Bibliometric Analysis of Articles Published on Artificial Intelligence in Education During the Last Five Years in Türkiye

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Abstract: This study aims to examine articles published in Turkey on Artificial Intelligence in education, including 2020 and 2024, using content analysis. The research seeks to identify general trends in Artificial Intelligence in education, including the distribution of keywords, research methods employed, types of sampling, and data collection tools. The analysis builds on literature addressing the impact of Artificial Intelligence on education, exploring how it modulates teaching strategies and engages students. Bibliometric analyses provide insight into the use of Artificial Intelligence tools across various educational levels and reveal trends in this domain. The study's findings aim to enhance understanding of research on Artificial Intelligence in education, identifying gaps and areas for further exploration. Additionally, it addresses the challenges of integrating Artificial Intelligence and machine learning into pedagogical processes, intending to guide future research directions for educators, researchers, and policymakers. This study is significant for understanding the evolution of Artificial Intelligence in education and providing guidance for future work in the field.

Keywords: Artificial Intelligence; Bibliometric Analysis, Education

1. Introduction

One of the most crucial factors driving the rapid advancement of digital technologies today is undoubtedly Artificial Intelligence (AI) technology (Prahani et al., 2022). Within the framework of Industry 4.0, AI stands out as a technology that enables the simulation of human intelligence, allowing machines to think like humans (Ribeiro et al., 2021). The development of modern technologies such as big data, autonomous vehicles, robotics, and the Internet of Things has been made possible by the capabilities provided by AI (Prahani et al., 2022). In this context, the impact of AI is evident across various fields, including technology, industry, medicine, business, and education (Benzer & Benzer, 2024).

Bibliometric analysis is a robust method for analyzing trends and the knowledge structure within a specific research field, providing measurable, reproducible, and objective data (Öztürk et al., 2024). This method offers researchers and relevant stakeholders a comprehensive understanding of their field and also promotes interdisciplinary collaboration (Zupic & Cater, 2015). Advances in data access, data collection, software analyses, techniques, and technologies have led to an increase in bibliometric studies, as these innovations facilitate more efficient collection, processing, and analysis of large data sets. Such analyses enable researchers to evaluate literature in any field with greater rigor and quantitatively. The accessibility of databases such as Web of Science (WoS), Scopus, and TR Dizin has also made it easier to access studies and perform analyses, contributing to a more manageable understanding of the impact and progression of scientific literature (Ülker et al., 2023).

The aim of this study is to analyze articles published on artificial intelligence in education in Turkey using content analysis. The research is designed to identify general trends in national publications on AI in education including 2020 and 2024. This includes examining the distribution of articles by year, keyword distribution, diversity of research methods, distribution of sampling types, data collection tools, and the objectives and recommendations of the articles. By enhancing understanding of trends in AI in education, the study intends to guide future research in the field. Finally, examining the objectives and recommendations of these articles will help clarify prevailing trends in AI in education, providing a foundation for future studies.

2. Background and Related Works

AI offers significant educational benefits, though certain challenges have emerged over time (Özizer, 2024). AI can help teachers adjust their instructional strategies to engage students (Cukurova et al., 2019) better. In this context, bibliometric reviews report trends and advancements in AI applications for learning (Eguchi, 2020). Hamilton et al. (2018) systematically reviewed 21 articles published between 2013 and 2017 on learning with virtual reality, finding limited effectiveness in enhancing participants' cognitive, psychomotor, and attitudinal skills. In another study, Moreno-Guerrero et al. (2020) performed a scientific mapping of AI's educational implications using various bibliometric indicators in the Web of Science, identifying 379 documents published between 1956 and 2020. Similarly, Talan (2021) reviewed the literature on the use of AI in pedagogical activities within the Web of Science database. His report, encompassing 2,686 publications from 2001 to 2021, highlights machine learning, deep learning, and higher education as the most relevant topics. Ouattara (2023) conducted a bibliometric analysis across 1,138 articles based on the terms "artificial intelligence," "machine learning," and "education pedagogy." This study aims to provide teachers, educators, policymakers, and researchers with a comprehensive perspective by identifying gaps, deficiencies, and challenges in the pedagogical improvement process related to AI and machine learning in education. In a similar study, Garcia Castro et al. (2024) analyzed 995 scientific studies from the Scopus database using keywords such as "teaching methods," "teaching strategies," "teaching techniques," "teaching methods," or "educational methods" alongside "artificial intelligence." Of these, 349 studies were included in the evaluation. The bibliometric analysis revealed that AI tools designed for integration across all educational levels, from primary to higher education, are currently available.

3. Method

This research is a qualitative study. The data were collected using document analysis, one of the qualitative research methods. Document analysis involves analyzing written materials that contain information about the phenomenon or phenomena being studied. The document analysis process consists of accessing and reviewing documents, interpreting them, analyzing the data, and following the steps for utilizing the data (Yıldırım & Şimşek, 2021).

Descriptive analysis and content analysis methods were used to analyze the data. A deductive approach to data analysis shapes descriptive analysis, while content analysis operates with an inductive perspective within the boundaries defined by the researcher. In this context, descriptive analysis is applied in studies where the conceptual framework is clearly established in advance. In contrast, content analysis requires an in-depth examination of the collected data and allows for the emergence of previously unidentified themes (Yıldırım & Şimşek, 2021).

3.1 Data Collection Tools

The dataset for this study was obtained from the Google Scholar database using the keywords "artificial intelligence in education" and "artificial intelligence in science education," consisting of 23 articles published between 2020 and 2024. These studies were listed according to their publication dates and labeled with the codes M1, M2, M3… M23 (Table 1).

Table 1. Article Codes

Article Title	Code
Investigation of Teachers' Opinions on the Applicability of Artificial Intelligence in Education in the Perspective of Industry 4.0 (Çetin & Yıldız Baklavacı, 2024).	M1
Academic Text Writing with Artificial Intelligence/Smart Learning Technologies: The Chatgpt Example (Altıntop, 2023)	M2
The Importance of Artificial Intelligence in Education According to Teachers' Views (Köse et al., 2024)	M3
Views of School Principals and Teachers on Using Artificial Intelligence in Education (Demir Dülger & Gümüşeli, 2023)	M4
Ethical Concerns Regarding the Use of AI in Scientific Publications (Uyan, 2023)	M5

Table 1. Article Codes (Continuation)

Teacher Trends in the Use of Artificial Intelligence (Şanlı et al., 2023)	M6
Analysis of Science Group Teachers' Use of Artificial Intelligence in the Distance Education Process (Çolak Yazıcı & Erkoç, 2023)	M7
A Socio-Science Activity Integrated with Reasoning and Entrepreneurial Skills on Artificial Intelligence: Pre-service Science Teachers' Views (Bayram & Çelik, 2023)	M8
Image Generate in Arts Applications Designed In Artificial Intelligence (Deveci, 2022)	M9
Investigation of Metaphorical Perceptions of Children on The Concept of "Artificial Intelligence" (Saçan et al., 2022)	M10
Using Artificial Intelligence in Education: Descriptive Content Analysis Study (Meço & Coştu, 2022)	M11
Development of Artificial Intelligence in History and Its Usage in Education (Coşkun & Gülleroğlu, 2021)	M12
The Use and Development of Artificial Intelligence in Education (İşler & Kılıç, 2021).	M13
Determining Teacher Candidates' Awareness of Artificial Intelligence Technologies (Çam et al., 2021)	M14
Today And Used ın The Future Artificial Intelligence (Uzun et al., 2021)	M15
The Position of Digitalization and Artificial Intelligence in School Administration (Küçükali & Çoşkun, 2021)	M16
Digitization and Education 4.0 From the Educational Philosophy Perspective (Alkayış, 2021)	M17
Eğitimde yapay zeka konusunda Türkiye adresli çalışmaların incelenmesi	M18
Artificial Intelligence and Future Scenarios in Education (Çetin & Aktaş, 2021)	M19
Artificial Intelligence and Applicatıons in Education (Arslan, 2020)	M20
A New Paradigm in Education: "Artificial Intelligence in Higher Education" (Taşçı & Çelebi, 2020)	M21
The Fifth Industrial Revolution: Society 5.0 and the Culture of Artificial Intelligence (Koçak, 2020)	M22
Teachers' views on the use of artificial intelligence in schools (Özer et al., 2023)	M23

3.2 Data Analysis

The data analysis was conducted using the MAXQDA 2024 qualitative data analysis software. Today, the most significant contribution of computers to qualitative research is during the data analysis phase. When qualitative data analysis is performed using software, it offers various advantages to researchers, such as providing a structured file system, easy retrieval of data, and the ability to organize reminder notes. Additionally, it allows researchers to visualize the results by creating visual models (Creswell, 2023).

Studies conducted in the field of artificial intelligence in education were analyzed through descriptive analysis based on keywords, data collection tools, samples, research methods, and publication year, and the findings were presented. The results derived from the objectives and recommendations of these studies were then presented through content analysis, where codes, categories, and themes were developed.

4. Results and Discussions

This study aims to investigate the general trends in articles on artificial intelligence in education published between 2020 and 2024. To this end, the distribution by year, keyword distribution, distribution by research method, distribution by sampling type, distribution by data collection tool, and distributions based on objectives and recommendations were examined.

4.1 Distribution of Studies on Artificial Intelligence in Education by Year

The distribution of studies on artificial intelligence in education by year shows 2 articles from 2024, 7 articles from 2023, 3 from 2022, 6 from 2021, and 5 from 2020 (Figure 1). The increase in studies on artificial intelligence in education in the past year, as shown in the graph, particularly indicates a surge in research in this field in the most recent year.

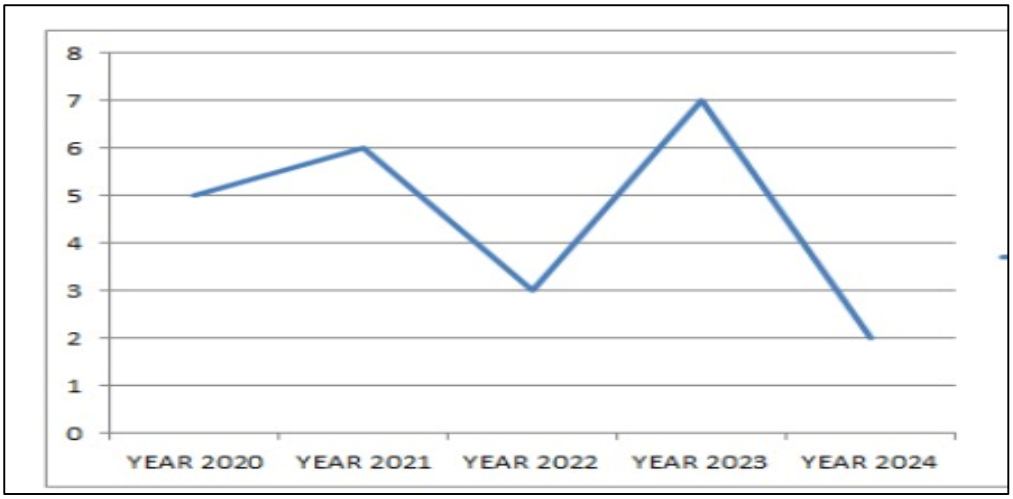


Figure 1. Distribution of Studies on Artificial Intelligence in Education Including 2020 and 2024

4.2 Distribution of Studies on Artificial Intelligence in Education by Keywords

The keywords of studies on artificial intelligence in education reveal that the most frequently used terms are "artificial intelligence," "education," "artificial intelligence in education," "teacher," and "technology." The integration of artificial intelligence into the education system emphasizes the roles of technology and teachers. Furthermore, concepts such as Education 4.0, digitalization, distance education, e-learning, and digital leadership underscore the digital transformation processes in education. Other keywords represent subtopics related to artificial intelligence and education (Figure 2).

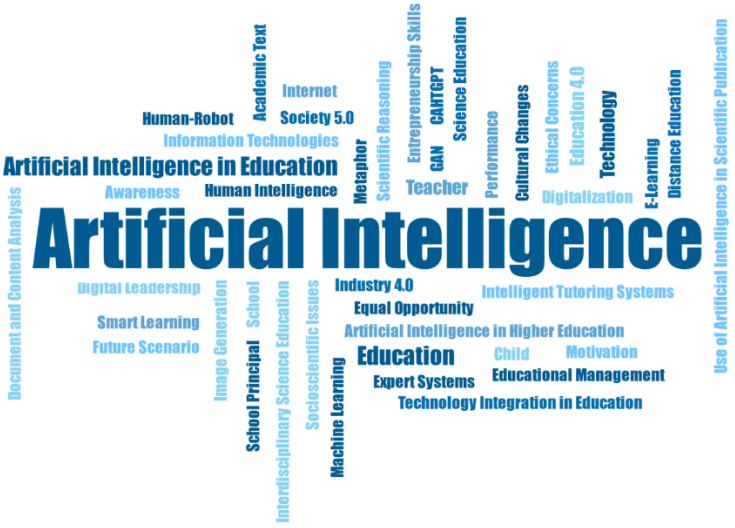


Figure 2. Distribution of Keywords in Studies on Artificial Intelligence in Education

4.3 Distribution of Studies on Artificial Intelligence in Education by Research Method

The distribution of studies on artificial intelligence in education by research method shows 7 document analyses, 6 phenomenological studies, 4 case studies, and 1 qualitative research study (Figure 3).

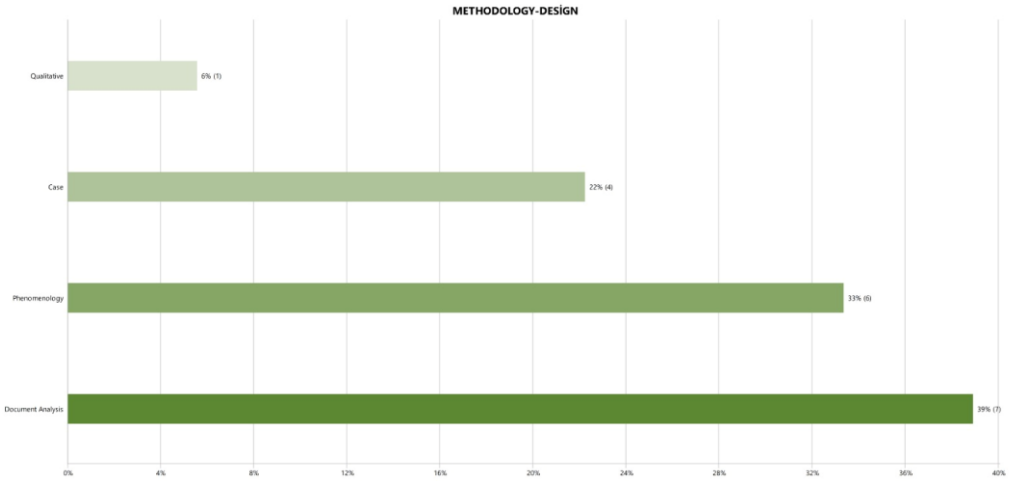


Figure 3. Distribution of Studies on Artificial Intelligence in Education by Research Method

In the studies, the potential of artificial intelligence in education has been explored in depth using different methodologies. Document analysis was employed to conduct a thorough literature review, while phenomenology was used to understand the experiences of teachers and students. Identifying how artificial intelligence can be most effectively utilized in education will be an important step for future research.

4.4 Distribution of Studies on Artificial Intelligence in Education by Sampling Type

The distribution of studies on artificial intelligence in education by sampling type reveals that four studies employed maximum variation sampling, while one study each used purposive sampling, extreme case sampling, simple random sampling, convenience sampling, quota sampling, and snowball sampling. Additionally, some studies did not specify the sampling method. Non-random sampling methods were predominantly preferred in these studies (Figure 4).

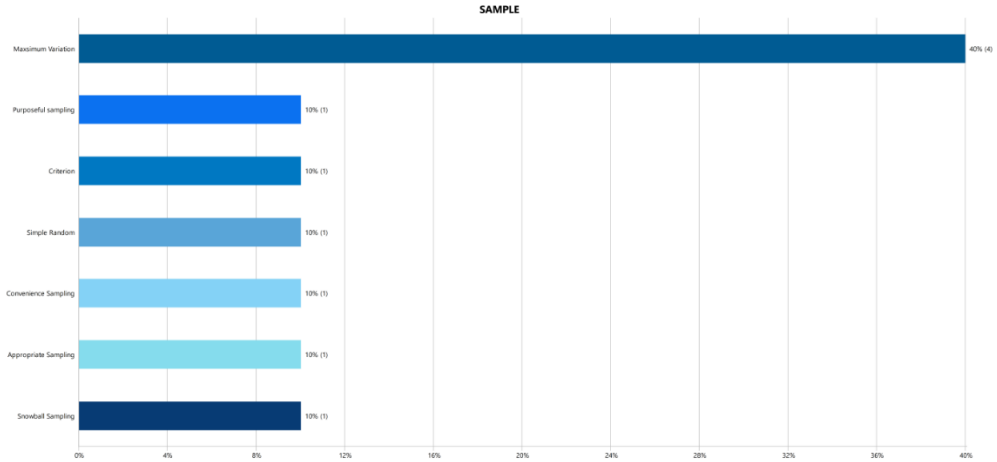


Figure 4. The Distribution of Sampling in Studies on Artificial Intelligence in Education

The most commonly used sampling method is the maximum variation sampling method. This approach suggests that researchers aim to reflect the diversity of participants to the greatest extent in their studies. The preference for non-random sampling methods, in particular, reflects the researchers' efforts to work with study groups possessing specific characteristics, allowing for a more in-depth examination of the effects of artificial intelligence in education.

4.5 Distribution of Studies on Artificial Intelligence in Education According to Data Collection Tools

The distribution of studies on artificial intelligence in education according to data collection tools shows that 58.8% of the data was collected through interviews, while 41.2% was collected through a literature review (Figure 5).

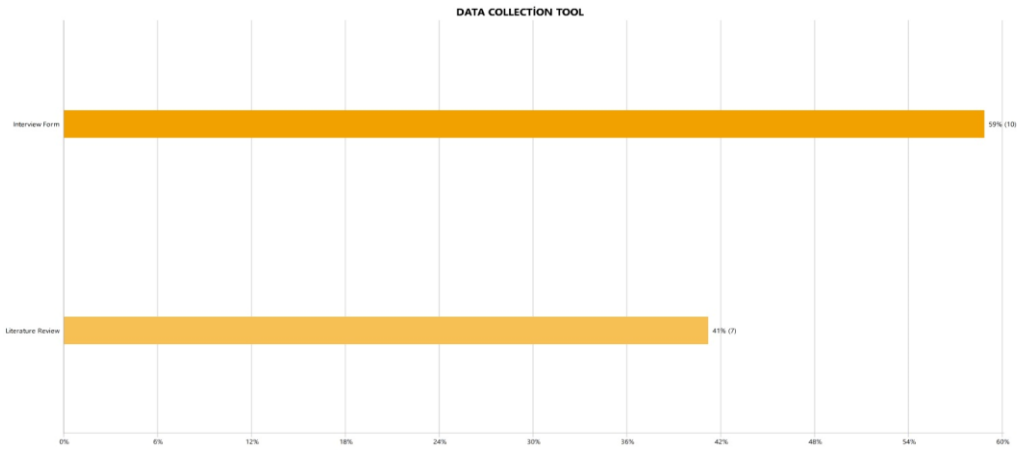


Figure 5. The Distribution of Studies on Artificial Intelligence in Education According to Data Collection Tools

The distribution above reveals that research on artificial intelligence in education largely relies on qualitative data collection methods. It is evident that researchers often prefer direct interviews with stakeholders to understand the role of artificial intelligence in the field of education.

4.6 Distributions of Studies on Artificial Intelligence in Education According to Their Objectives

The studies on artificial intelligence in education were examined through content analysis according to their objectives. Each result obtained from the articles was individually coded in this analysis. Subsequently, categories and themes were identified. As shown in Table 2 and Figure 7, the objectives of the studies tend to be grouped under two main themes: "opinions" and "applications." Under the theme "opinions," there are 4 categories, while the theme "applications" includes 7 categories. When looking at the frequency of codes related to the objectives, artificial intelligence applications in education and the opinions of teachers and school principals are prominent.

Table 2. The Objectives of Studies on Artificial Intelligence in Education

Category	Code	f	Article
Applications	The development of artificial intelligence	1	M12
	The use of artificial intelligence in distance education	2	M17, M16
	Artificial intelligence technologies in education	9	M2, M3, M6, M11, M13, M16, M17, M18, M20
	Machine learning methods	1	M9
	Artificial intelligence activity application	1	M8
	Future use of artificial intelligence	3	M19, M21, M22
	Artificial intelligence technologies in higher education	1	M21
Opinions	Teachers' and school principals' views on artificial intelligence	9	M1, M3,M4, M6, M7, M8, M14, M15, M23
	Artificial intelligence as perceived by children	1	M10
	Ethical concerns in the use of artificial intelligence	1	M5
	Students' opinions on artificial intelligence	1	M15

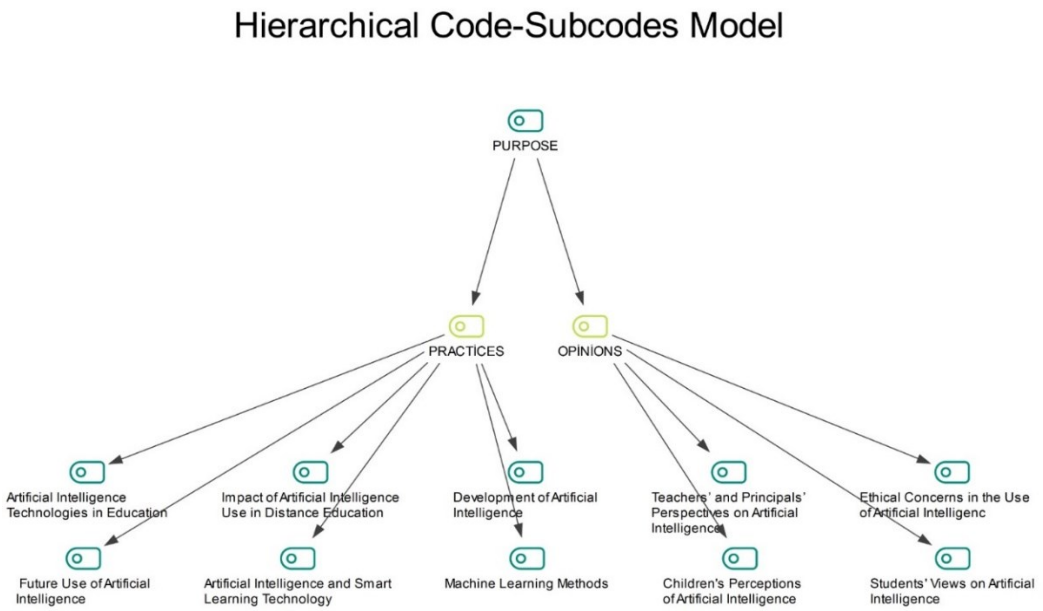


Figure 7. The code map of the objectives of studies on artificial intelligence in education

In the "Applications" category, the most frequently used code is "artificial intelligence technologies in education," with 10 articles associated with this code. These articles provide various perspectives on how artificial intelligence can be utilized in educational processes and the role of technological advancements in education. The articles with the codes "future use of artificial intelligence" and "use of artificial intelligence in distance education" discuss the potential future impacts of artificial intelligence in education and its role in distance education processes.

The most frequently used code in the "Views" category is "teachers' and school principals' views on artificial intelligence," with 9 articles associated with this code. These articles detail the thoughts and experiences of educators who play an active role in education and have direct interaction with students regarding the use and impact of artificial intelligence in education. Other codes include "children's perceptions of artificial intelligence" and "ethical concerns in the use of artificial intelligence." These codes discuss the ethical dimensions of artificial intelligence in educational processes and how children perceive this technology.

Applications Category:

1. The "Artificial Intelligence Development" code in M12 is expressed as follows:
   The aim of this study is to examine the development of artificial intelligence, a rapidly advancing field that, despite being relatively new, is impacting nearly all disciplines. It discusses the relationship between artificial intelligence and human intelligence, explores the current state of AI, and debates whether it poses a threat or an advantage to humanity, as well as its potential impacts on education (M12).

2. The use of artificial intelligence in distance education is expressed as follows in M16 and M17:
   The aim of this study is to examine in depth the use of artificial intelligence by science teachers before, during, and after the distance education process, using the case study method, one of the qualitative research designs (M17).
   The study aims to examine the impact of digitalization across various fields in light of

technological advancements. In this context, the research addresses topics such as education and technology, digitalization and the digital world, digitalization in education and artificial intelligence, as well as the effects of distance education and digitalization on school management (M16).

3. The use of artificial intelligence technologies in education is discussed in studies M3, M6, M11, M13, M16, M17, M18, and M20 as follows:
   This article provides educational insights on the impact of artificial intelligence in education to facilitate a better understanding of future studies on this topic (M13).

4. Machine learning methods are expressed in M9 as follows:
   The study aims to understand machine learning methods and to evaluate various approaches within these methods, discussing the possibilities provided by artificial intelligence in image generation. Additionally, the research examines examples of images generated through artificial intelligence, reviewing these artworks or images via a literature review methodology (M9).

5. The artificial intelligence activity application in M8 is expressed as follows:
   The aim of the study is to introduce the implementation steps of a socio-scientific activity integrated with scientific reasoning and entrepreneurial skills, developed through an interdisciplinary approach on the topic of artificial intelligence within the framework of the 6E learning model. Additionally, the study seeks to gather science teacher candidates' views on the pedagogy of the activity (M8).

6. The use of artificial intelligence in the future is discussed in M19, M21, and M22 as follows:
   The aim of this study is to present scenarios in which artificial intelligence will be involved in education in light of the same concerns and to examine these scenarios based on expert opinions (M19).

7. In higher education, artificial intelligence technologies are expressed as follows in M21:
   In this context, this article not only discusses the role of artificial intelligence in higher education, but also examines the applications of AI in higher education and explores, from an optimistic perspective, how higher education institutions can prepare for the future with artificial intelligence (M21).

Category of Opinions:

1. Teacher and School Principal Opinions on Artificial Intelligence (M3, M4, M6, M7, M8, M14, M15, M23):
   This study aims to determine the perspectives and thoughts of school principals and teachers working in primary and secondary schools regarding the use of artificial intelligence in education (M4).

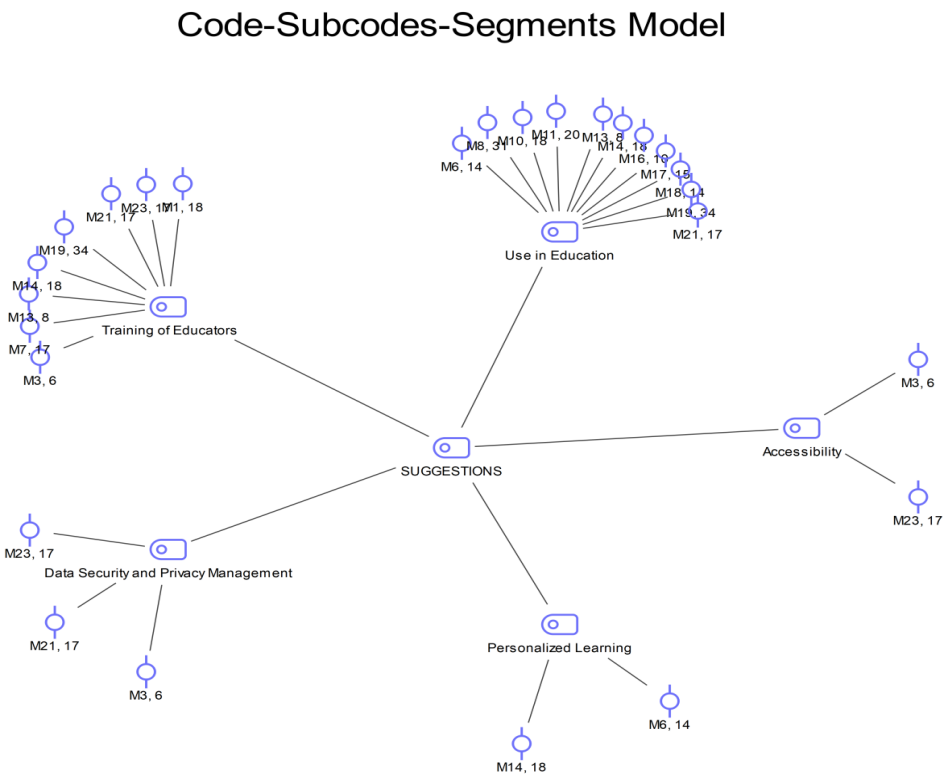
2. Children’s Perception of Artificial Intelligence (M10):
   This study aims to determine how children, particularly those in the 6-10 age group, perceive artificial intelligence, which is increasingly present in their lives, especially in the field of education (M10).

3. Ethical Concerns in the Use of Artificial Intelligence (M5):
   This study aims to highlight the ethical concerns related to the use of such technologies in scientific publishing activities (M5).

4. Student Opinions on Artificial Intelligence (M15):
   The purpose of the study is to explore the usability of artificial intelligence technologies, considering the personal skills of students and instructors, and to provide instructional information for a better understanding of current and future educational concepts (M15).

4.7 Distributions According to the Recommendations of Studies on Artificial Intelligence in Education

Studies on artificial intelligence in education have been analyzed through content analysis according to their recommendations and categorized under four main themes: "*use in education, educator training, data security and privacy management, accessibility, and personalized learning*" (Figure 8 and Table 3). When examining the frequency of codes in the recommendations, it is observed that the use of artificial intelligence in education is emphasized the most.



Şekil 8. Eğitimde yapay zeka konulu çalışmaların önerilerinin kod haritası

Table 3. Recommendations of Studies on Artificial Intelligence in Education

Code	Coded Sections	f
Use in education	"Artificial intelligence applications could be emphasized, especially in subjects like history and geography, to help students better understand areas they cannot physically visit. AI applications could also be used to enable both students and teachers to work independently of time and space in tasks such as assessment, homework, and project work. With AI-based applications, administrative tasks in schools, student attendance, exam analyses, and fostering collaboration between students, parents, and schools can be carried out much faster and more reliably." (M6)	11
	"The activity is designed for use in face-to-face education. The activity can be supported with Web 2.0 tools in alignment with the distance education process and can be used for teaching programs across different disciplines and grade levels. In the activity, applications can be carried out through programs such as Scratch, and the effects of the application on techno-pedagogical competencies can be examined. Based on this activity, experimental research can be planned to develop national artificial intelligence technologies in the field of education, particularly for teaching science, technology, and laboratory courses." (M8)	
	"It is believed that, while introducing children to the concept and applications of artificial intelligence, raising awareness among parents, as well as incorporating AI into school curricula such as media literacy, critical thinking education, or philosophy with children, from a critical perspective, will minimize the potential harm children may be exposed to." (M10)	
	Due to the scarcity of graduate studies focused on artificial intelligence in education, researchers may be advised to explore AI as a new research area. Considering the results obtained from examining the methods of AI-themed studies in education, researchers could be encouraged to conduct quantitative studies on this topic. Based on the sample group results, researchers could be advised to work with students at all grade levels, particularly those in secondary education (primary, middle, and high school). Given the research area, experts in science education, including physics, chemistry, and biology, could be advised to fill the gaps in the literature. AI-themed projects could be developed for each learning outcome, and activities could be prepared. Studies that have not been covered in this analysis could be reviewed, and research on other techniques not addressed in this study could be conducted. A similar study could be conducted as part of an international study. Instead of using general keywords such as "artificial intelligence in education," more detailed studies could be conducted by examining the specific techniques used in the studies. More research is needed on the integration of AI-based smart tools (such as software and hardware) into educational environments. Experts in this field should approach AI from the educational perspective and develop and promote the necessary applications. (M11)	
	"Considering the benefits, it is recommended that schools transition to fully AI-supported education." (M13)	
	"It is believed that artificial intelligence technologies can be utilized not only for activities that support teaching and learning, such as lesson delivery and student assessment, but also for improving the educational process and increasing its efficiency." (M14)	
	"Therefore, in the near future, more emphasis should be placed on topics such as robotics-coding, artificial intelligence, the digital world, and technology in schools." (M16)	
	"Along with these studies, digital training should continuously develop knowledge and skills for individuals entering the workforce after their student years." (M17)	
	"On the other hand, the increase in qualitative studies that comprehensively address work conditions will provide more in-depth insights into the use of artificial intelligence in education." (M18)	
	"On the other hand, future research could focus on artificial intelligence assistance in the context of classroom management and school administration." (M19)	
	"To understand the role of artificial intelligence in higher education policy and management, more emphasis should be placed on research related to artificial intelligence." (M21)	

Table 3. Recommendations of Studies on Artificial Intelligence in Education (Continuation)

Code	Coded Sections	f
Training of Educators	"It can be recommended that policymakers view teachers' curiosity about artificial intelligence and their willingness to receive training as an opportunity and utilize this potential. Teachers should be introduced to AI technologies they can use in their lessons and be equipped with the necessary skills without falling behind developments." (M1)	8
	"Teachers and administrators should receive training on the proper use of artificial intelligence, and the training should be updated as technology evolves." (M3)	
	"It is believed that making courses on technology integration, which can contribute to the professional competence of prospective teachers who have not yet started their careers and whose teaching methods and styles have not become habitual, mandatory will increase teachers' recognition and use of AI/technological applications and enhance the integration of technology into their lessons. For current teachers, supporting this process with in-service training will be beneficial." (M7)	
	"School administrators need to develop themselves in this regard and possess the knowledge to lead teachers. Therefore, it is recommended that in-service training be provided to school administrators to acquire the necessary information. Additionally, it is essential to offer courses to teachers and students on the importance of artificial intelligence, its benefits, and how to use the required programs." (M13)	
	"To increase candidates' awareness of artificial intelligence technologies, such topics can be incorporated into the courses they take during their undergraduate studies, thereby enhancing pre-service teachers' AI literacy. Specifically, these courses can emphasize the learnable aspects of artificial intelligence technologies. Through the education provided by teacher training faculties on the use of AI technologies in the teaching process (McArthur, Lewis, and Bishary, 2005), teachers can be encouraged to adopt AI technologies on a larger scale and incorporate their use into their lessons." (M14)	
	"For this reason, it is important for teachers to develop their educational skills, stay updated with technological knowledge, understand the benefits of artificial intelligence, and integrate it into education in order to be prepared for the future. On the other hand, school administrators need to enhance their leadership skills and raise their awareness regarding the integration of artificial intelligence into all school processes to prepare themselves for the future." (M19)	
	"Enhancing institutional awareness and knowledge of artificial intelligence in higher education, and providing training for faculty members in this field." (M21)	
	"School administrators and teachers should undergo continuous training at regular intervals on the use of AI-based teaching tools and technologies; they should also be educated on responsibilities, privacy, and security standards." (M23)	
Data security and privacy management	"Utmost care must be taken to ensure data privacy in the use of artificial intelligence within educational processes. The confidentiality of student and teacher information must be strictly protected." (M3)	3
	"Higher education institutions must take legal measures to protect data and ensure privacy in the use of artificial intelligence within higher education." (M21)	
	"Schools and technology providers should be required to adhere strictly to protocols and regulations aimed at ensuring the privacy and security of student data. Ethical guidelines and student rights must be respected in the use of artificial intelligence, and student data should not be used for purposes beyond what is necessary and appropriate." (M23)	
Accessibility	"There should be no inequity among students in access to artificial intelligence technologies." (M3)	2
	"Equal opportunities should be ensured by facilitating affordable access to technology for educational institutions and students." (M23)	
Personalized learning	"Individualized education can be emphasized through the use of artificial intelligence." (M6)	2
	"Planned steps can be taken in the educational process to determine student success, manage suitable career planning, and organize employment processes effectively." (M14)	

The code with the highest frequency of emphasis is "use in education." The potential of artificial intelligence to digitally transform educational processes is highlighted. In particular, AI applications provide opportunities in areas such as personalizing teaching materials and monitoring and assessing student performance, which could contribute to the development of more efficient and effective methods in education. This could enable teachers to be relieved from routine and time-consuming tasks, allowing them to engage more in pedagogical interactions.

The other frequently used code, "educator training," points out that in order for artificial intelligence technologies to be successfully implemented, teachers and educational administrators must possess sufficient knowledge and skills about these technologies.

The code "data security and privacy management" draws attention to the ethical and security issues that may arise during the use of artificial intelligence applications in education. Addressing these concerns can enhance the reliability of AI-based systems and increase their acceptability in education.

The codes "accessibility" and "personalized learning" emphasize the potential of artificial intelligence to offer customized educational experiences tailored to student needs, enabling the development of learning materials and methods adapted to different learning styles and paces. This can be seen as an important step toward achieving equity and inclusivity in education.

5. Conclusion

This study presents the findings of research conducted in the field of artificial intelligence in education through descriptive analysis, focusing on keywords, data collection tools, sample, research methods, and publication years. The objectives and recommendations of these studies are presented through content analysis, generating codes, categories, and themes. The dataset for the study was obtained from the Google Scholar database using the keywords "artificial intelligence in education" and "artificial intelligence in science education," identifying 23 articles published between 2020 and 2024. This assessment emphasizes that the results of these 23 articles published between 2020 and 2024 could play an important role in shaping future research directions.

The recommendations of the reviewed articles can provide a foundation for future researchers, offering insights into how artificial intelligence in education studies can be utilized in research and identifying areas where further investigation is needed.

Bibliometric analysis aims to help researchers, academics, publishers, and policymakers understand the impact, visibility, and significance of this method. The bibliometric analysis conducted can serve as a guide for determining scientific research strategies in the field of artificial intelligence in education.

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