control groups in their posttest mean scores on the CTDS?

7. Is there a significant difference between the experimental group's pretest and posttest mean scores on the Innovation Skills Scale (ISS)?

8. Is there a significant difference between the control group's pretest and posttest mean scores on the ISS?

9. Is there a significant difference between the experimental and control groups in their posttest mean scores on the ISS?

10. How do the qualitative data help explain the quantitative findings regarding the effects of AI-supported activities on academic achievement, critical thinking, and innovation skills?

2. METHODS

2.1. Research Design

This research collected quantitative and qualitative data to examine the effects of AI-supported activities on academic achievement, critical thinking, and innovation skills. For this purpose, an explanatory sequential mixed-methods design was used. The quantitative phase utilised a quasi-experimental pretest-posttest control group design, while the qualitative phase followed a case study approach. The independent variable in the study was the use of AI-supported activities, whereas the dependent variables were academic achievement, innovation skills, and critical thinking disposition.

2.2. Sample

The sample was selected using simple random sampling and consisted of 7th-grade students enrolled in two different sections of a public school. Table 1 shows the demographics of the sample group.

Table 1. Demographics of the sample

Gender	Age	Experimental	Control	Total
Girls	12	4	4	8
	13	5	8	13
	14	-	-	-
Boys	12	2	2	4
	13	13	10	23
	14	1	-	1
Total		25	24	49

Table 1 presents the demographic information of 25 students in the experimental group and 24 students in the control group. The participants were aged between 12 and 14 years. The qualitative data were collected through semi-structured interviews with eight students (four girls and four boys) from the experimental group.

2.3. Data Collection Tools

The data were collected using four instruments: the Academic Achievement Test (AAT) developed by Toy and Akpınar (2020), the Critical Thinking Disposition Scale (CTDS) developed by Yıldırım-Döner and Demir (2022), the Innovation Skills Scale (ISS) originally developed by Chell and Athayde (2009) and adapted into Turkish by Akkaya (2016), and a set of semi-structured interview questions developed by the researcher.

The AAT developed by Toy and Akpınar (2020) is designed to measure students' attainment of the learning outcomes in the "Global Connections" unit, which is also the focus of the present research. The test involves 25 multiple-choice questions. The KR-20 reliability coefficient of the test was reported as .850, indicating high internal consistency.

The CTDS, developed by Yıldırım-Döner and Demir (2022), measures middle school students' tendencies toward critical thinking. The scale consists of 21 items, each rated on a 5-point Likert scale ranging from always to never. The minimum and maximum scores are 21 and 105, respectively. The scale's overall Cronbach's alpha reliability coefficient was calculated as .87. It consists of three factors: dialectical thinking (e.g., "My main goal in the thinking process is to reach the truth"), tendency (e.g., "I use critical thinking in my daily life"), and analysis (e.g., "I can sense bias in a sentence"). Since the scale was subjected to second-order confirmatory factor analysis, the total score is available for statistical analysis. Researchers conducted second-order confirmatory factor analysis on a different sample to test model fit. The analysis revealed that the model fit was within an acceptable range and the scale structure was validated (Yıldırım-Döner & Demir, 2022).

The ISS developed by Chell and Athayde (2009) was adapted into Turkish by Akkaya (2016). The scale was developed to measure innovation skills. The adaptation study was conducted with 7th-grade students. Items are scored using a 5-point Likert scale (strongly agree to strongly disagree), and the total score ranges from 31 to 155. The scale consists of five factors: creativity composed of six items (e.g., I want my classes to include many different creative activities), leadership composed of six items (e.g., I like to be the leader of a group), energy composed of seven items (e.g., I really push myself to get good grades), self-efficacy composed of eight items (e.g., I was raised to be able to make my own decisions), and risk-taking tendency composed of four items (e.g., I would not take a risk for an activity that might prevent me from getting good grades at school) (Akkaya, 2016).

The researcher formulated semi-structured interview questions to analyse the experimental intervention process in greater depth. The interview form consisted of eight open-ended questions. Expert feedback was obtained from two experts in social studies education, two in measurement and evaluation, and two in Turkish language teaching. The questions were then revised based on expert suggestions to ensure clarity and content validity.

2.4. Experimental Procedure

While artificial intelligence-supported activities were implemented in the experimental group, the control group followed the activities in the standard social studies textbook. The experimental procedure lasted six weeks and focused on the "Global Connections" unit of the 7th-grade social studies curriculum. The global connections learning area focuses on solving global issues at the 7th-grade level of social studies and is based on the concept of global citizenship, which emerges from the scientific processes involved (Dere &Uçar, 2020). In the literature, various studies have shown that artificial intelligence tools have a significant impact on students' global citizenship connections (Cathrin et al., 2024; Swarts, 2020). For this reason, students' academic achievements, critical thinking, and innovation skills, which have been transformed by the influence of artificial intelligence, have been examined based on the topics of the global connections unit, and the aim has been to observe the research results in terms of their becoming effective citizens.

The AI-based activities implemented in the experimental group were designed with the support of Microsoft Copilot, an LLM-powered tool. Rahman and Watanobe (2023) highlighted that educators can utilise large language models (LLMs) to prepare outlines for specific courses or subject content. LLMs offer various capabilities, including generating instructional content that benefits both teachers and students (Agarwal et al., 2023; Naidu & Sevnarayan, 2023). In this context, Microsoft Copilot was used to assist in lesson planning. First, relevant sections of the textbook and information about the curriculum's learning outcomes were provided to the system. Then, it was prompted to design weekly lesson plans and corresponding activities based on an appropriate learning approach. Microsoft Copilot recommended project-based learning for teaching the unit. Based on the feedback and suggestions generated by Microsoft Copilot, a six-week instructional plan was developed and implemented in the experimental group.

After obtaining the necessary ethical approval and research implementation permissions, the study was conducted in a public middle school selected using simple random sampling. Subsequently, school administrators and teachers teaching 7th-grade social studies and technology design classes were given detailed information and asked for their opinions. There were five separate 7th-grade sections in the school. After the administration of pretests, two sections with similar mean scores were randomly assigned as the experimental and control groups.

One week before the experimental procedure began, the researcher met with both groups in their classrooms to provide information about the study and obtain their informed consent. The researcher attended all sessions in both groups. Classes for the experimental group were conducted in the information and technology classroom of the school. The experimental group used Microsoft Copilot for the defined activities. In this context, the students had the opportunity to use the AI software during lessons whenever they wanted. In contrast, the control group followed the regular textbook-based instruction in their standard classroom.

The "Global Connections" unit was selected for this study due to its rich content and potential to enhance students' academic achievement, critical thinking, and innovation skills. Table 2 provides detailed information about the unit.

Table 2. Information about the unit

Subject Title	Content	Possible achievements and skills	Explanation
Turkey and the World	Turkey's foreign policy and role in international organizations	Academic achievement, critical thinking, innovation	It helps students learn about Turkey's foreign policy and international relations. Relations between countries can help foster critical and creative thinking and problem-solving skills.
Thriving Turkey	Turkey's relations with economic zones and organizations	Academic achievement, critical thinking	Academic achievement in economic knowledge and economic development enables the development of critical thinking skills through the organizations in which countries participate in line with their economic interests.
False Facts We Think Are True	Cultures of different countries and stereotypes	Academic achievement, critical thinking	Getting to know diverse cultures, respecting differences, questioning stereotypes, and proposing solutions to problems are important for critical thinking.
Solutions to Today's World Problems	Global problems such as natural disasters, climate change, hunger, terrorism, and migration	Academic achievement, critical thinking, innovation	This section encourages students to think about these problems and undertake projects and activities to bring effective solutions to the problems. This allows them to use their critical thinking and innovation skills.

2.5. Data Collection and Analysis

Within the scope of the research, the experimental implementation, data collection, and interviews were carried out by the researchers. The interviews were conducted by the researcher in a quiet and distraction-free classroom at the school. Prior to the interviews, each student was informed in detail about the purpose of the interview, and their voluntary consent was obtained for audio recording. The interviews lasted approximately 62 minutes in total. Following the interviews, the recordings were played back for the students, who were then asked whether they had anything to add; final approval was obtained for the use of their responses. For the citation of interview findings, male students were coded as B (Boy) and female students as G (Girl), and they were numbered according to the interview sequence (e.g., B1, G1).

The interview data were transcribed using Microsoft 365 Word software and subsequently subjected to content analysis using the MAXQDA 2020. During the content analysis, codes, categories, and themes were generated. For the analysis of quantitative data, SPSS 23.0 and Microsoft 365 Excel were utilised. All data were analysed independently by the researcher and a doctoral student.

To determine the appropriate statistical tests for the quantitative data, normality tests were conducted. The normality of the data was assessed by examining whether the skewness and kurtosis values fell within the acceptable range of ±1.96 or not (Can, 2020).

2.6. Ethical Approval

This study has been conducted in full compliance with ethical principles throughout all stages, including the development of the conceptual framework, data collection, data analysis, and interpretation. The Editorial Board of the JANCR Journal holds no responsibility for any ethical violations that may arise; all responsibility lies with the authors. I certify that this study has not been submitted for evaluation in any other academic publication outlet besides the JANCR Journal. All rules specified in the "Directive on Scientific Research and Publication Ethics of Higher Education Institutions" have been strictly followed. None of the actions listed under the second section of the directive, titled "Violations of Scientific Research and Publication Ethics," has been committed. Ethical approval for this research was obtained from the Education Research Ethics Committee of Aydın Adnan Menderes University with the resolution numbered VII at the 2024/3 meeting held on 03.04.2024.

3. FINDINGS

3.1. Findings Related to the First Sub-Problem

To determine whether there was a significant difference between the pretest and posttest mean scores of the experimental group on the AAT, a dependent samples t-test was conducted, as the data met the assumption of normality. The results of the analysis are presented in Table 3.

Table 3. Dependent samples t-test results for the experimental group's pretest and posttest mean scores on the AAT

Group	Test	N	$\bar{X}$	SD	t	df	p	Cohen's d
Experimental	Pretest	25	12.96	5.18	-7.90	24	.000*	.77
	Posttest	25	17.00	5.27				

*p<.05

experimental group on the AAT increased statistically significantly from 12.96 to 17.00. Additionally, the effect size of the difference was large [t(24) = -7.90; p < .05; Cohen's d = .77].

3.2. Findings Related to the Second Sub-Problem

To examine whether there was a significant difference between the pretest and posttest mean scores of the control group on the AAT, a dependent samples t-test was conducted, as the data were normally distributed. The results are presented in Table 4.

Table 4. Dependent samples t-test results for the control group's pretest and posttest mean scores on the AAT

Group	Test	N	$\bar{X}$	SD	t	df	p	Cohen's d
Control	Pretest	24	12.88	3.72	-.97	23	.345	-
	Posttest	24	13.46	3.93				

*p<.05

As can be seen in Table 4, the mean scores of the control group on the AAT increased from 12.88 in the pretest to 13.46 in the posttest. However, this increase was not statistically significant, indicating that the textbook-based activities implemented in the control group did not result in a meaningful improvement in academic achievement [t(23) = -.97; p > .05].

3.3. Findings Related to the Third Sub-Problem

To examine whether there was a significant difference between the experimental and control groups in their adjusted posttest mean scores on the AAT, an analysis of covariance (ANCOVA) was conducted, as the data met the assumption of normality and other relevant statistical assumptions. The results are presented in Table 5.

Table 5. ANCOVA results for the adjusted posttest means of the experimental and control groups on the AAT

Dimension	Source of Variance	SS	df	MS	F	p	η2
Overall Test	Pretest	686.581	1	686.581	94.17	.000*	.305
	Group	147.419	1	147.419	20.22	.000*	
	Error	335.378	46	7.291			
	Sum	1.169,378	48				

*p<.05

The ANCOVA results showed that the adjusted posttest means of the experimental group ($\bar{X}$experimental = 16.97) were significantly higher than those of the control group ($\bar{X}$control = 13.50). This difference was statistically significant and represented a large effect size [$F(1, 46) = 20.22$; $p < .05$; $\eta2 = .305$].

3.4. Findings Related to the Fourth Sub-Problem

To examine whether there was a significant difference between the pretest and posttest scores of the experimental group on the CTDS, the Wilcoxon signed-rank test was conducted because the posttest scores were not normally distributed. The results are presented in Table 6.

Table 6. Wilcoxon signed-rank test results for the experimental group's pretest and posttest scores on the CTDS

Test	Dimension	Groups	N	$\bar{X}$rank	∑rank	Z	p	r
Pretest-Posttest	Overall	Negative ranks	16	12.81	205.00	-1.14	.253	-
		Positive ranks	9	13.33	120.00			
		Ties	0					
		Total	25					

*p<.05

According to the results of the Wilcoxon signed-rank test, the AI-supported activities implemented in the experimental group did not result in a statistically significant difference between the pretest and posttest scores on the CTDS ($Z = -1.14$; $p > .05$).

3.5. Findings Related to the Fifth Sub-Problem

To examine whether there was a significant difference between the pretest and posttest scores of the control group on the CTDS, the Wilcoxon signed-rank test was conducted, as the posttest scores did not meet the assumption of normality. The results are presented in Table 7.

Table 7. Wilcoxon signed-rank test results for the control group's pretest and posttest scores on the CTDS

Test	Dimension	Groups	N	X̄rank	∑rank	Z	p	r
Pretest-Posttest	Overall	Negative ranks	2	4.00	8.00	-4.06	.000*	.83
		Positive ranks	22	13.27	292.00			
		Ties	0					
		Total	24					

*p<.05

According to the results of the Wilcoxon signed-rank test, the textbook-based activities implemented in the control group resulted in a statistically significant difference between the pretest and posttest scores on the CTDS. Additionally, the effect size of this difference was large (Z =- 4.06; p < .05, r = .83).

3.6. Findings Related to the Sixth Sub-Problem

To examine whether there was a significant difference between the experimental and control groups in their posttest scores on the CTDS, the Mann-Whitney U test was conducted, as the posttest scores were not normally distributed. The results are presented in Table 8.

Table 8. Mann-Whitney U test results for the posttest scores of the experimental and control groups on the CTDS

Test	Dimension	Groups	N	X̄rank	∑rank	U	Z	P	r
Posttest	Overall	Experimental	25	16.34	408.50	83.50	-4.33	.000*	.62
		Control	24	34.02	816.50				
		Total	49						

*p<.05

According to the results of the Mann-Whitney U test, the experimental group students obtained a lower posttest mean rank on the CTDS (16.34) compared to the control group (34.02). The difference between the two groups was statistically significant in favour of the control group students, and the effect size was large (U = 83.50; Z = -4.33; p < .05; r=.62).

3.7. Findings Related to the Seventh Sub-Problem

To determine whether there was a significant difference between the pretest and posttest mean scores of the experimental group on the ISS, the Wilcoxon signed-rank test was conducted, as the data did not meet the assumption of normality. The results are presented in Table 9.

Table 9. Wilcoxon signed-rank test results for the experimental group's pretest and posttest means on the ISS

Test	Dimension	Groups	N	X̄rank	∑rank	Z	p	r
Pretest-Posttest	Creativity	Negative Ranks	0	0.00	0.00	-4.11	.000*	.82
		Positive Ranks	22	11.50	253.00			
		Ties	3					
		Total	25					

	Leadership	Negative Ranks	0	0.00	0.00	-4.20	.000*	.84
		Positive Ranks	23	12.00	276.00			
		Ties	2					
		Total	25					
	Energy	Negative Ranks	5	7.40	37.00	-3.23	.001*	.65
		Positive Ranks	19	13.84	263.00			
		Ties	1					
		Total	25					
	Self-efficacy	Negative Ranks	2	3.75	7.50	-4.08	.000*	.82
		Positive Ranks	22	13.30	292.50			
		Ties	1					
		Total	25					
	Risk-taking tendency	Negative Ranks	4	5.75	23.00	-3.37	.001*	.67
		Positive Ranks	18	12.78	230.00			
		Ties	3					
		Total	25					
	Overall	Negative Ranks	2	4.25	8.50	-4.15	.000*	.83
		Positive Ranks	23	13.76	316.50			
		Ties	0					
		Total	25					

*p<.05

According to the results of the Wilcoxon signed-rank test, AI-supported activities caused a statistically significant positive difference in the experimental group's mean scores on the total ISS, with a large effect size ($Z = -4.15$; $p < .05$, $r = .83$). There were also statistically significant positive differences across all sub-scales, with large effect sizes: the creativity sub-scale ($Z = -4.11$; $p < .05$, $r = .82$), the leadership sub-scale ($Z = -4.20$; $p < .05$, $r = .84$), the energy sub-scale ($Z = -3.23$; $p < .05$, $r = .65$), the self-efficacy sub-scale ($Z = -4.08$; $p < .05$, $r = .82$), and the risk-taking tendency sub-scale ($Z = -3.37$; $p < .05$, $r = .67$).

3.8. Findings Related to the Eighth Sub-Problem

To examine whether there was a significant difference between the pretest and posttest mean scores of the control group on the ISS, a dependent samples t-test was conducted, as the data met the assumption of normality. The results are presented in Table 10.

Table 10. Dependent samples t-test results for the control group's pretest and posttest means on the ISS

Dimension	Test	N	X̄	SD	t	df	p	Cohen's d
Creativity	Pretest	19.63	24	6.04	-.26	23	.799	-
	Posttest	20.08	24	7.25				
Leadership	Pretest	14.54	24	2.96	-2.04	23	.053	-
	Posttest	17.00	24	4.49				
Energy	Pretest	23.71	24	8.28	.49	23	.627	-
	Posttest	22.71	24	6.89				
Self-efficacy	Pretest	23.75	24	6.44	-1.03	23	.316	-
	Posttest	25.71	24	7.60				
Risk-taking tendency	Pretest	12.71	24	2.74	-.51	23	.615	-
	Posttest	13.21	24	3.80				
Overall	Pretest	94.33	24	24.69	-.61	23	.546	-
	Posttest	98.71	24	26.15				

*p<.05

As can be seen in Table 10, the mean scores of the control group students on the ISS increased from 94.33 to 98.71. However, this difference was not statistically significant [t(23) = -.61; p > .05]. Although the increases were not statistically significant, the mean scores also increased. Similarly, increases were observed in the mean scores for some sub-scales, but none of these changes reached statistical significance: from 19.63 to 20.08 for the creativity sub-scale [t(23)=-.26; p>.05], from 14.54 to 17.00 for the leadership sub-scale [t(23)=-2.04; p>.05], from 23.75 to 25.71 for the self-efficacy scale [t(23)=-1.03; p>.05], and from 12.71 to 13.21 for the risk-taking tendency sub-scale [t(23) = -.51; p > .05]. The mean score decreased from 23.71 to 22.71 for the energy sub-scale; however, this difference was also not statistically significant [t(23) = .49; p > .05].

3.9. Findings Related to the Ninth Sub-Problem

To examine whether there was a significant difference between the posttest mean scores of the experimental and control groups on the ISS, the Mann-Whitney U test was conducted, as the posttest scores of the experimental group were not normally distributed. The results are presented in Table 11.

Table 11. Mann-Whitney U test results for the posttest scores of the experimental and control groups on the ISS

Test	Dimension	Groups	N	X̄rank	∑rank	U	Z	p	r
Posttest	Creativity	Exp.	25	31.04	776.00	149.00	-3.04	.002	.43
		Control	24	18.71	449.00				
		Total	49						
Posttest	Leadership	Exp.	25	30.86	771.50	153.50	-2.94	.003	.42
		Control	24	18.90	453.50				
		Total	49						
Posttest	Energy	Exp.	25	31.32	783.00	142.00	-3.17	.002	.45
		Control	24	18.42	442.00				
		Total	49						
Posttest	Self-efficacy	Exp.	25	30.78	769.50	155.50	-2.90	.004	.41
		Control	24	18.98	455.50				
		Total	49						
Posttest	Risk-taking tendency	Exp.	25	30.52	763.00	162.00	-2.78	.005	.40
		Control	24	19.25	462.00				
		Total	49						
Posttest	Overall	Exp.	25	31.92	798.00	127.000	-3.46	.001	.49
		Control	24	17.79	427.00				
		Total	49						

*p<.05

According to the test results, the mean rank of the experimental group on the ISS (31.92) was higher than that of the control group (17.79). The difference was statistically significant, with a moderate effect size (U = 127.00; Z = -3.46; p < .05; r = .49). Likewise, the mean ranks of the experimental group were higher than those of the control group across all sub-scales, and the effect sizes of the differences were also moderate.

3.10. Findings Related to the Tenth Sub-Problem

In this part of the research, middle school students' views about AI-supported social studies instruction were explored. The data collected through semi-structured interviews were used to help interpret the quantitative findings. The qualitative data were analysed through inductive content analysis to generate codes, categories, and themes. Students' views about AI-supported social studies instruction were subsumed under two overarching themes: 'Advantages' and 'Disadvantages'. There were ten categories under the two themes. The 'Advantages' theme involves six categories (academic achievement, thinking processes, education, daily life, motivation, and use of AI), and the 'Disadvantages' theme involves four categories (difficulties in use, critical thinking, misdirection, and not a substitute for the teacher).

The academic achievement category under the theme of advantages involves the following codes: facilitating learning (in social studies and other courses), research, learning information (topics in the Global Connections unit), and conceptual knowledge. The interviewed students stated that the experimental process improved them, especially in terms of their research skills. For example, G1 stated, "*For example, we did scientific research, didn't we? We learned how to do scientific* research*, and we learned how to access accurate sources*." B1 expressed, "*I was able to get more comprehensive information with AI, whereas I normally got less information when I did research*." With respect to the category of facilitating learning, it was observed that students adopt AI processes for social studies and other courses and find them useful, as is clear in the remarks of B1: "*I can use artificial intelligence in other courses such as Mathematics, Science, and Turkish*." The code of conceptual knowledge can be exemplified by G2 saying, "*Our conceptual knowledge has also improved AI courses."* Likewise, the following remarks of B1 are indicative of the positive effect of AI-supported activities on the learning of the topics in the Global Connections unit, stating: "*First, I had a hard time using the app, but later AI made it easier for me to learn G20, global warming, and natural disasters*."

The thinking processes category under the theme of advantages involves the following codes: gaining a perspective for the future, technology-driven thinking, new and innovative, scientific learning processes, and creativity. It was observed for this category that students especially emphasise the novelty and innovative nature of AI. For example, B4 stated, "T*his process by which we learned with AI led me to generate new ideas*." G4, on the other hand, stated, *"In general, we thought about new things*." G2 also expressed, "*The activities we do with AI are useful in developing my creative thinking and versatile perspective*." Their remarks indicate the effect of AI-supported activities on their thinking processes. G3 mentioned the advantage of AI for scientific learning processes, stating, *"My research and scientific thinking skills have improved. I saw that I improved my scientific learning knowledge by researching myself*."

The education category under the theme of advantages has the highest number of codes: technology literacy (learning to use computers, digital knowledge, internet literacy, knowledge of technology, and knowledge of writing), learning (facilitating education, awareness, visuality-appeal, homework, and learning environments), and guiding learning. The impact of AI on technology literacy can be illustrated by G2 saying, "*For example, I did not know much about saving files. And I learned it, and I am more competent now. We are more competent when we are preparing a presentation for a class. And we know more*." What B2 stated is also remarkable: "*During the class, a classmate copied and pasted, and some parts were left in English. We saw how wrong copy-paste was*." In the learning category, the facilitating role of AI can be seen in the comments of G1, who stated, "*AI should be used in classes because it has a facilitating aspect*." B2 also mentioned the impacts of AI in learning environments, stating, "*It also improved our level of knowledge. I realised that I learned the subject better after we did AI-supported activities*." B4 also emphasised the guiding aspect of AI for learning, stating, "*AI is useful because it teaches. It is like a teacher*."

Another category under the theme of advantages is daily life. In this category, students stated that AI can also be applied and beneficial in everyday contexts. G3 remarked, "*Maybe it can help with* housework*, such as recipes*." Likewise, B3 emphasised the impact of AI in daily life, noting, "*I plan to use AI in daily life to learn more*."

The motivation category under the theme of advantages includes the following codes: encouragement and motivation, happiness, excitement and curiosity, and effectiveness and fun. The positive effects of AI on learning processes, as well as factors affecting motivation, were highlighted under this category. B1, for example, commented, "*It took us a while to get used to it because it was the first time we used it. But it was a nice process, and it was fun to have classes with AI and the computer*." G4 reflected, *"Normally, I rarely do research. Thanks to this project, my interest in studying and researching has increased, and I can say that it* *encourages and excites me in this sense.*" Likewise, B3 emphasised his increasing motivation with AI-supported learning, stating, "*It made me want to study more in social studies classes*."

The use of AI category under the theme of advantages includes the following codes: ethical use, effective use, easy access, AI course, proliferation, and software. In this category, the students especially emphasised the effectiveness of AI in educational contexts. G4, for example, stated, "*AI has benefited us in terms of easy and rapid teaching*." B2 remarked, "*Thanks to AI, we can easily access a scientific study or a school assignment in our classes*." B1 also noted, "*We used to take social studies in the classroom, but in this process, we had a more advanced class because we learned with AI*." B3 also indicated the impact of generative AI software, noting, "*It helped me to do more research on applications such as AI on topics I did not understand. It helped me with topics and vocabulary I did not understand in classes and homework*."

Four categories were subsumed under the theme of disadvantages: critical thinking, difficulties in use, misdirection, and not a substitute for the teacher. The students expressed concerns that AI may negatively affect critical thinking processes, pose challenges in initial use, mislead learners, and cannot replace the role of the teacher. B2, for example, reflected, "*It can guide us more accurately if there is a teacher. As it does not put a limit on us in terms of critical thinking, AI-supported teaching may have a negative effect on this process.*" G4 commented, "*I do not think AI positively affects our critical thinking. I think we look more critically when we learn in the regular way*." Likewise, B3 remarked, *'I do not think AI improved my critical thinking skills.'* They emphasised that AI may have a negative impact on critical thinking skills. Additionally, the following remark of B1 illustrates the misdirection category: "*The answers to the questions we asked the AI were sometimes correct and sometimes wrong or meaningless, and it was a bit strange*." B2 also stated, "*AI is an effective learning tool, but it fails to create the same interaction as the teacher does*."

4. DISCUSSION AND CONCLUSION

This research examined the effects of AI-supported activities on middle school students' academic achievement, critical thinking disposition, and innovation skills by collecting both quantitative and qualitative data. The findings revealed that the AI-supported activities implemented in the experimental group led to a statistically significant increase in academic achievement, with a large effect size. In contrast, the textbook-based activities in the control group did not result in a statistically significant improvement. Furthermore, a statistically significant difference was observed between the adjusted posttest means of the experimental and control groups on the Academic Achievement Test, favouring the experimental group, with a large effect size. These findings indicate that AI-supported instructional practices are more effective in enhancing students' academic achievement than traditional textbook-based methods.

These results are largely consistent with earlier observations. Numerous studies have demonstrated that AI applications in educational settings can directly or indirectly improve students' academic achievement and overall learning performance (Gülel et al., 2023; Karsenti, 2019; Kumar, 2019). In a meta-analysis study, Deng and Yu (2023) found that AI technologies have a significant impact on learning outcomes, with a moderate to large effect size, regardless of factors such as intervention duration, chatbot function, or learning content. Similarly, Garcia-Martinez et al. (2023), in a systematic review and meta-analysis of 25 studies, concluded that AI positively influences student performance and enhances student attitudes and motivation, particularly in STEM disciplines. Sun and Zhou (2024) found that generative artificial intelligence tools have a moderate positive effect on academic achievement. Their meta-analysis revealed significant differences in some moderator variables, such as activity categories, sample size, and generated content, while no significant differences were found for others, such as intervention duration, discipline types, and assessment tools. Chang et al. (2022) also highlighted the effectiveness of AI-powered chatbots in supporting learning. They emphasised that AI is effective because chatbots provide personalised learning opportunities to students, and they offer an interactive learning mode where students can learn what they need to learn according to their progress. In an experimental study with engineering students, Bahçeci (2011) reported that those who used an AI-supported personalised learning portal achieved higher posttest scores than students who received traditional instruction. Pertiwi et al. (2024) concluded that artificial intelligence tools contributed to students' intrinsic motivation, curiosity and autonomy skills in addition to academic achievement. In a case study with 184 students, Tapalova and Zhiyenbayeva (2022) explored the role of AI in building personalised learning systems for students. They pointed out the possible social and ethical concerns that AI may create and suggested that such a teaching approach has a positive effect on students' academic achievement. Additionally, earlier studies have noted that AI-based tools play a significant role in predicting academic performance and developing effective instructional models (Alyahyan & Düştegör, 2020). Jeon and Lee (2023) similarly stressed the importance of teachers integrating technology into instruction, suggesting that educators should adopt more professional and adaptive roles in technology-enriched environments.

AI applications have the capacity to identify and address students' misconceptions or incomplete knowledge by activating prior knowledge (Lee et al., 2022). Today, AI-based learning environments are being created in many countries and the positive contributions of AI tools are being utilised (Forero-Corba & Bennasar, 2024). The integration of AI into education can revolutionise traditional learning methods and improve student performance. AI applications can track student progress and provide a personalised educational experience to plan an intervention model needed for students. This allows students to easily adjust the difficulty and pace of activities and learning materials according to their level (Abbas et al., 2023). One key reason why AI improves student performance is its ability to centre the learning process around the student (Garcia-Martinez et al., 2023). Integrating chatbots into education increases student participation, helps achieve learning outcomes, and contributes to the reduction of student stress (Perez et al., 2020). The interactive nature of LLMs also contributes to making learning more engaging (Khan et al., 2023) and may even facilitate access to education for learners with disabilities (Lyerly, 2023).

Despite the positive effects on academic achievement, the present study found that AI-supported activities did not significantly improve students' critical thinking disposition. In contrast, the control group, which followed textbook-based instruction, showed a statistically significant improvement in critical thinking, with a large effect size. Additionally, posttest scores on the CTDS were significantly higher in the control group compared to the experimental group, again with a large effect size. These findings suggest that traditional instructional activities, as implemented in the social studies textbook, were more effective in fostering students' critical thinking disposition than the AI-supported activities. Several studies have argued that the integration of AI-based activities and AI-supported tools into educational settings may weaken students' critical thinking skills (Kasneci et al., 2023; Lintner, 2024; Park et al., 2021; Szmyd & Mitera, 2024; Şenocak, 2020; Tapan-Broutin, 2023; Wach et al., 2023; Zhai, 2022).

It is essential to consider not only the educational opportunities that LLMs offer, but also the potential risks they pose (Yeşilyurt et al., 2025; İnel & Çetin, 2025; Karakuş, 2023). In this regard, Ifenthaler et al. (2024) stated that the human factor should not be ignored in the use of AI tools in education and that privacy-ethics, reliable algorithms and equity-justice challenges should be taken into account, especially for policymakers and researchers in this field. In their research with academics, Farazouli et al. (2024) argued that AI introduces a sense of unknowability in assessment practices and may even have destructive effects on critical thinking evaluation. Similarly, Abbas et al. (2023) noted that AI-powered applications may misinterpret unconventional student responses, leading to inaccurate assessments of students' capabilities. The potential for misuse or over-reliance on AI tools is also a concern, as such tools may encourage shortcut behaviours that are fundamentally opposed to the development of critical thinking (Susnjak & McIntosh, 2024). Crawford et al. (2023) stated that LLMs can also be trained on incomplete, inaccurate, and low-quality data; thus, despite producing outputs that may appear logical, they can provide factually incorrect information or false references. LLMs are shaped by the data they are trained on. Therefore, their responses may include prejudice, discriminatory language, and distorted perspectives (Labadze et al., 2023). LLMs also have limitations, such as the inability to access many scientific databases that require membership, and sometimes making incorrect mathematical calculations (Sullivan et al., 2023). These issues point to a range of ethical concerns regarding the use of LLMs in education, particularly with respect to the accuracy, reliability, and fairness of their responses (Labadze et al., 2023).

Artificial intelligence models can be utilised to collect, analyse, assess, and predict students' learning performance by accumulating various data such as personal background information, academic performance, and verbal records (Reiss, 2021). While these models can optimise the learning experience within the classroom, they also raise ethical concerns regarding data privacy, including issues like personal information leakage, lack of informed consent, and the right to be forgotten (Tang & Su, 2024). For these reasons, many researchers, including Rusandi et al. (2023), emphasise the critical importance of maintaining critical thinking when using artificial intelligence tools. It is quite natural for people to worry that AI might replace humans and become uncontrollable (Epstein, 2016), and it is also natural for teachers to worry that AI might take away their jobs. While these concerns are rising, it is important to integrate AI tools into our daily lives in a user-friendly way to make people's lives easier. Teachers must be trained to use AI software effectively to equip future generations with these skills and to make effective use of AI in their learning environment (Crompton & Burke, 2023). In doing so, teachers should not deviate from the principles of academic honesty and should not put the act of supporting students' original thoughts in the background (Alier et al., 2024).

Researchers have argued that developing critical thinking skills enables individuals to approach AI-generated information rigorously, make sound decisions based on reliable information, and use AI tools effectively across various fields. This calls for a balanced approach that considers the ethical, social, and pedagogical aspects of AI use in education to minimise potential negative consequences (Abbas et al., 2023). For example, Darwin et al. (2024) drew attention to this situation in a study on English language learning and concluded that one should be aware of the negative aspects as well as the positive aspects of artificial intelligence tools while developing critical thinking tendencies. When using AI tools, it is important for users to be aware of their limitations. Users should critically evaluate the accuracy and objectivity of AI-generated information and analyses and always keep these limitations in mind. Users should also be aware that LLMs may violate data privacy, security, and ethical principles.

The findings revealed that AI-supported activities implemented in the experimental group led to a statistically significant improvement in students' innovation skills, with a large effect size. On the other hand, textbook-based activities in the control group did not lead to any significant improvement in innovation skills. Furthermore, a statistically significant difference was observed between the experimental and control groups' posttest scores on the ISS, in favour of the experimental group, with a moderate effect size. These findings suggest that AI-supported instructional strategies are more effective in enhancing students' innovation skills compared to traditional textbook-based approaches.

Innovation skills are commonly associated with innovation and thinking and producing new ideas. AI can help students produce novel solutions and develop innovative projects by approaching problems from different perspectives. The literature also confirms the present findings (Chang & Tsai, 2024; Cockburn et al., 2019; Demir-Dülger, 2023; Dengiz, 2023; Soydemir-Bor & Alkış-Küçükaydın, 2021). Zhan et al. (2022) investigated whether AI-powered product-oriented pedagogy has an impact on students' creative and innovation skills. They found that this pedagogy positively improved students' creativity and innovation skills. In their study with science teachers, Bayram and Çelik (2023) showed the innovative benefits of activity design with AI. Öner (2023) focused especially on metaverse software and argued that AI-supported activities can be employed for many learning outcomes in social studies education. Similarly, Yetişensoy and Rapoport (2023) stated that AI tools can be integrated into social studies to foster innovative learning experiences. Based on the findings of the present study and the similar conclusions reached in prior research, it can be stated that instructional activities supported by AI tools contribute significantly to students' innovative thinking and have the potential to broaden their innovation skill sets.

Wollny et al. (2021) noted that chatbots have the potential to function as educational tools that enhance students' problem-solving skills. Today, societies are increasingly engaged with rapidly evolving AI technologies across various sectors, which underscores the growing importance of innovation and innovative thinking (Verganti et al., 2020; Yavuz-Aksakal & Ülgen, 2021). Thus, it can be said that AI is directly related to innovation, that is, the concept of innovation. Especially in educational settings, LLMs can provide real-time support and feedback to students. This can increase the efficiency and fluidity of the creative thinking process by allowing students to access relevant information quickly and easily (Abbas et al., 2023). AI can also take over some of the roles performed by teachers, assisting students in understanding complex concepts using simplified language. Guo and Wang (2023) argued that LLMs provide more balanced, more frequent, more comprehensive, and faster feedback to students compared to teachers. The authors also emphasised that LLMs give students direct guidance on what needs to be revised, while teachers give more indirect feedback. It is a fact that LLMs give more complimentary feedback and motivate students more to do what they do.

According to the code-category-theme analysis conducted in the qualitative phase of the study, most students emphasised the advantages of AI-supported education ($f = 191$), while a smaller number pointed to its disadvantages ($f = 27$). Under the theme of advantages, six categories were identified: education, academic achievement, motivation, thinking processes, use of AI, and daily life. The theme of disadvantages comprised four categories: critical thinking, misdirection, difficulties in use, and not a substitute for the teacher. The perceived benefits of AI-supported education in enhancing academic achievement and improving learning environments are also reflected in previous research (Bahçeci, 2011; Chen et al., 2022; Hooda et al., 2022; İşler & Kılıç, 2021). Additionally, AI applications have been shown to positively influence cognitive processes and motivation-related factors (Hooda et al., 2022). In a qualitative study with teachers, Parlak et al. (2023) found that AI and other innovative technologies have grown in importance in terms of thinking skills and achievement factors, together with the process of digital transformation in educational environments. Moreover, the advantages of AI in daily life, as noted by students in this study, are similarly emphasised in previous research (Atak, 2022; Dirican, 2015; Kim et al., 2022; Lee et al., 2023). In this context, taken together, the interview findings suggest that AI-supported activities contribute to students' academic achievement and innovation skills and make the learning environment interesting and engaging.

Looking at students' views subsumed under the theme of disadvantages, the prevailing view was that AI-supported teaching would weaken critical thinking and mislead students. Several studies have also addressed similar concerns (Demir-Dülger, 2023; Doğankaya, 2023; Kaya, 2023; Park et al., 2021). However, students' views that AI cannot replace the teacher are valuable in terms of the position of AI with respect to the role of the teacher. It is also emphasised that AI-powered robots, which take on the role of teachers, cannot fully replace the teacher and mostly act as a guide (Raaflaub, 2021). In his study in which he interviewed 74 teachers on this subject, Uygun (2024) expressed that artificial intelligence tools have a positive effect in educational environments as a general opinion, but on the other hand, he also included concerns especially in terms of ethics and privacy and emphasized that artificial intelligence tools should take place in education with a balanced use in which the rights and interests of stakeholders are protected. Similarly, a study on pre-service teachers revealed that they perceive AI through both positive metaphors like "Help Mechanism" and negative ones like "Harmful," underscoring this need for a balanced perspective (Bartın-Savran et al., 2025). In this respect, it can be said that it would be right to use productive artificial intelligence tools in educational environments in a conscious way and by considering their possible negative effects.

AI applications have notable features that distinguish them from other learning materials and make them superior. First, AI can be integrated into every stage of the teaching and learning process, as identifying student readiness, course design and planning, preparation for courses, teaching courses, student engagement, feedback, exams, and retention. It is fast, affordable, easily accessible, user-friendly and practical. AI is suitable for every lesson. Since it can solve questions, formulate questions, allow practical applications, translate, write code, perform mathematical operations, and can be used as a multimodal system (such as text, tables, slides, pictures, and videos that recognise different contents), it can be used in every course from mathematics to English, from informatics to social studies. AI is also suitable for individual work or group activities, as it allows you to share content. Like a close friend, AI gives kind, understanding, and motivating answers to questions. AI applications can also be used on different devices and accessed from anywhere. One of its most prominent features is that even if it gives inaccurate information or comments, it can update itself when new information and valid comments are provided. Thanks to these features, AI tools are helpful learning materials for both teachers and students.

In the present study, AI-supported activities in the experimental group were conducted in the school's computer laboratory to ensure student access to AI tools. This highlights the need for equipping classrooms with the necessary technological infrastructure to facilitate the effective integration of AI in educational environments. However, LLMs sometimes provide false or stereotypical information due to the data that they are trained in. Therefore, it would be beneficial to fine-tune LLMs for educational purposes using more scientific and reliable sources. For easier and more effective integration of LLMs into education, these models could be tailored to specific grade levels, subject areas, or curricular goals.

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Research Article

Yapay Zekâ Destekli Etkinliklerin Sosyal Bilgiler Dersinde Öğrencilerin Akademik Başarılarına, Eleştirel Düşünme ve İnovasyon Becerilerine Etkisi

The Effect of Artificial Intelligence-Supported Activities on Academic Achievement, Critical Thinking, and Innovation Skills in Social Studies Classes

Alaattin ARIKAN

GENİŞLETİLMİŞ ÖZET

Giriş

21. yüzyıl, yenilikçi bilgi teknolojileri ve araçlarının etkisinin belirgin bir biçimde hissedildiği bir çağdır. Özellikle son yıllarda yapay zekâ teknolojisinde önemli gelişmeler yaşanmaktadır. Teknolojik değişim ve dönüşümler, eğitim ortamlarına da yansımaktadır. Bilişim teknolojileri ve yapay zekâ araçlarının eğitim ortamlarına entegrasyonu, öğretim yöntemlerinin desteklenmesinde ve hedeflenen öğrenme çıktılarına ulaşılmasında önemli bir rol oynayabilir.

Eğitim ortamlarında, öğrencilerin kazanması beklenilen bazı hedefler vardır. Bu hedeflerin en önemlilerinden biri de öğrencilerin bilişsel gelişimlerinin sağlanmasıdır. Bu noktada "akademik başarı" kavramı ön plana çıkmaktadır. Akademik başarı, bireyin öğrenme süreci boyunca istenilen hedef davranışa yönelik performans ölçütlerini ortaya koyar. Akademik başarının yanı sıra, son yıllarda çeşitli düşünme becerilerinin gelişimine de önem verilmektedir. Modern eğitim sistemleri, düşünen ve üreten bireyler yetiştirme odaklı bir bakış açısıyla (Seferoğlu & Akbıyık, 2006), özellikle 21. yüzyılın dört temel becerisi olarak bilinen eleştirel düşünme, yaratıcılık, iletişim ve iş birliği becerilerinin gelişimine odaklanmıştır (Spector & Ma, 2019).

Eleştirel düşünme; bilgi edinme sürecinde çok yönlü düşünmeyi, zihinsel ve duyuşsal açıdan etkin düşünebilmeyi gerektirir (Akınoğlu, 2001, s. 20). Elçi vd. (2020, s. 3318), eleştirel düşünmeyi, önyargı ve kalıp yargıların fark edilerek karmaşık olay ve durumların zihinsel süreçte kanıt ve doğru dayanaklarla mantıksal olarak anlamlandırılması biçiminde tanımlamıştır. Eleştirel düşünme, bilimsel gelişmenin, dolayısıyla eğitimin vazgeçilmez bileşenlerinden biridir. Ancak eleştirel düşünme gelişiminin geleneksel okul ortamlarında yeterince ele alınmadığı da araştırmacılar tarafından ifade edilmektedir (Spector & Ma, 2019).

Eleştirel düşünme becerisinin, özellikle eğitim ortamlarında teknolojik donanımların yaygınlaşmasında önemli bir etkisi bulunmaktadır. Eleştirel düşünme becerisi; düşünsel süreçte teknolojinin eğitimde yaygınlaşmasına öncülük etmiştir (Evcim & Topsakal, 2019; Schooner vd., 2017). Fakat eleştirel düşünme becerisinin eğitim ortamlarında teknolojik yeniliklerle geliştiğine yönelik aynı düzeyde bir etkiden söz edilemeyebilir. Rusandi vd. (2023), günümüzde temel odak noktalarından birinin yapay zekânın öğrenme ve araştırmayı geliştirirken eleştirel düşünme becerilerini nasıl destekleyebileceği olduğunu belirtmiştir. Bu sebeple, eleştirel düşünme becerisinin eğitimde teknolojik bağlamda yapay zekâ destekli uygulamalarla yakından ilişkili olduğunu ve bu ilişkinin araştırılması gerektiğini söylemek yerinde olacaktır.

Eğitimde yapay zekâ teknolojileri açısından "inovasyon" kavramı da dikkat çekmektedir. İnovasyon; çoğunlukla yenilik ile ilişkilendirilir ve topluma fayda sağlayan yeni bir fikir, ürün veya hizmet olarak tanımlanabilir (Nakano & Wechsler, 2018). İnovasyon becerisi ise; yeni, farklı ve var olan kalıpların dışında düşünebilmek, özgünlük, yüksek farkındalık, üretkenliğe açıklık ve girişkenlik gibi özellikleri içerir (Aras, 2020, s. 9; Koyuncuoglu, 2021, s. 105-106; Özmusul, 2012, s. 732). İnovasyon; eğitim ortamlarının süreç, imkân ve program açısından dönüşümünde etkili olduğundan, eğitim ve inovasyon kavramlarının temelde ilişkili olduğunu söylemek mümkündür (Keleşoğlu & Kalaycı, 2017).

MEB (2018a) Sosyal Bilgiler Öğretim Programı'nda yenilikçi düşünme becerisine yer verilmiştir. Özellikle programın "Küresel Bağlantılar" ve "Bilim, Teknoloji ve Toplum" öğrenme alanlarının, inovatif düşünmeyi geliştirmeye odaklandığı söylenebilir. Benzer şekilde, fen bilimleri öğretim programında da yaratıcı düşünmeye yer verildiği ve disiplinlerarası boyutta düşünüldüğünde eğitim ortamlarında inovasyon becerisinin geliştirilmesine önem verildiği belirtilmelidir (MEB, 2018b). IBM tarafından yapılan bir araştırmada, özellikle sektörel düzeyde birçok kişinin yeni becerilere ihtiyaç duyacağı ve yapay zekâda yaşanacak olan gelişmelere paralel olarak inovasyon becerisinin ön plana çıkacağı vurgulanmıştır (Solimano, 2023). Bu bağlamda eğitimde inovasyonu, inovasyon becerisinin gereklerini ve yaratacağı etkileri değerlendirmek önemlidir. Özellikle yapay zekâ entegrasyonu ile farklı bir boyut kazanan inovatif düşüncenin eğitim ortamlarında nasıl kullanılacağı ve geliştirileceği ortaya konmalıdır.

Zhai (2022), ChatGPT gibi yapay zekâ yazılımlarının birçok açıdan olumlu etkilerinin bulunduğunu ancak özellikle eleştirel ve yaratıcı düşünme becerileri açısından sürecin doğru yönetilmesi gerektiğini belirtmiştir. Yapay zekâ destekli araçlar, öğrenci odaklı öğretim ve değerlendirme süreçlerini daha sistematik ve verimli hale getirse de (Chassignol vd., 2018), insan zihninin düşünsel süreçleri olan yaratıcı, yansıtıcı ve eleştirel düşünme gibi beceriler açısından bazı sınırlılıklara sahip olabileceği ifade edilmektedir (Coşkun & Gülleroğlu, 2021; Karakoç-Keskin, 2023). Bu nedenle eğitim ortamlarında, öğrenme sürecine yapay zekâ araçlarının nasıl entegre edileceğine ilişkin çalışmalar yapılması önemlidir. Bu çalışmada, yapay zekâ etkinliklerinin sosyal bilgiler dersinde akademik başarı, eleştirel düşünme ve inovasyon becerisi üzerindeki etkisini ortaya koymak amaçlanmıştır. Çalışmanın karma desenle yürütülmesi; Büyük Dil Modellerinin öğrenme ortamına etkilerini ortaya koyma açısından literatüre önemli bir katkı sağlayabilir.

Yöntem

Bu araştırmada açıklayıcı sıralı karma desen kullanılmıştır. Çalışmanın nicel boyutunda ön test-son test kontrol gruplu yarı deneysel desen; nitel boyutunda ise durum çalışmasından yararlanılmıştır. Araştırmanın bağımsız değişkeni yapay zekâ etkinlikleri, bağımlı değişkenleri ise akademik başarı, inovasyon becerisi ve eleştirel düşünme eğilimidir. Veri toplama aracı olarak Toy ve Akpınar (2020) tarafından geliştirilen Akademik Başarı Testi, Yıldırım-Döner ve Demir (2022) tarafından geliştirilen Eleştirel Düşünme Eğilimi Ölçeği, Chell ve Athayde (2009) tarafından geliştirilen ve Akkaya (2016) tarafından Türkçeye uyarlanan İnovasyon Becerisi Ölçeği ile araştırmacı tarafından geliştirilen görüşme soruları kullanılmıştır.

Araştırmanın deney grubunda 25, kontrol grubunda ise 24 öğrenci yer almıştır. Deney grubunda yapay zekâ etkinlikleri, kontrol grubunda ise Sosyal Bilgiler ders kitabındaki etkinlikler uygulanmıştır. Deneysel uygulama, 7. sınıf düzeyinde sosyal bilgiler dersinin "Küresel Bağlantılar" öğrenme alanında 6 hafta boyunca sürdürülmüştür.

Bulgular ve Sonuç

Araştırma bulguları, yapay zekâ etkinliklerinin Sosyal Bilgiler ders kitabındaki etkinliklere göre öğrencilerin akademik başarıları ve inovasyon becerilerini geliştirmede daha etkili olduğunu ortaya koymuştur. Buna karşılık, ders kitabındaki etkinliklerin, öğrencilerin eleştirel düşünme eğilimlerini geliştirmede yapay zekâ etkinliklerine göre daha etkili olduğu belirlenmiştir.

Öğrencilerle yapılan görüşmelerde büyük çoğunluk, yapay zekânın avantajlarını dile getirmiş; az sayıda görüşte ise yapay zekâ destekli eğitimin dezavantajlarına değinilmiştir. Bu bağlamda, öğrenci görüşlerinden elde edilen kategoriler birlikte değerlendirildiğinde, yapay zekâ etkinliklerinin öğrencilerin özellikle akademik başarıları ve inovasyon becerilerine katkı sağladığı, öğrenme ortamını zenginleştirdiği ve daha ilgi çekici hale getirdiği söylenebilir. Buna karşın bazı öğrencilerin yapay zekâ destekli eğitimin eleştirel düşünmeyi zayıflatabileceği ve yanlış yönlendirmelere neden olabileceği yönünde görüş bildirdikleri de görülmüştür. Ayrıca, öğrencilerin yapay zekânın öğretmenin yerini alamayacağına ilişkin görüşleri de dikkat çekicidir.

Yapay zekâ teknolojileri, öğrenme ve öğretme süreçleri açısından önemli bir potansiyele sahip olduğundan eğitim ortamlarında kullanılmaya başlanmıştır. Bu bağlamda, Büyük Dil Modellerinin eğitimdeki potansiyel fırsatlarının yanı sıra yaratabileceği tehditler de göz önünde bulundurulmalıdır. Bu nedenle, araştırma karma desenle yapılandırılmıştır. Bu bütüncül yaklaşım, Büyük Dil Modellerinin bilişsel süreçler üzerindeki etkilerini daha kapsamlı biçimde anlamaya olanak tanımıştır. Bu doğrultuda, ortaokul düzeyinde gerçekleştirilen bu araştırmanın, öğrenme ortamlarında yapay zekâ uygulamalarının deneysel olarak derinlemesine incelenmesi ve buna yönelik önerilerin sunulması açısından önemli bir katkı sağlayacağı düşünülmektedir.