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Artificial intelligence in education: Bibliometric analysis of postgraduate theses in Türkiye

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Abstract

Artificial intelligence (AI) plays an increasingly significant role in education today, with applications such as student assessment, personalized teaching, process optimization, and enhancing teacher performance. Its transformative potential enables the creation of innovative learning environments, bridging gaps in traditional teaching methods and offering scalable solutions to educational challenges. This study conducts a bibliometric analysis of postgraduate theses on AI in education in Türkiye to evaluate the current research landscape and provide insights for future studies. Among 751 AI-related theses, 24 were specifically identified as focusing on education, with titles explicitly emphasizing these fields. The analysis reveals that AI-related theses in education have grown significantly since 2019, peaking in 2022 and 2023. Despite this growth, findings highlight a predominant focus on technical applications, such as information technologies, while direct classroom applications remain limited. Most of these theses adopt qualitative research methods, emphasizing in-depth exploration over large-scale data analysis. Additionally, a high proportion of theses are at the master's level, reflecting a need for more doctoral-level research in the field. Key trends include a preference for convenience sampling methods and a concentration of research in social sciences. Furthermore, the study identifies significant variations in citation counts and sample sizes, underscoring diverse research approaches and objectives. Ethical considerations, teacher training, and infrastructural challenges were highlighted as critical barriers to AI integration in education. This study highlights the pressing need for more comprehensive research on integrating AI into educational practices and aims to guide future work in this domain.

Keywords: Artificial intelligence, education, teaching, bibliometric analysis

Eğitimde yapay zekâ: Türkiye'deki lisansüstü tezlerin bibliyometrik analizi

Öz

Yapay zekâ (YZ), günümüzde eğitim alanında giderek daha önemli bir rol oynamaktadır. Öğrenci değerlendirmesi, kişiselleştirilmiş öğretim, süreç optimizasyonu ve öğretmen performansının artırılması gibi uygulamalarla eğitimdeki etkisini artırmaktadır. YZ'nin dönüştürücü potansiyeli, yenilikçi öğrenme ortamlarının oluşturulmasını mümkün kılmakta, geleneksel öğretim yöntemlerindeki eksiklikleri kapatmakta ve eğitimsel zorluklara ölçeklenebilir çözümler sunmaktadır. Bu çalışma, Türkiye'de eğitim alanında yapılmış yüksek lisans ve doktora tezlerini bibliyometrik bir analizle inceleyerek mevcut araştırma eğilimlerini değerlendirmekte ve gelecekteki çalışmalara ışık tutmayı amaçlamaktadır. YZ ile ilgili toplam 751 tez arasında, başlıklarında eğitimle ilgili ifadeler açıkça belirtilmiş olan 24 tez, eğitim odaklı olarak belirlenmiştir. Analiz sonuçları, eğitim alanındaki YZ ile ilgili tez sayısının 2019 yılından itibaren belirgin şekilde arttığını ve bu artışın 2022 ve 2023 yıllarında zirveye ulaştığını göstermektedir. Bu büyümeye rağmen, bulgular teknik uygulamalara—özellikle bilgi teknolojilerine—odaklanmanın baskın olduğunu, doğrudan sınıf içi uygulamaların ise sınırlı kaldığını ortaya koymaktadır. Tezlerin çoğunluğu nitel araştırma yöntemlerini benimsemekte olup, geniş ölçekli veri analizinden ziyade derinlemesine incelemeye odaklanmaktadır. Ayrıca, tezlerin büyük bir kısmının yüksek lisans düzeyinde olması, bu alanda daha fazla doktora düzeyinde araştırmaya ihtiyaç olduğunu göstermektedir. Belirgin eğilimler arasında kolayda örnekleme yöntemlerinin tercih edilmesi ve araştırmaların sosyal bilimler alanında yoğunlaşması yer almaktadır. Ayrıca, atıf sayıları ve örneklem büyüklükleri arasında önemli farklılıklar tespit edilerek, araştırma yaklaşımlarının ve hedeflerinin çeşitliliği vurgulanmıştır. Etik kaygılar, öğretmen eğitimi ve altyapı yetersizlikleri, YZ'nin eğitime entegrasyonunda öne çıkan temel engeller olarak belirlenmiştir. Bu çalışma, YZ'nin eğitim uygulamalarına entegrasyonuna dair daha kapsamlı araştırmalara duyulan acil ihtiyacı vurgulamakta ve bu alandaki gelecekteki çalışmalara yön göstermeyi amaçlamaktadır.

Anahtar Kelimeler: *Yapay zekâ, eğitim, öğretim, bibliyometrik analiz*

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INTRODUCTION

Artificial intelligence (AI) has emerged as a transformative technology, influencing numerous fields, including education. Its applications in education range from evaluating student performance to personalizing learning materials and optimizing educational processes. These advancements highlight AI's potential to address educational challenges and create innovative learning environments. According to Žalėnienė & Pereira (2021), AI has seen revolutionary progress in the last few years. Deep learning has enabled machines to start performing tasks that were thought impossible for machines to perform. As Li (2022) mentions fields such as voice recognition, self-driving cars, automatic text summarization, intelligent automated assistants, video gaming, and many more benefit greatly from the advancements in AI. Few sectors in society have the potential for such a strong impact as education. It is of the utmost importance to acknowledge the positive aspects of AI to benefit from them while addressing potential challenges of this technology and how to overcome them.

AI is inherently interdisciplinary, drawing from diverse fields such as computer science, engineering, sociology, and education. While technical research frequently precedes discussions of societal impacts, incorporating perspectives from social sciences, including philosophy, sociology, economics, and psychology, enhances the depth and relevance of AI research (Ligo et al., 2021; Mete, 2023). For instance, Russell and Norvig (2010) explore AI's connections with disciplines like mathematics and philosophy, examining its applications in areas such as information processing, robotics, and natural language processing. Similarly, studies by Whitby (2005), Nabiyev (2012), and Say (2018) emphasize AI's cognitive capabilities, while Nilsson (1982) highlights the distinctions between human, animal, and machine intelligence. Luger (2005) and Gardenfors (2004) delve into AI's problem-solving strategies and its relationship with cognitive psychology and linguistics. These interdisciplinary perspectives underscore the necessity of integrating diverse methodologies and insights to understand AI's role in education comprehensively.

The relationship between AI and education is multifaceted, encompassing numerous opportunities, challenges, and ethical considerations. AI's integration into educational settings has the potential to enhance personalized learning experiences, improve engagement, and facilitate efficient assessment methods. However, this integration also presents significant challenges, including the need for teacher training, infrastructural support, and ethical frameworks. AI technologies can significantly enhance educational practices by providing personalized learning experiences tailored to individual student needs. For instance, AI can

adapt learning materials and assessments based on real-time data regarding student performance, thereby fostering a more engaging and effective learning environment (Mahligawati, 2023; Alshehri, 2023; Hashim et al., 2022). The use of adaptive learning systems, which adjust the difficulty of tasks based on student responses, exemplifies how AI can optimize educational outcomes (Chan & Zary, 2019; Jian, 2023). Moreover, AI-driven tools have shown promise in supporting students with neurodevelopmental disorders, allowing for customized learning pathways that cater to their unique challenges (Barua et al., 2022). Despite these advantages, the implementation of AI in education is fraught with challenges. A primary concern is the need for substantial teacher training and professional development to ensure educators are equipped to utilize AI tools effectively (Chukwubueze, 2024).

In Türkiye, the integration of AI into education has gained momentum, sparking academic interest and increasing the number of graduate theses on this topic. Despite this growing interest, there remains a notable gap in the literature. Existing studies often emphasize the technological aspects of AI, such as system design and functionality, while its direct applications in educational settings and broader societal implications are less explored. Moreover, the distribution, focus areas, and methodologies of graduate theses on AI in education in Türkiye have not been systematically analyzed. This creates a knowledge gap in understanding how AI research aligns with Türkiye's unique educational challenges and priorities. To address these gaps and build on this interdisciplinary foundation, the present study conducts a bibliometric analysis of postgraduate theses on AI in education in Türkiye. By systematically reviewing the Higher Education Council (YÖK) Thesis Center database, the study examines trends, methodologies, and thematic focuses of these theses. It aims to uncover patterns and deficiencies, offering insights for future research.

EDUCATION AND ARTIFICIAL INTELLIGENCE

Education is the process of shaping individuals' behaviors. Tyler (2013), a significant contributor to curriculum development in the 1950s, defined education as "the process of changing individuals' behaviors," a definition that remains widely accepted. Many educators argue that the primary innovation in education lies in reshaping individuals' behaviors. Achieving this requires clearly defined educational objectives and bridging the gap between these objectives and assessment processes. This gap primarily concerns creating an environment conducive to desired behavior changes, emphasizing "what" to teach and "how" to teach, necessitating more guidance for teachers (Varış, 1971). Ertürk (2013) defines education as a process where individuals consciously achieve desired changes through their

own experiences. Similarly, Yeşilyurt (2020) emphasizes that planned educational activities aim fundamentally at behavior change, highlighting the need to design experiences that foster effective learning. In the 21st century, rapid advancements in science and technology have inevitably influenced education, making high-quality education essential to meet the demands of the information explosion. Challenges such as increasing class sizes and diverse student abilities have created opportunities for new teaching methods and technologies, with self-directed learning technologies gaining prominence alongside the growth of the computer industry. Programmed instruction, a notable example, has found increasing application in education (Külahçı, 1985). Education, viewed through social and open-system approaches, is considered a societal structure created to meet community needs, thus functioning as an open system (Küçükahmet et al., 2002).

Education is a process organized around specific objectives, involving planned activities designed to influence and reshape behaviors. These activities target the elimination of undesirable behaviors and the development of new ones, forming the core components of education. As Baykul (1992) notes, education outcomes may vary, with some targeted behaviors successfully achieved, others partially realized, or even unexpected behaviors emerging, underscoring the need for outcome monitoring as a critical component. In the era of globalization, technology integration in education has become increasingly vital, offering advantages such as enhanced management efficiency and enriched learning environments (Aksan & Kutluca, 2021). Since the late 20th century, education systems have adapted to technological advancements by creating interactive, technology-driven environments that support student-centered learning (Akkoyunlu, 2002). These technologies foster engagement, enable personalized instruction, and provide universal access to educational materials, resulting in improved student outcomes and teacher proficiency (Elvan & Mutlubaş, 2020). In education, AI extends beyond the notion of "robot teachers," facilitating tailored learning styles and offering on-demand expertise at home (Arslan, 2020). AI applications in education are categorized into three main approaches: data-based, logic-based, and knowledge-based. Historically, knowledge-based approaches dominated AI education applications, particularly from the 1980s to the 2000s (Sleeman, 1984). Modern implementations encompass a broader spectrum, including personalized and dialogue-based systems, discovery-driven learning, educational data mining, automated essay analysis, and adaptive systems for students with special needs. Advanced applications like intelligent agents, chatbots, robot-student

interactions, AI-driven assessments, and automated test generation further exemplify the transformative potential of AI in education (Holmes et al., 2023).

AI stands as one of the most debated topics of our time. While some argue that AI offers unprecedented opportunities for growth and innovation, others view it as a significant threat to humanity's future (Köroğlu, 2017). Additionally, the ethical implications of AI use in educational contexts cannot be overlooked. Issues related to data privacy, algorithmic bias, and the potential for inequitable access to AI resources must be addressed to create a fair and just educational landscape (Holmes et al., 2021; Wafik, 2024). The establishment of a comprehensive ethical framework is essential to guide the responsible use of AI in education, accommodating the diverse interpretations and evolving nature of educational practices (Holmes et al., 2021; Eden, 2024). Furthermore, the infrastructural disparities between developed and developing regions pose significant barriers to the equitable implementation of AI technologies in education. Many educational institutions may lack the necessary technical infrastructure to support AI integration, which can exacerbate existing inequalities in educational access and quality (Alotaibi & Alshehri, 2023). As such, policymakers must prioritize equitable access to AI resources and training to ensure that all students can benefit from these advancements (Wafik, 2024; Tanveer et al., 2020). In summary, while AI holds transformative potential for enhancing educational experiences through personalized learning and efficient assessment, its successful integration requires careful consideration of the associated challenges and ethical implications. Ongoing research and dialogue among educators, policymakers, and stakeholders are crucial to navigate these complexities and harness the full potential of AI in education.

AI reduces reliance on low-cost labor while increasing the demand for skilled professionals, leading to profound changes across various sectors, including education and business, affecting all levels of society. As current skills may become obsolete soon, governments must consider AI in their development plans and education systems (Demir, 2019). Recognizing this shift, the OECD has integrated essential skills such as digital literacy, critical thinking, creativity, and problem-solving into its PISA framework, emphasizing their growing relevance in the AI era (Günay & Şişman, 2019). AI-based systems not only reshape skill requirements but also revolutionize education. By leveraging big data, personalized learning programs are created, individual student performance is tracked, and course content is customized, enhancing teaching effectiveness (Karaca & Telli, 2019). Current advancements in AI focus heavily on student learning processes, fostering collaboration among educational

institutions, teachers, parents, and students (Çetin & Aktaş, 2021). Research highlights diverse applications, including grading and assessment, dropout prediction, personalized learning, emotion analysis, recommendation systems, smart education platforms, classroom monitoring, and school management (Ahmad et al., 2020; C. Chen et al., 2020). These developments suggest that AI will play an increasingly significant role in classroom and school management in the future (Çetin & Aktaş, 2021).

The 21st century has brought rapid changes that influence all aspects of life, making AI education a critical factor in developing 21st-century skills. This section focuses on research conducted in Türkiye regarding AI education, with selected studies chosen for their close relevance to the topic. Kalafat (2022) explores the impacts of AI technologies on education, emphasizing their roles in teaching and learning processes rather than focusing on stakeholders like students, teachers, or parents. The findings reveal a lack of consensus on AI's educational effects, underscoring the need for further research into its pedagogical implications to develop effective strategies. Uzun et al. (2021) provide a general introduction to AI, highlighting its ability to mimic and learn from human thought processes. They stress the increasing adoption of AI in various sectors, including education, where its applications continuously update educational practices. Güzey et al. (2023) emphasize AI's transformative potential in education, noting its role in reshaping learning processes through applied studies often focused on specific domains. Their research contributes to understanding AI's role in education and the changes it drives. Arslan (2020) examines AI's broad applications in education, discussing its use in supporting learning and teaching approaches while emphasizing the diversity of applications depending on factors like target audience and learning objectives.

METHOD

This study conducts a bibliometric analysis of graduate theses on AI in the field of education in Türkiye. The aim is to identify the quantitative and qualitative characteristics of these theses and evaluate their scientific impact. The data source comprises 751 AI-themed theses and 24 education-themed AI theses available in the Higher Education Council National Thesis Center database as of October 17, 2023. Some theses were not accessible due to restricted access. The study does not use sampling; instead, the entire population is analyzed. Qualitative research methods, including literature review and bibliometric analysis, were employed. Full-count analysis was used for qualitative data. Bibliometrics involves the mathematical and statistical analysis of the quantitative and qualitative attributes of scientific publications (Pritchard, 1969). This method identifies trends, publication productivity, research

impact, and interdisciplinary relationships within a given field. It evaluates scientific activities by analyzing books, articles, and other academic outputs using statistical methods (Garfield, 1972). An effective bibliometric analysis requires a systematic data collection and processing strategy, covering criteria for selection, filtering, organization, and storage of data (Köksoy & Saraç, 1998).

Bibliometrics, initially defined as a counting-based examination, is the application of statistical and mathematical methods to analyze books and other communication materials (Yılmaz, 2017; Temelli & Karcıoğlu, 2018). It serves as a systematic and replicable approach for reviewing prior studies in a given field (Araújo et al., 2018). Bibliometric analysis quantitatively examines publications, including journal articles, author contributions, topics, and publication details, offering insights into scientific communication trends and outputs (Yılmaz, 2017; Bar-Ilan, 2008). This method is particularly valuable in fields where the growing volume of research makes comprehensive review challenging, addressing this gap by analyzing trends, collaborations, and productivity (Kurutkan & Orhan, 2018). In its broader sense, bibliometrics evaluates topics, citations, disciplines, authors, institutions, and countries using quantitative methods, uncovering relationships between these elements (Al & Tonta, 2004). Examples include Hendrik and Henkens (1999), who analyzed citation impact in demography journals, finding that 64% of articles received citations within five years. Kalyane and Sen (1995) examined 498 studies in a journal based on criteria like author productivity, keywords, and publication timelines. Jacobs and Ingwersen (2000) studied South African universities' publications and citation trends, focusing on differences in publication quality and output across institutions.

Further studies, such as Wang et al. (2022), analyzed journal publication processes across disciplines, examining factors like acceptance rates and publication speeds. Granados et al. (2011) focused on social entrepreneurship, analyzing 286 articles published from 1991 to 2010, revealing increased collaboration and international participation in the field. These diverse examples demonstrate bibliometrics' utility in understanding publication trends and fostering insights across disciplines. Al & Tonta (2004) conducted a bibliometric study analyzing master's theses completed in Hacettepe University's Department of Information and Document Management, focusing on citations in their references. The study aimed to identify characteristics such as topics, methods, advisors, jury members, citation counts, types, cited journals, and authors, as well as calculate the half-life of citations. Results revealed that an average of four theses were completed annually, with descriptive research being the most

commonly used method. Topics such as university libraries, public libraries, reading habits, and user studies were prominently featured in the theses.

A sample refers to a subset of objects or individuals selected from a population using specific methods (Kaptan, 1998; Ural & Kılıç, 2005). In contrast, the full counting method involves analyzing all units within a population, typically used when the population is finite and entirely accessible. This study employs the full counting method, as all 24 graduate theses related to education and AI from the YÖK National Thesis Database were accessed and analyzed. The research universe comprises 24 theses selected from a total of 751 AI-related theses, focusing exclusively on those concerning education and teaching. These theses represent a specific subset of AI research in education, conducted across various Turkish universities within a defined timeframe. By employing the full counting method, the study aims to provide a bibliometric analysis of all relevant theses, highlighting their characteristics and trends. To facilitate this analysis, data collection tools were developed to extract essential information such as titles, authors, advisors, institutions, publication dates, themes, methodologies, findings, and recommendations. An Excel dataset comprising 24 rows and 20 columns was prepared, named the YZEÖ (Artificial Intelligence in Education and Teaching) dataset. For each thesis, a data collection form was created to capture information including thesis title, language, year, page count, type (master's or doctoral), author, advisor, institution, institute, department, summary, abstract, keywords, research type, sampling method, sample size, total references, Turkish and foreign references, and publication date. Using these tools, detailed data on the selected theses were gathered, highlighting their unique attributes and the AI-focused educational topics they addressed.

FINDINGS

Between 1900 and 2024, a total of 850,433 theses were recorded in Türkiye, according to the Higher Education Thesis Center (YÖKTEZ) database. A specific search for the term "artificial intelligence" revealed that only 751 of these theses are related to this topic. Statistical analysis of the numerical data obtained from the Higher Education Thesis Center shows that AI-focused theses constitute approximately 0.105 % of all theses. This exceptionally low percentage highlights the limited prevalence of AI as a research subject within academic studies in Türkiye. These findings suggest that this area of study has not yet gained sufficient traction in Turkish academia and underlines the need for increased research efforts in this domain.

The evolution of AI theses in the field of education in Türkiye began with a pioneering study conducted by Özden (1999) at Gazi University, which explored the philosophical and

ethical aspects of AI programming techniques, highlighting its transformative potential in education. By 2004, AI-focused research expanded to include practical applications, such as the development of AI-supported instructional software that simulated teacher characteristics to teach users how to operate Microsoft Word, with its effectiveness assessed through faculty surveys. These early works established AI as a multidimensional topic, integrating technical, ethical, and pedagogical considerations, and marked the beginning of its adoption in educational processes, showcasing its potential to innovate instructional design and learning outcomes over time. From 2004 onwards, significant technological advancements and educational policy shifts have expanded the scope of AI applications in education. The use of AI tools to address evolving student needs and educational profiles has grown substantially. A marked increase in the number of theses on AI in education began in 2019, peaking in 2022 and 2023. Table 1 illustrates the distribution of AI-focused theses over the years, highlighting the growing academic interest in integrating AI into educational practices. This evolution underscores the role of AI as a critical area of study, offering innovative solutions to contemporary educational challenges. Continued research is essential to maximize AI's transformative potential in shaping future learning environments.

Table 1. Specification of AI based theses in Türkiye

Year	**f**	**University**	**f**	**Departments**	f
1999	1	Atatürk University	4	Computer Education	2
2004	2	Anadolu University	3	Computer and Instructional Technologies Education	6
2007	1	Gazi University	2	Secondary Education in Social Sciences	1
2008	1	Çukurova University	2	Secondary Education in Science and Mathematics	1
2010	1	Bahçeşehir University	2	Distance Education	3
2014	1	Marmara University	1	Mathematics Education	1
2019	2	Ankara University	1	Interdisciplinary Museum Education	1
2020	1	Yıldız Teknik University	1	Computer Engineering	1
2021	2	İstanbul University	1	Educational Technologies	2
2022	4	Muğla Sıtkı Koçman University	1	Turkish and Social Sciences Education	1
2023	7	Düzce University	1	English Language Education	1
Advisor		Afyon Kocatepe University	1	Informatics	1
Professor	10	Karadeniz Teknik University	1	Fine Arts Education	1
Associate	6	Trabzon University	1	Innovation and Entrepreneurship	1
Assistant	8	Kütahya Dumlupınar University	1	Basic Education	1
Type		İstanbul Aydın University	1	**Institute**	
PhD.	6	**Language**		Social Sciences Institute	7
Master's	18	Turkish	23	Educational Sciences Institute	6
		English	1	Sciences Institute	6
				Graduate Education Institute	5

Data from Table 1 shows a steady increase in theses on AI in education, with a significant rise from 2019, peaking in 2022 and 2023. The first AI-related thesis appeared in 1999, and lower activity periods, like 2004 and 2020, may be due to limited infrastructure or slow global adoption. The 2023 surge highlights AI's growing importance in educational research. However, challenges such as restricted publication permissions emphasize the need for improved data transparency. Regarding language, most theses are written in Turkish, reflecting local academic preferences, though writing in widely spoken languages like English is important for international visibility. AI research in foreign language education also indicates the interdisciplinary nature of the field. Encouraging broader language use will promote Türkiye's global scientific interaction. Theses in AI education in Türkiye are predominantly at the master's level (18 out of 24), suggesting a focus on graduate education. This trend may be driven by the rapid advancements in AI, the growing need for trained professionals, and the limited number of doctoral programs. The lower number of doctoral theses indicates that AI research at this level requires more specialization. Advisors of these theses hold diverse academic titles, including professors, associate professors, and assistant professors, reflecting varied expertise across the research areas. This diversity enriches the academic environment for students.

In terms of university distribution, Atatürk University and Anadolu University have the most theses, indicating their strong academic capacity and interest in AI. Regional needs may also contribute to this trend. Furthermore, AI research spans multiple disciplines, with a higher concentration in social sciences, showing an interdisciplinary approach. Equal representation in the Institutes of Natural and Educational Sciences highlights the close relationship between AI and education, while research in graduate education focuses on areas like educational management and teacher training. In conclusion, graduate theses demonstrate AI's interdisciplinary role in education, with a growing emphasis on diverse academic perspectives. In Figure 1, a distribution chart based on page numbers is presented.

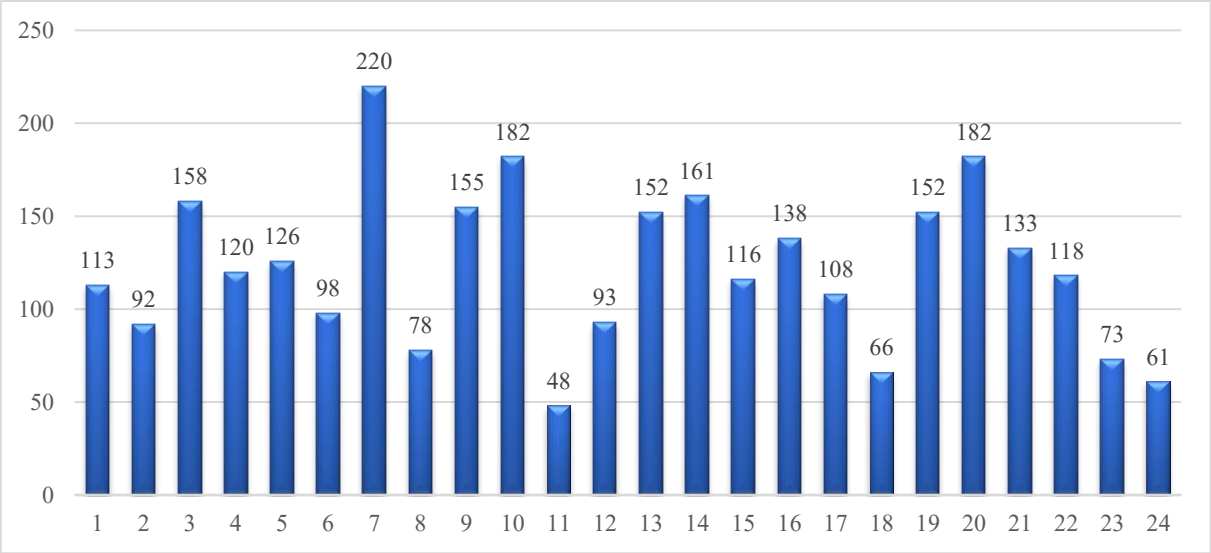

Figure 1. Distribution chart based on page numbers of theses

When looking at Figure 1, the minimum page count is 48, the maximum page count is 220, and the average page count is 127.5. Based on this data, it can be said that thesis studies generally have an average number of pages. However, the distribution appears to be quite broad. The average page number obtained from the Excel dataset is 407.099. The wide distribution of page numbers in theses on AI in education suggests that researchers approach their topics with varying depth and breadth. The high average page count implies that theses generally cover a range of topics and present researchers with a broad base of knowledge. Based on this data, it can be said that graduate theses on AI in Türkiye generally have an average number of pages, with a wide distribution. Some theses are quite short or long, indicating different research and writing styles, reflecting the diversity and various approaches of graduate theses on artificial intelligence. Additionally, the variety in page numbers reflects differences in the level of detail, scope, and methods of the research. A higher page count could indicate that theses are typically more detailed and comprehensive. Longer theses generally provide more information and offer greater depth on the topic. However, the page count alone does not determine the quality of a thesis; the key factor is the quality of the information presented and the contribution the thesis makes.

Figure 2 displays data on the number of references used in thesis studies. These data illustrate the distribution of the number of references cited in each thesis.

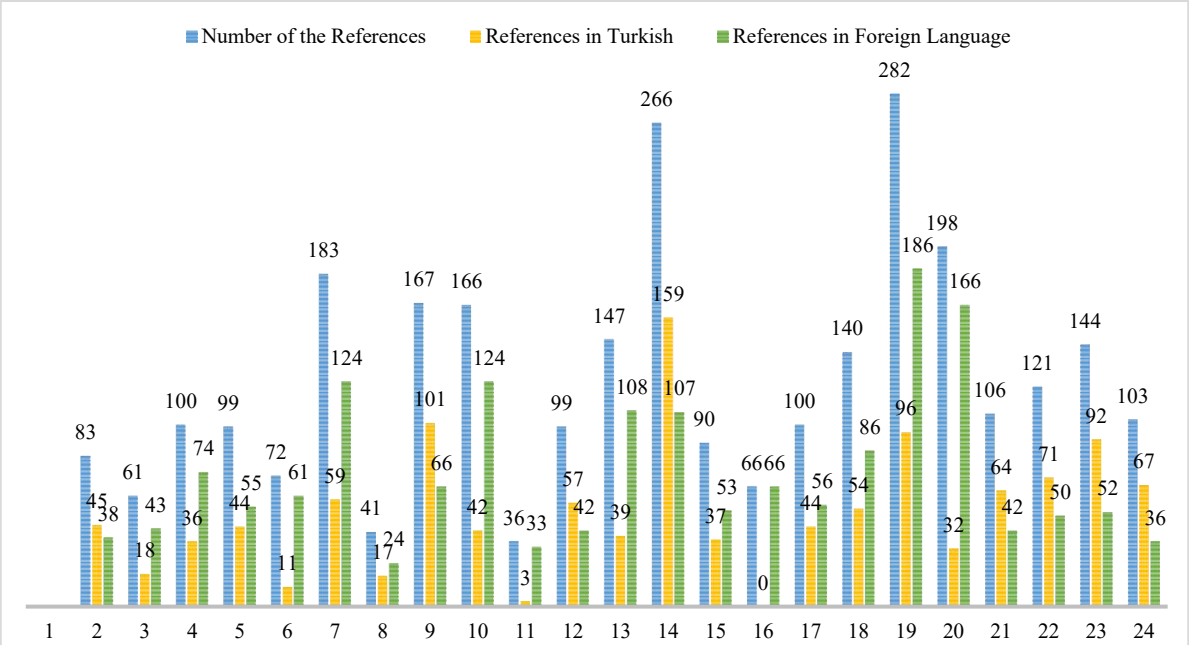

Figure 2. Distribution chart based on references within the theses

Based on the data in Figure 2, the following observations can be made regarding the use of references in graduate theses on AI: The total number of references used in the theses shows significant variation, ranging from 41 to 282. This variation reflects the different research focuses and methodologies of the theses. Theses with a higher number of references are likely to have conducted more extensive literature reviews and utilized more detailed research methods. For example, Thesis 19, with 282 references, indicates a solid foundation, suggesting a comprehensive literature review and a broad knowledge base on the subject. On the other hand, Thesis 11, with fewer references, might be due to the topic being relatively new or having limited literature available. However, considering the potential contributions of the study to the Turkish education system and AI research, it may still offer valuable insights, despite the lower number of references. This could serve as a starting point for future researchers to explore discoveries and further studies. A notable difference is observed between the number of local and international sources used. In some theses, local sources outweigh international ones, while in others, the opposite is true. This variation likely depends on the topics, research areas, and strategies used for literature reviews in each thesis. Some theses show a predominant use of international sources, suggesting that they may focus more on leading global literature in the field of AI. These theses likely aim to follow international research and development trends, as well as the latest methodologies. On the other hand, some theses emphasize the use of local sources from Türkiye, which could indicate a stronger focus on local research areas, AI applications, and trends specific to Türkiye, highlighting the importance of local needs and

priorities in the field. In conclusion, the use of references in graduate theses on artificial intelligence varies depending on research focus, methodologies, and local/global trends. Literature review strategies, research methods, and the intended contributions of each study influence the number and type of references used.

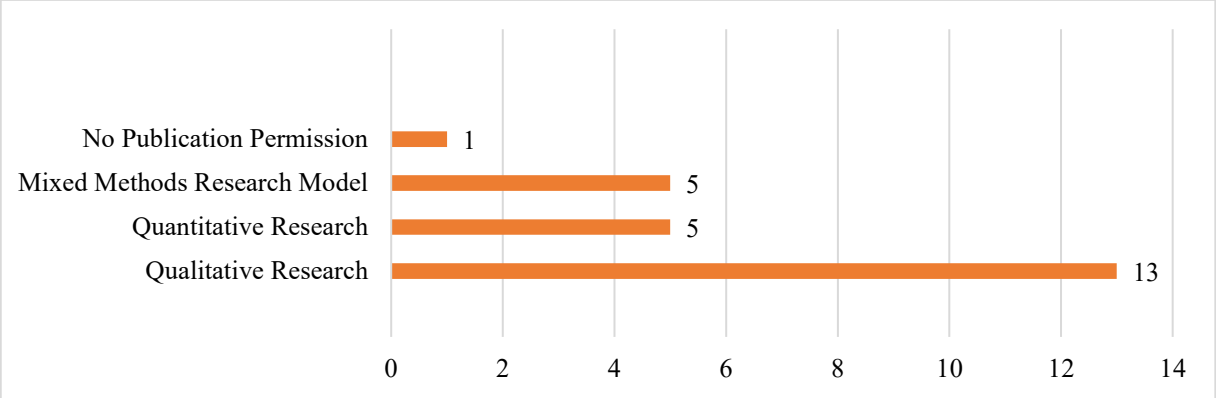

Figure 3. Distribution chart based on research methods of the theses

According to Figure 3, the majority of the theses examined are qualitative research studies (13). This result suggests that AI research in education is generally explored in-depth and in detail. Qualitative research is often used to understand participants' experiences, emotions, and thoughts, providing valuable insights for effectively integrating AI into educational practices. Quantitative research (5) constitutes a significant portion of the examined theses. This indicates that some of the theses involved collecting, analyzing, and interpreting numerical data. Quantitative research typically uses large-scale data sets to identify general trends and relationships. The mixed-methods approach, which combines both qualitative and quantitative research methods to obtain a more comprehensive understanding, is also widely used in the examined theses. This approach allows the integration of both numerical data and in-depth understanding. The use of mixed methods indicates that AI-related research in education and teaching has been balanced, addressing both general trends supported by quantitative data and detailed insights. This approach provides researchers with the opportunity to understand different aspects of the topic and reach more comprehensive conclusions. One thesis falls under the "No publication permission" category, representing a rare situation. This thesis may not have received publication permission yet or may require further information regarding its results and findings. Considering the various types of research methods used in the examined theses, this diversity demonstrates that AI-related research in education and teaching is conducted across a broad spectrum. This information may assist future researchers in exploring new research areas and methods.

Figure 4 shows the word cloud of the English abstracts of theses on artificial intelligence. When the English abstracts were examined, it was found that the discourse, consisting of a total of 7,079 words, included 1,591 unique words and the word density at the beginning of sentences was 25.5. Compared to the Turkish abstracts (5,463 words), there was a 29.5% increase in the word count of the English abstracts (7,079 words). According to Coleman & Liau (1975), this score reflects the density and level of detail in the texts. Designed to assess the readability levels of texts by computers, this formula typically estimates syllable counts using subprograms based on vowel counting. A higher word density may indicate a more technical and in-depth analysis. Upon examining the most frequently used words, it was determined that similar to the Turkish summaries, the words 'artificial' (89) and 'intelligence' (83) were the most frequent. However, in the English summaries, the most frequently used words were 'learning' (69), 'education' (58), and 'student' (52). These findings suggest that the English abstracts are more focused on education and learning, while the Turkish abstracts place more emphasis on the concept of AI. This difference indicates that the emphasis in both the language and content of the theses has been adapted to the language and interests of the target audience. Such diversity enables the theses to effectively reach a broader audience, thus enhancing the overall impact of the research.

Figure 4. Word cloud of english abstracts of the Theses

The distribution chart based on sample sizes of the theses can be seen in Figure 5. According to Figure 5, the sample sizes of the 24 examined thesis studies vary significantly. While some theses have small sample sizes, others have much larger ones. This diversity likely arises from the researchers adopting different methodologies and approaches. For instance, Thesis 14 uses a sample size of 1643, Thesis 11 has 420, and Thesis 12 includes 591. These large sample sizes indicate that these studies aim to obtain more generalizable results through

extensive data collection and analysis processes. On the other hand, the sample size for Thesis 1 is not specified, likely due to its publication being restricted. Theses 8 and 22 have a sample size of zero, suggesting they may be literature reviews or theoretical studies. The differences in sample sizes reflect the unique characteristics and focal points of each study. Some studies may choose to examine a specific topic in-depth, while others may opt for a broader data collection approach or compare different elements. Also, this diversity highlights the complexity and richness of AI-related research in education. Sample sizes are important for the reliability and generalizability of a thesis's results. Generally, larger sample sizes provide more reliable results and increase the external validity of the findings. However, it is important to consider that each thesis may have a specific purpose and methodology suited to its research question. In conclusion, the differences in sample sizes reflect the diversity and complexity of AI-related research in education. These variations offer valuable insights into the methodological approaches, scope, and findings of the studies. Understanding this diversity and the role of sample sizes can help future researchers explore new areas and reach more comprehensive conclusions.

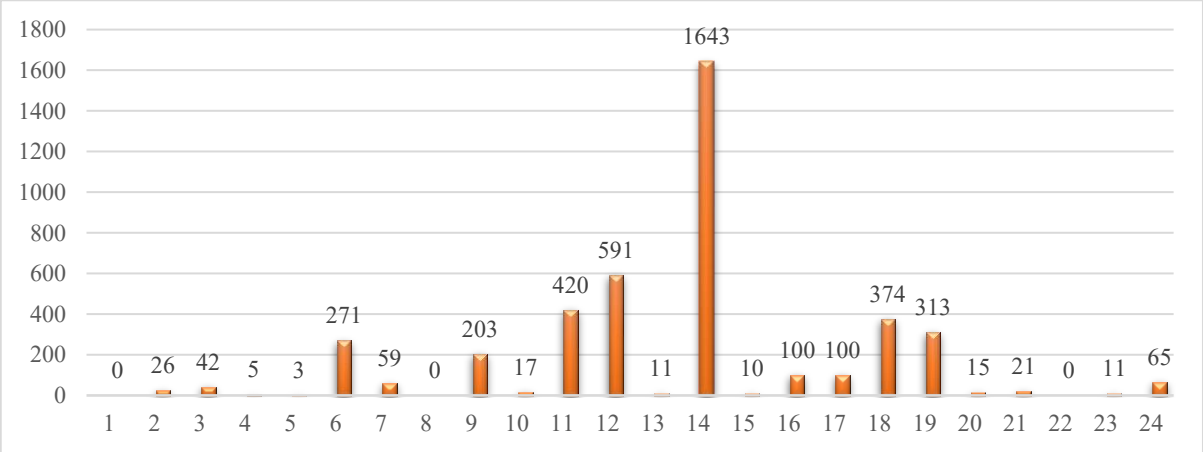

Figure 5. Distribution chart based on sample sizes of the theses

Figure 6. displays data on the types of samples used in thesis studies related to artificial intelligence. These data provide insights into the different sample types employed in the research, reflecting the diversity in the approaches used for data collection and analysis in the field of AI. According to the data in Figure 6, various sampling methods are used in AI studies in the field of education and teaching in Türkiye. The "Convenience Sampling" method stands out as the most commonly used sampling technique. This preference indicates that researchers often choose easily accessible sample groups to save time and costs. "Purposive Sampling" and "Targeted Sampling" methods are also frequently used. This suggests that researchers select

specific groups based on certain criteria or objectives to obtain more in-depth and focused results.

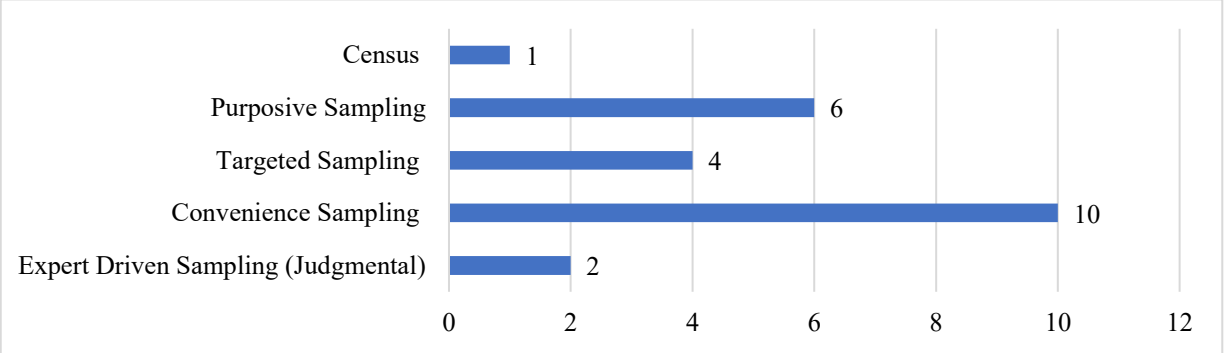

Figure 6. Distribution chart based on sampling methods of the theses

The presence of a single study using the "Census" method indicates that this study included all units from the population. Such an approach is typically used in research aiming to gather comprehensive and detailed data. In conclusion, various sampling methods are employed in AI research in education and teaching in Türkiye. While convenience sampling is the most widely used, purposive and targeted sampling methods also play a significant role. This diversity in sampling methods indicates that research is conducted both with easy access to sample groups and with specific objectives in mind. This variety enriches the scope and depth of AI research, contributing diverse and valuable insights to the literature.

DISCUSSION AND CONCLUSION

The bibliometric analysis of postgraduate theses on AI in education reveals a dynamic and evolving field. While AI holds the promise of transforming educational practices through personalized learning and improved administrative efficiency, it also presents challenges that necessitate careful consideration of ethical implications and the need for clear definitions and frameworks. Ongoing research and dialogue among educators, policymakers, and stakeholders will be essential in navigating these complexities and maximizing the benefits of AI in education. One of the primary benefits of AI in education is its ability to facilitate personalized learning experiences. AI technologies, such as intelligent tutoring systems, can provide tailored feedback and support to students, thereby enhancing their learning outcomes. For instance, intelligent tutoring systems can analyze student responses and adapt instructional materials accordingly, promoting a more individualized approach to education (Tonbuloğlu, 2023; Souza, 2024). This personalization is crucial in addressing diverse learning needs and fostering student engagement (Castellani, 2024). Furthermore, studies have shown that AI applications can significantly improve students' writing skills, as evidenced by enhanced coherence and clarity

in thesis writing facilitated by AI tools (Ilma, 2024). However, the implementation of AI in educational settings is not without challenges. A systematic literature review highlighted the predominance of adaptive systems and personalization in Brazilian theses, indicating a need for clarity in defining adaptive systems and their applications in education (Durso & Arruda, 2022). Moreover, the integration of AI raises ethical concerns, particularly regarding data privacy and the potential for algorithmic bias (Rashmi, 2023; Singh & Hiran, 2022). As AI technologies become more prevalent, it is essential to establish ethical guidelines to ensure their responsible use in educational contexts (Harry, 2023; Xia et al., 2023). This study makes a valuable contribution to the literature. First, it provides a comprehensive bibliometric analysis of AI-related graduate theses in Türkiye, revealing trends and gaps in the field. It serves as a guide for future research and highlights the importance of interdisciplinary collaboration in AI studies. The low proportion of AI-related theses compared to overall thesis studies suggests that more research is needed in this field. The concentration of theses in social sciences emphasizes the interdisciplinary nature of AI and its interaction with social sciences.

This study aims to determine the scope, distribution, and content characteristics of graduate theses on AI in the field of education in Türkiye. The primary goal of the research is to emphasize the importance of AI in education, understand how it is addressed across different disciplines, and provide guidance for future research. The main motivation for this study is to uncover trends and gaps in AI-related graduate theses in the fields of education and teaching in Türkiye. Specifically, the distribution of theses was analyzed based on institutes, topics, years, universities, departments, page numbers, sample types, sample sizes, citation counts, and research methods. Additionally, the analysis considered how AI-related theses are approached across different academic disciplines and their interrelationships. There are a total of 850,433 AI-related theses in Türkiye. While 751 theses were reviewed during the thesis process, AI-related theses have shown an increasing trend and are expected to continue growing. AI-related thesis research has been conducted across various fields, including educational sciences, natural sciences, social sciences, and graduate education. This demonstrates that AI is an interdisciplinary subject with broad research coverage. The higher number of theses in the Institute of Social Sciences compared to other institutes indicates that AI research often includes interactions with social sciences, particularly in areas like education, psychology, and sociology. The equal number of theses in the Institutes of Natural Sciences and Educational Sciences shows a strong connection between AI research and information technologies and education. The moderate number of theses in the Graduate Education Institute suggests that AI-

related theses are concentrated in areas such as educational management and teacher training. A significant increase in AI-related theses has been observed in recent years, indicating a growing interest in AI and research activity in this area. Most theses range from 80 to 120 pages, reflecting the detailed and comprehensive nature of the research. Citation counts show that recent theses have received more citations, indicating an increase in academic attention and contributions to the field's literature. The most commonly used sampling methods in these theses are purposive and convenience sampling, reflecting researchers' prioritization of specific objectives and practical solutions. The sample sizes for most theses are between 100 and 200, indicating that research is conducted with medium-sized sample groups to enhance the reliability of the findings. The distribution of theses across universities shows that large, established universities play a leading role in AI-related thesis research. Universities in major cities such as Istanbul, Ankara, and Izmir make significant contributions to AI research.

The findings indicate that interest in AI has increased in recent years and that theses in this field are spread across various disciplines. AI-related theses have been conducted in fields such as educational sciences, natural sciences, social sciences, and graduate education, highlighting the interdisciplinary nature of AI as a topic and its broad research scope. The higher number of theses in the Institute of Social Sciences, compared to other institutes, shows that AI-related research particularly involves interdisciplinary approaches, especially in fields such as education, psychology, and sociology. The equal number of theses in the Institutes of Natural Sciences and Educational Sciences indicates a strong connection between AI and information technologies and education. The moderate number of theses in the Graduate Education Institute suggests a concentration of research in areas such as educational management and teacher training.

Most theses were found to be between 80 and 120 pages in length, and more recent theses have received more citations. The most commonly used sampling methods were purposive and convenience sampling, with sample sizes typically ranging from 100 to 200. Large, well-established universities have played a leading role in AI-related thesis research, particularly in major cities such as Istanbul, Ankara, and İzmir. In terms of AI's role and potential impact on education, AI can bring significant changes to teaching and learning. First, it can individualize student learning processes and customize instructional materials. Additionally, AI-supported teaching can offer more objective and effective methods for assessing student performance. AI algorithms that identify students' strengths and weaknesses can create personalized learning experiences, thereby increasing academic success. These technological advancements in the

education system also redefine the role of teachers. Teachers can track student progress based on data provided by AI and offer more personalized guidance. For instance, exam and assignment assessments can be automated, allowing teachers to devote more time to students and monitor their development more closely. Moreover, AI plays a crucial role in teachers' professional development, as they can receive personalized feedback and recommendations tailored to their educational needs. However, AI in education also raises challenges and concerns. For example, the question of whether educational institutions' infrastructures can adapt to these innovations and the potential inequality in access to technology, which might exacerbate the digital divide, is crucial. Privacy and ethical use of student data are also important considerations. In summary, AI has the potential to transform education systems, but many factors need to be carefully planned and implemented during this transformation process. For AI to be used effectively and fairly in education, collaboration among all stakeholders is essential, while also considering the ethical and social aspects of the technology.

Recommendations

This study suggests several recommendations to improve AI development in education in Türkiye. Graduate theses on AI should encourage interdisciplinary collaboration, combining fields like education, psychology, and technology for more comprehensive research. Universities and research institutions should increase funding to support deeper studies on AI's potential in education. Educational programs, especially in education sciences and natural sciences, should be updated to reflect AI's rapid development. AI-related findings should be published and applied in educational practices, bridging academic knowledge and real-world use. Additionally, AI research in social sciences should be expanded, exploring its impact on student achievement and society. National policies should be developed to integrate AI into the education system. Implementing these strategies will enhance AI's role in education and drive further research progress.

Limitations and strengths

This study has several noteworthy strengths. First, it provides a comprehensive bibliometric analysis of postgraduate theses on artificial intelligence (AI) in education in Türkiye, offering valuable insights into research trends, institutional distributions, methodological choices, and thematic focuses. By utilizing full-count analysis and covering all accessible theses, the study ensures a complete overview of the current academic landscape. Furthermore, the integration of quantitative and qualitative data strengthens the validity of the

findings and contributes to the understanding of interdisciplinary research dynamics in the context of AI and education.

However, some limitations must also be acknowledged. The study is restricted to theses archived in the Higher Education Council National Thesis Center, which may exclude relevant works with restricted access or unpublished academic research. Additionally, bibliometric methods, while robust in quantitative mapping, do not assess the quality or impact of the theses' content beyond citation counts and metadata. The lack of in-depth content analysis or expert evaluation limits the interpretation of thematic depth and methodological rigor. Moreover, the overrepresentation of master's theses and the scarcity of doctoral research in the dataset may skew the academic level of insights obtained. Finally, language limitations—most theses being in Turkish—could hinder international visibility and comparative analysis.

Despite these limitations, the study offers a solid foundation for future research and policymaking by highlighting current trends, gaps, and opportunities in AI-focused educational studies. It encourages more rigorous, diverse, and interdisciplinary approaches in graduate research, particularly at the doctoral level.

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Fikir ve Kavramsal Örgü *Idea or Notion*	Araştırma hipotezini veya fikrini oluşturmak *Form the research hypothesis or idea*	Sevil GÜVEN Muhammet SAYGIN
Tasarım *Design*	Yöntem ve araştırma desenini tasarlamak *To design the method and research design.*	Sevil GÜVEN Muhammet SAYGIN
Literatür Tarama *Literature Review*	Çalışma için gerekli literatürü taramak *Review the literature required for the study*	Sevil GÜVEN
Veri Toplama ve İşleme *Data Collecting and Processing*	Verileri toplamak, düzenlemek ve raporlaştırmak *Collecting, organizing and reporting data*	Sevil GÜVEN
Tartışma ve Yorum *Discussion and Commentary*	Elde edilen bulguların değerlendirilmesi *Evaluation of the obtained finding*	Sevil GÜVEN Muhammet SAYGIN

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Bu çalışma yalnızca literatür taramasına dayanan ve bibliyometrik analiz yönteminin kullanıldığı bir araştırmadır. Herhangi bir deneysel uygulama, insan ya da hayvan katılımcıdan veri toplama süreci içermemektedir. Bu nedenle, etik kurul onayı gerektirmemektedir. Çalışma, ilgili derginin yazım kuralları ve yayın politikalarına uygun olarak hazırlanmıştır.

This study is based solely on literature review and employs a bibliometric analysis method. It does not involve any experimental procedures or data collection from human or animal participants. Therefore, ethics committee approval is not required. The research has been conducted in accordance with the writing and publishing policies of the relevant journal.