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Artificial Intelligence and Education: An Insight Through Bibliometric Analysis

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Abstract: The utilization of artificial intelligence has experienced significant growth and expansion in recent years. The education field is no exception, and this development holds the potential for revolutionary impacts on the educational landscape. These radical effects can improve learning experiences by making them more effective and efficient. This research aims to illustrate the evolution of the artificial intelligence landscape within education, identifying shifts in research focus over time and assessing the performance of publications and authors. This study was designed as a systematic literature review. Data were collected from the Web of Science database, which contains the most cited and high-quality publications in the international literature and offers the opportunity to download and analyse the appropriate data required for systematic literature reviews. After the queries, which contain filters to obtain pertinent literature, 1164 publications have been found. Although studies on artificial intelligence in education can be traced back to the 1980s, most publications have emerged within the last five years. Notably, journals centred on technology in education have published the most articles. While publications in various languages, such as Spanish, Russian, and Portuguese, exist, English (92% - 1074) serves as the lingua franca for discussing artificial intelligence in education.

Keywords: artificial intelligence, education, bibliometric analysis

Yapay Zekâ ve Eğitim: Bibliyometrik Analiz Yoluyla Bir Bakış

Öz: Özellikle son yıllarda yapay zekâ kullanım alanının ve sıklığının arttığı görülmektedir. Bununla birlikte yapay zekâ alanında meydana gelen önemli gelişmelerin eğitimde devrim niteliğinde değişikliklere yol açma potansiyeli olduğu tartışılmaktadır. Eğitim alanında yapay zekâ konusunda yapılan çalışmaların incelenmesi ve değerlendirilmesi yapay zekânın öğrenme deneyimlerini etkili ve verimli kılma potansiyelinin gerçekleşmesi açısından gerekli görülmektedir. Bu çalışmada eğitim alanında yapay zekâ çalışmaları incelenerek eğilimlerin ortaya konması amaçlanmıştır. Bu amaca yönelik olarak çalışmaların yıllar içerisindeki değişimi, yapay zekâyla birlikte ele alınan konuların belirlenmesi, bu konuların zaman içerisindeki değişimi, yayınların ve yazarların performansına ilişkin göstergelerin bulunması hedeflenmiştir. Sistematik literatür taraması olarak tasarlanan bu çalışmada uluslararası alanyazında en çok atıf alan ve kaliteli yayınların yer aldığı kabul edilen ayrıca sistematik literatür çalışması için gerekli uygun verileri indirme ve analiz etme imkânı sunan Web of Science veri tabanından yararlanılmıştır. Sorgulamalar

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sonucunda elde edilen 1164 yayına ait analizler sonucunda, eğitim alanında yapay zekâ konusundaki çalışmaların 1980'li yıllara kadar uzandığı görülmekle birlikte, özellikle son beş yılda pozitif yönde bir kırılma yaşanmış ve yayınların sayısında büyük bir artış ortaya çıkmıştır. En fazla yayın, teknoloji temalı eğitim dergilerinde yer almıştır. Bununla birlikte İspanyolca, Rusça, Portekizce gibi farklı dillerde yayınlar olmasına rağmen, İngilizce'nin (%92-1074) eğitimde yapay zekâ konusunda çok daha fazla tercih edildiği görülmüştür.

Anahtar kelimeler: yapay zekâ, eğitim, bibliyometrik analiz.

Introduction

Artificial intelligence (AI) systems are computational models that perform cognitive and perceptual tasks previously reserved for humans, such as thinking, judging, and reasoning. The initial focus of AI research was on its potential to improve human life. The phrase "artificial intelligence" was coined in 1956 at a workshop at Dartmouth College (Norvig & Russell, 2011). Since then, the field of AI has experienced intense interest and been the subject of utopic predictions. However, there were times called AI winters when these utopic predictions failed to become reality, and the interest diminished (Duan et al., 2019). Researchers on AI have been mainly interested in two techniques: symbolic and connectionist AI. Symbolic (rule based) AI is concerned with encoding principles of human reasoning, while connectionist (neural networks) AI mimics the structure of the human brain with its neurons (Norvig & Russell, 2011).

Artificial Intelligence in Education

Significant developments in the field of AI in recent years have led to widespread use and increased frequency of applications. Even before ChatGPT's impact on education (Lo, 2023; Tlili et al., 2023), the Council of Europe's committee of ministers advised not only on the opportunities offered by AI in education, but also its potential threats (Holmes et al., 2022). In other words, the impact of AI was expected, but maybe not to the extent that it now has. AI is seen by many authorities as a rapidly developing technology that has the potential to revolutionize education (Alam, 2022). Likewise, scientific research on AI has increased. AI in education offers powerful pedagogical tools that can help improve the quality of teaching (Terzi, 2020). The main purpose of using AI in education is to enhance students' learning experiences in effective and efficient ways. In other words, AI has a strategic value for education (Seldon & Abidoye, 2018).

Pedagogical Approaches in Artificial Intelligence and Education

AI has revolutionized the landscape of education by offering innovative pedagogical approaches that cater to the diverse learning needs of students. Many AI applications profile students, which allows predictions on student learning (Zawacki-Richter et al., 2019). AI makes personalized and adaptive learning possible for every student by evaluating the learning process and improving the feedback loop. AI has found a critical place in key domains of education, namely: learning, teaching, assessment, and administration. In other words, AI has become one of the key research areas for educational research (Chiu et al., 2023). Applications of AI in education and its impact on pedagogy include personalized learning, smart tutoring, assessment and evaluation, predictive analytics, and virtual assistants.

Personalized learning aims to tailor instruction to individual student needs. Personalized or adaptive learning has always been an appealing topic in education. Recent developments in

hardware, such as smartphones, wearable devices, and tablets, offer new opportunities for personalized learning. By analysing student data, AI can identify areas where students need extra help and provide personalized learning experiences by giving specific resources and feedback (Xie et al., 2019).

Smart tutoring: AI tutoring systems can help students learn more effectively by providing them with instant feedback and guidance while offering a more customized learning experience by adapting to each student's learning needs and pace (Schiff, 2021). Intelligent tutoring systems are developed using AI techniques. Although most of these systems are developed for web interfaces and are most effective when used with computers, the recent development of mobile devices and smartphones will enable the development of mobile-based intelligent tutoring systems (Mousavinasab et al., 2021).

Assessment and evaluation approaches of AI in education mainly focus on automatic grading. AI can be used to grade assignments and tests, freeing up teachers' time for other important tasks. This can also help ensure that grading is objective, consistent, and fair (Chen et al., 2020). Researchers are also interested in giving feedback by utilizing AI (Zawacki-Richter et al., 2019). Given the importance of feedback on student learning (Hattie, 2012), these approaches will encourage students to continue on their learning journey.

Predictive analytics can detect at-risk students, enable preventive measures, and significantly improve student success. By improving student success, predictive analytics help educational institutions' performance metrics (Alyahyan & Dustegor, 2020). Furthermore, AI can be used to analyse students' data and predict which students are falling behind or at risk of dropping out. This enables teachers to intervene early and provide the needed support to these students (Cardona et al., n.d.; Dalipi et al., 2018).

Virtual assistants are relatively new in education. These assistants can be useful both for teaching and learning by solving educational problems and completing routine tasks (Chocarro et al., 2023). AI-powered virtual assistants can help students with their homework and answer their questions. They can also provide personalized recommendations for more learning resources (Seo et al., 2021).

Challenges and Limitations

The potential of AI to solve the most pressing educational concerns and revolutionize teaching and learning has been discussed in the literature. However, these rapid advancements bring many risks and challenges. These risks and challenges include inclusion, equity, ethics, and transparency (UNESCO, 2021). Despite utilizing cutting-edge technologies, existing commercial AI tools are designed using behaviourist or instructionist approaches (Holmes et al., 2022).

Benefiting from the potential of AI in education is only possible if teachers effectively and efficiently use and familiarize themselves with these technologies. In order to see the development of AI in education a number of bibliometric studies have been conducted (Hinojo-Lucena et al., 2019; Prahani et al., 2022; Song & Wang, 2020; Talan, 2021). The field of AI in education has been the subject of extensive academic inquiry, aiming to chart its development, applications, and impacts on teaching and learning methodologies. There are numerous studies that provide an overview of AI in education. Wang and Wang (2020) reviewed 20 years of research development

on worldwide educational AI using bibliometric analysis. They have used the Scopus database for publication selection with the topic search terms "artificial intelligence", "machine intelligence", "machine learning", "deep learning", and "deep networks" along with "education". One of their key findings is the five core clusters of educational AI research namely, intelligent tutoring systems, learning system, student (student-centred learning), labelled training data, and pedagogy. In addition, they have conceptualized the development of AI in education as (1) technological foundation, (2) technological breakthrough, (3) intelligent application, (4) symbiotic integration. Zhang and Aslan (2021) reviewed 40 empirical studies published in 1993-2020 on AI technologies for education using content analysis, categorical meta-trends analysis, and bibliometrics. In this period, the most prolific countries were the USA, China, Türkiye, and Spain. AI was integrated in the following learning technologies; chatbots, expert systems, intelligent tutors/agents, personalized learning systems/environments, and visualizations. Authors have highlighted proven and potential benefits of these technologies for teaching and learning in each category such as chatbots increasing learners' interest and engagement.

Although these studies provided important findings, they were conducted before the impact of the generative AI wave such as ChatGPT, Bard, Claude, Dall-e, and Midjourney. Moreover, this present study is different from aforementioned studies because of the query terms used, query process, and how the filters are used during the query. In this respect, it is important to examine the studies on AI in education. From this perspective, this present study aims to reveal how AI studies have changed over the years, the issues addressed, and the points emphasized in these studies. Furthermore, this study can provide insights into how AI applications in education have evolved over time and help us understand the progress made in this field and the challenges that have been overcome. Identifying trends will provide valuable information about the direction in which the field is moving, which can be useful for researchers, educators, and policymakers. Also, recognizing influential authors and works provides a useful reference for those who are new to the field or those who are looking for authoritative sources on the subject.

The aim of this study is to examine the AI studies conducted in the field of education, to reveal the changes in these studies over the years, to determine the topics addressed with AI and the changes over the years, to determine the authors with the most publications and the publications cited. In short, the aim of this study is to reveal the trends of AI studies in education and guide future research on the subject.

Method

This study was designed as a systematic literature review. Systematic literature review studies are defined as a research methodology used to collect, identify, and critically analyse existing research in the literature (e.g., articles, conference proceedings, books, dissertations) with systematic methods and rules (Pati & Lorusso, 2018). To conduct this systematic review, the following steps were taken to ensure the validity and reliability of the data (Figure 1).

1. Data collection: This initial stage involves a comprehensive search of relevant databases to gather all potential sources of information. The search is conducted using specific keywords and inclusion/exclusion criteria to ensure that only the most relevant and high-quality literature was included in the review.

2. Data check and cleaning: After the data collection, a thorough check is conducted to remove any duplicates, correct any errors, and standardize the data entries. This step ensured that the data was clean and reliable for further analysis.

3. Data analysis: The cleaned data is then analysed using appropriate statistical methods. This involves studying the relationships between various scientific items, identifying trends, and interpreting patterns. The analysis was conducted in a systematic and unbiased manner to ensure the reliability of the findings.

4. Reporting findings: The results of the data analysis are then reported in a clear and concise manner. This includes a detailed discussion of the findings, highlighting the key trends and patterns identified in the data.

5. Results and discussion: Finally, the overall results of the study are discussed in the context of the existing literature. This involves interpreting the findings, discussing their implications, acknowledging the limitations of the study, and suggesting directions for future research.

By following these steps, this study aimed to provide a comprehensive and reliable overview of the existing literature on the chosen topic. The systematic approach ensured that the review was conducted in a transparent, replicable, and unbiased manner. This rigorous methodology forms the backbone of this systematic literature review, ensuring its validity and reliability.

Figure 1

Workflow of the Study

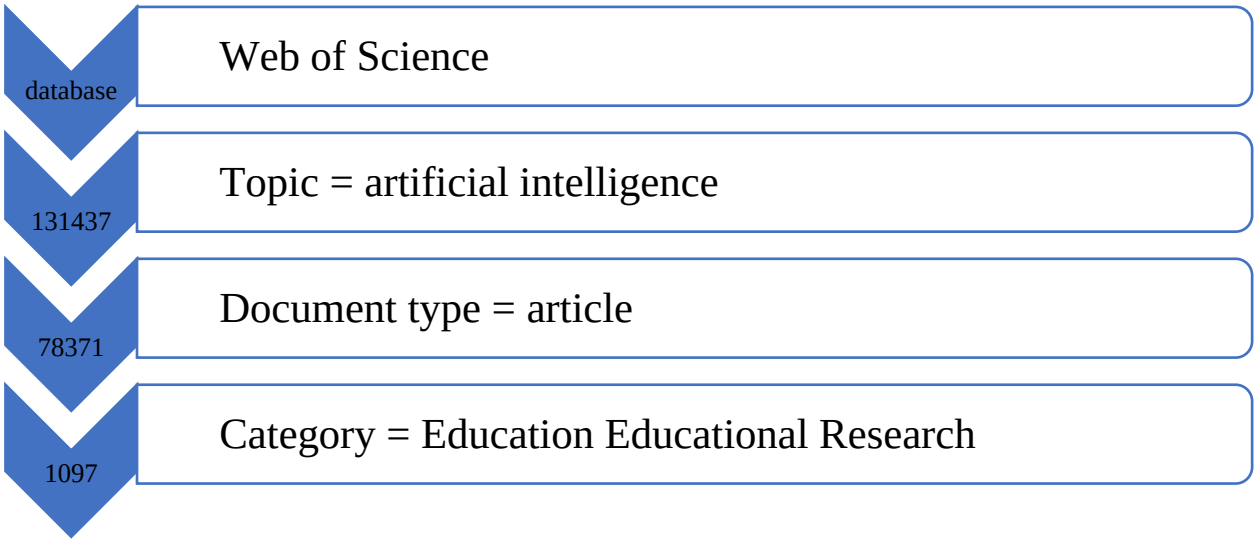
Data Collection

The Web of Science (WoS) database has been selected as the data source for this study since it is considered to contain the most cited and highest quality publications in international literature (Falagas et al., 2008; Harzing & Alakangas, 2016) and offers researchers the opportunity to download and analyse appropriate data to conduct systematic literature studies. Moreover, WoS is the world's oldest, most widely used and most influential data source (Birkle et al., 2020). For this purpose, the WoS database was used to search for "Topic ("Topic" search in the WoS database searches the "author keywords", "keyword plus", "title" and "abstract" fields of articles, papers, books, etc. in the WoS database) with the term "artificial intelligence". After the initial search "131437" articles were found. Then, the document type was selected as "article" and the number was reduced to "78371". Finally, "Education Educational Research" was selected from the WoS categories and "1097" articles related to AI in the field of education were found. The search was conducted in November 2023. The search process is given in Figure 2.

Data Check & Cleaning

Figure 2

Inclusion and exclusion criteria



To obtain more accurate and dependable results during bibliometric data analysis, it is essential to perform data cleaning (Donthu et al., 2021). This is because bibliometric data may contain errors such as duplicates, incorrect entries, and missing information. As bibliometric data is editable, it is examined to identify and minimize possible errors and duplications before analysis. In the current study, three types of errors were identified, including misspelling of author names, duplications of author names in different formats and duplications of author affiliations in different formats. To address these issues, the bibliometric data was checked, fixed, and cleaned by authors using text-editing software (like notepad++, sublimetext etc.).

Data Analysis

Bibliometric analysis was used to analyse the data obtained. Bibliometric analysis is an analysis technique that uses text-based data from scientific studies to evaluate global scientific knowledge production, characterize scientific research activities, and identify trends in specific scientific research areas (Linnenluecke et al., 2020). Bibliometrics is a powerful tool for understanding the landscape of a research field, identifying trends, and informing future research directions. It involves rigorous data collection, analysis, and interpretation processes to provide comprehensive insights into the research topic of interest (Ninkov et al., 2022). The bibliometric analysis of the data obtained was carried out using the pyBibX python library. pyBibX is a free Python library written in Python programming language that allows researchers to analyse the data of scientific publications (Pereira et al., 2023). The advantages of using pyBibX can be summarized as follows;

- Comprehensive functionality: pyBibX can perform various types of bibliometric analysis, such as exploratory data analysis, network analysis, and AI analysis, using state-of-the-art techniques and models. It can also handle data from multiple sources, such as Scopus, WoS, and PubMed, and merge them into a single dataset.
- Visual appeal: pyBibX can generate visually appealing and informative graphics to illustrate the results of the analysis, such as word-clouds, n-grams, evolution plots, Sankey diagrams, bar plots, citation networks, collaboration networks, similarity networks, and world map collaboration networks. This library provides graphics (stacked bar graphics such as most frequent words, most cited articles) that are not available in other bibliometrics analysis software.
- Artificial intelligence integration: pyBibX can leverage advanced AI capabilities, such as embedding vectors, topic modelling, text summarization, and general NLP tasks, to enhance the accuracy and efficiency of bibliometric analysis. It can also interact with generative AI tools.

Findings

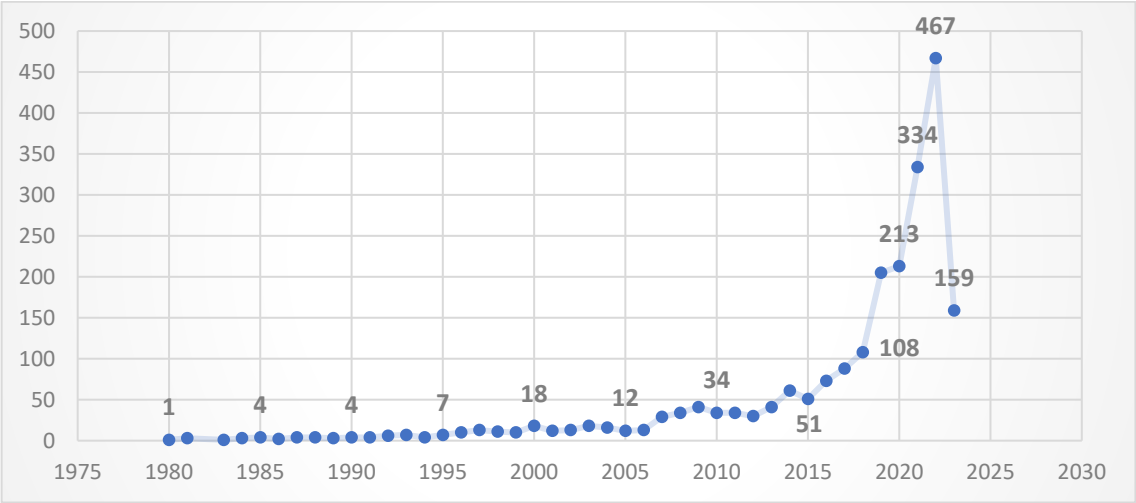
Bibliometric analyses can be classified as performance analyses and science mappings. Performance analyses cover metrics related to publications, while science mappings include analyses related to citations and network analyses such as centrality and clustering analyses (Donthu et al., 2021).

Performance Analysis

The topic "artificial intelligence" in the field of educational sciences has a history of more than 40 years, dating back to 1980. Between 1980 and 2023, there have been a total of 1164 publications that fulfil the search criteria. While the average number of publications per year is 29.85, there has been a noticeable increase in the number of publications in the last five years. The highest number of publications (467) was made in 2022. However, since the search from the WoS database for data collection was made in November 2023, a decrease was observed in the graph. The possible reason for this decrease is that not all publications in 2023 were published in that year. In 1980 and 1983, there was only one publication, and the number of publications per year was at most 10 for the first 15 years of AI in education. The change in the number of publications over the years is given in Figure 3.

Figure 3

Number of Publications per Year



The articles originate from 88 different countries, showing the worldwide interest in AI in education. However, most of the articles have been published in English (1074), which suggests that the lingua franca is English for AI in education. Spanish follows with 51 articles, Russian with 10, and Portuguese with 8.

In terms of the number of authors contributing to these publications, a cumulative total of 3053 authors was found. Furthermore, these publications collectively received 8127 citations as of the search date, reflecting an average of nearly 8 citations per publication. When the journals of the publications are examined, it is seen that those journals focusing on the theme of technology published the most. Education and Information Technologies (74), International Journal of Emerging Technologies in Learning (59), British Journal of Educational Technology (42), and Educational Technology Society (41) were found to have the highest number of publications. Other journals in the top ten are given in Table 1.

Table 1

Journals and Number of Publications

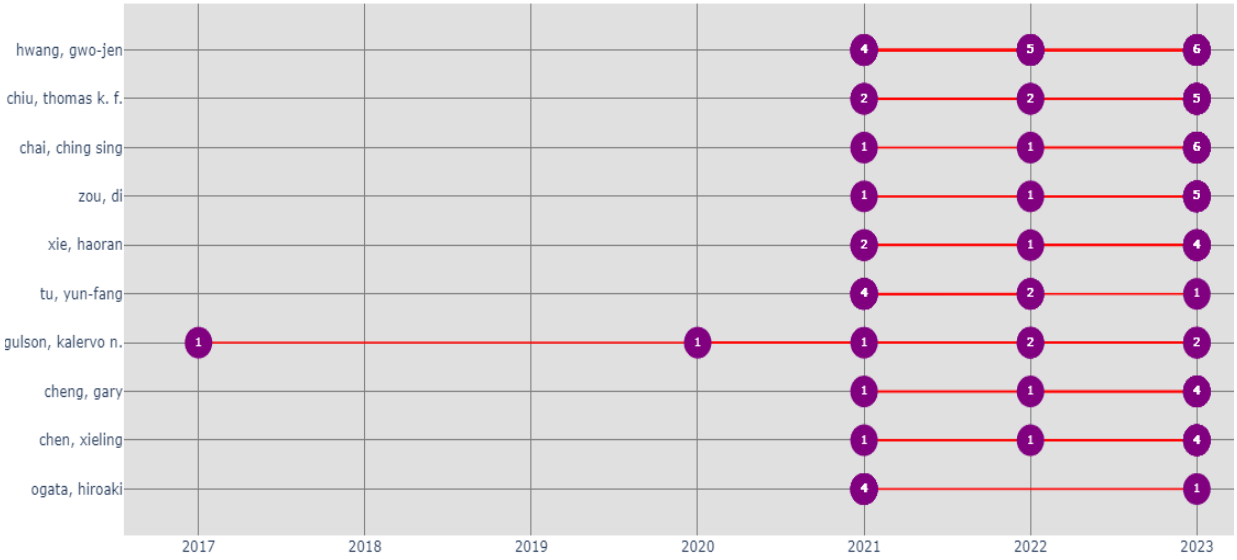
Journal Title	Number of Articles
Education and Information Technologies	74
International Journal of Emerging Technologies in Learning	59

British Journal of Educational Technology	42
Educational Technology Society	41
Interactive Learning Environments	38
Computers and Education	33
Education Sciences	31
Frontiers in Education	22
IEEE Transactions on Learning Technologies	21
International Journal of Educational Technology in Higher Education	19

When we examine the authors with the highest number of publications, we come across authors of Asian origin, such as Taiwan, China, and Hong Kong, who have risen to the top by publishing in recent years. The most published authors are Gwo-Jen Hwang, Thomas K. F. Chiu, Haoran Xie, Di Zou, and Xielling Chen, respectively. The top ten authors and their publication years are given in Figure 4.

Figure 4

Top 10 Published Authors on AI in Education

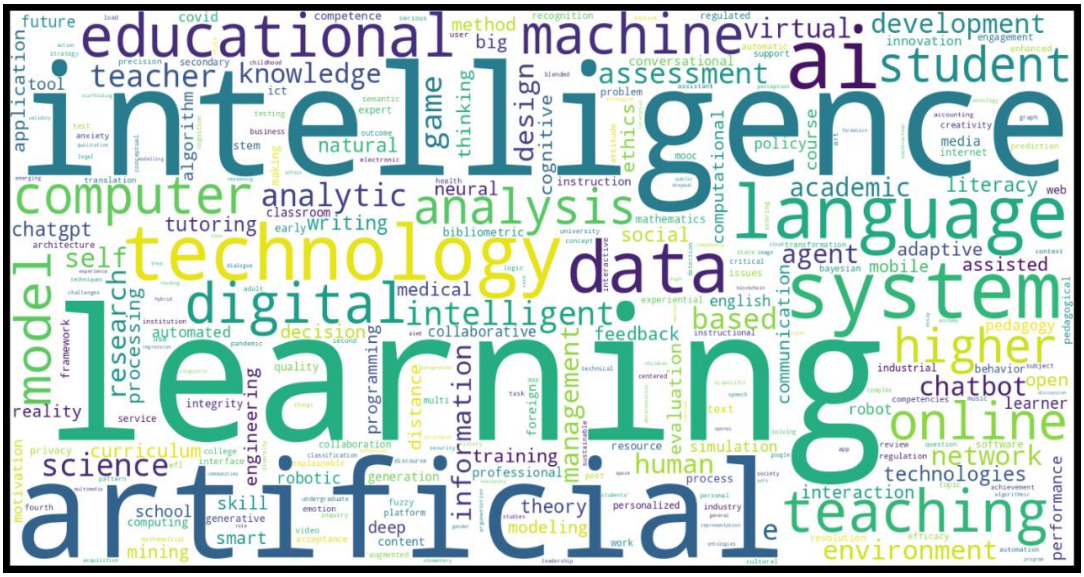


When the word frequencies in the authors' abstracts are analysed, it becomes evident that the theme of learning has been particularly emphasized in recent years. While the terms 'artificial' and 'intelligence' consistently ranked among the top three, as they were used as keywords in the search, the term 'learning' stood out by appearing 2583 times in the abstracts, surpassing all other

words. Moreover, when closely examining the frequently recurring terms, it becomes apparent that efforts are being made to develop intelligent tutoring systems and other educational technologies using AI. The word cloud generated from the abstracts and the words with the highest frequency are given in Figure 5.

Figure 5

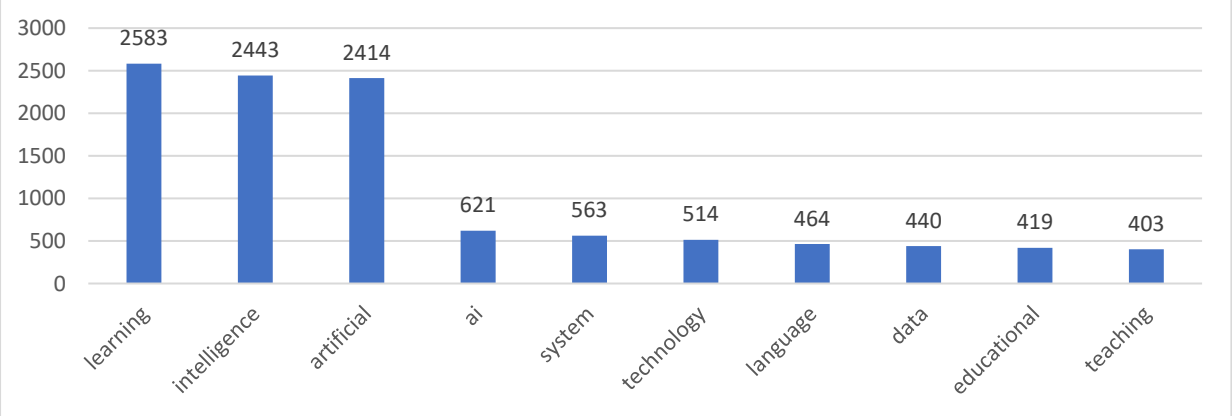
Top 10 Word cloud of the Abstracts



Parameters used in creating word clouds can affect the final representations of the words. So, in order to see the frequencies more clearly, a bar graph (Figure 6) is given for the most common 10 words.

Figure 6

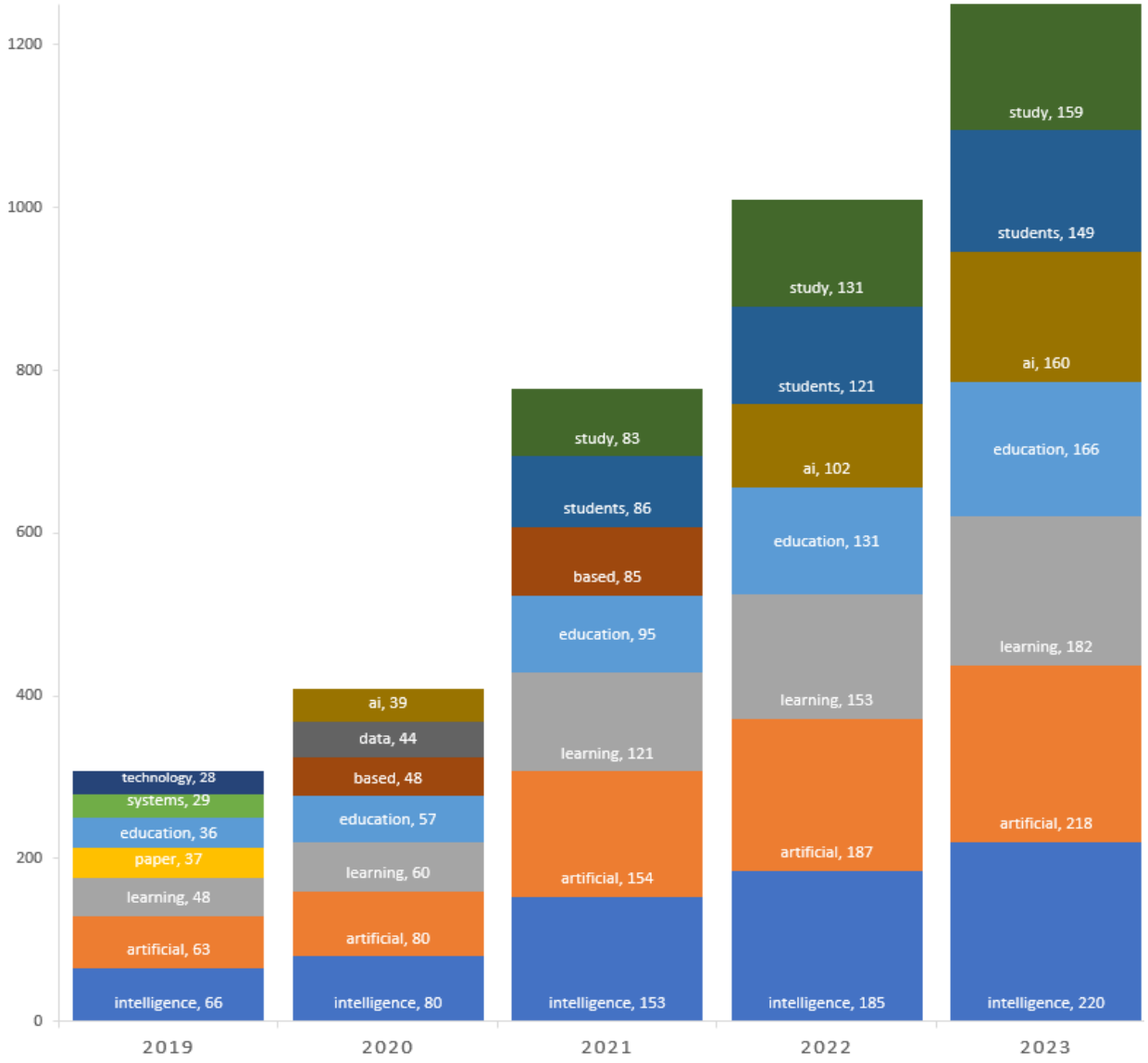
Top 10 Most Used Words in the Abstracts



When the word frequencies in the abstracts are re-evaluated, considering the growth of publications in recent years, it becomes evident that the words "learning" and "student" are used more frequently, reflecting increased attention to these aspects in current research. An analysis of Figure 7, which displays the most frequently used words for the last five years, underscores the prominence of 'student' and 'learning'.

Figure 7

Top 10 Most Frequent Words for the Last Five Years

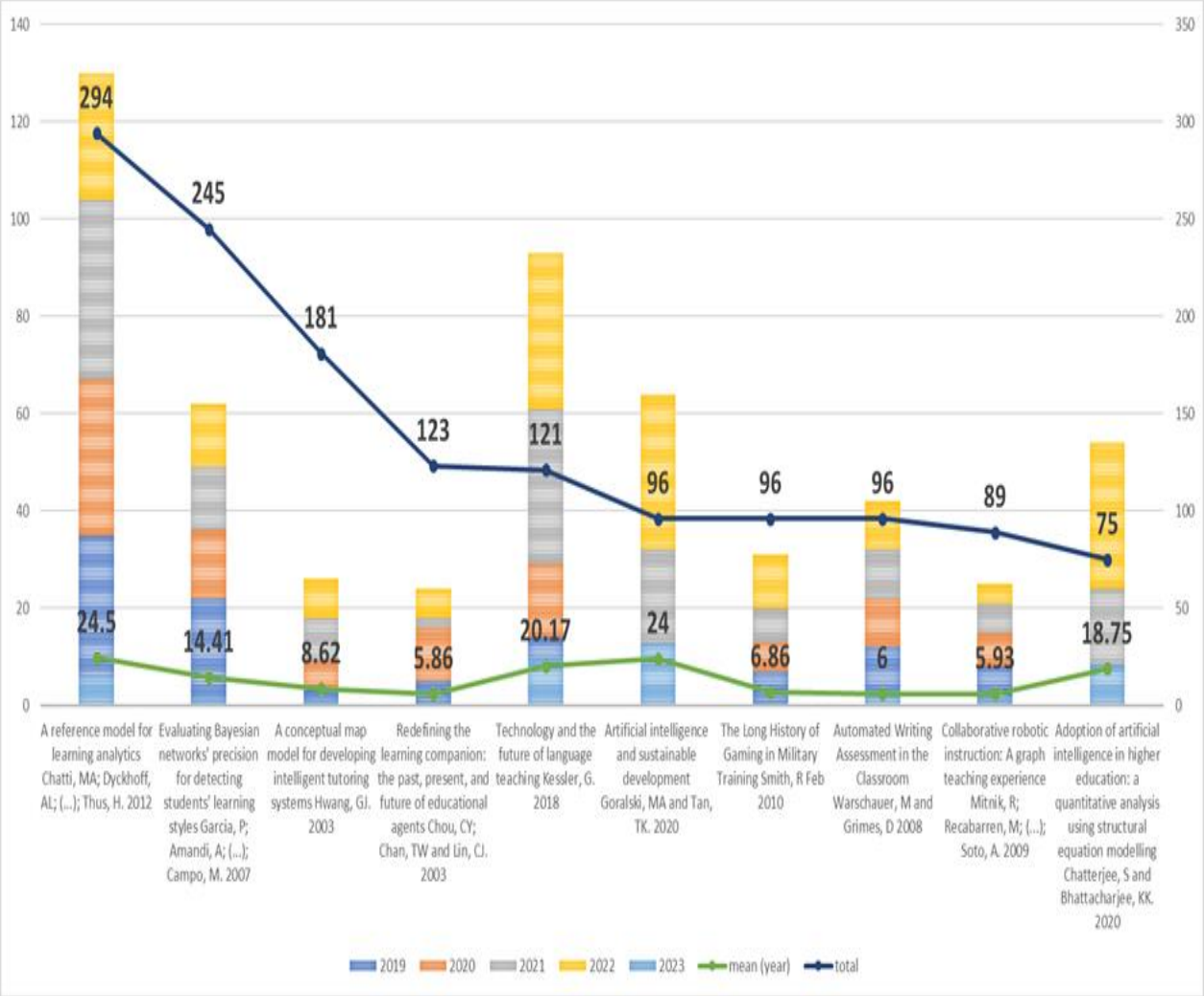


In order to examine the top ten most cited articles in the search results more closely, a figure of the citations to these articles in the last five years was created (Figure 8). The article "A reference model for learning analytics", which ranks first with the total number of citations, was published in 2012, the year of the emergence of learning analytics, and proposes a reference model for learning analytics. "Evaluating Bayesian networks' precision for detecting students' learning styles" and "A conceptual map model for developing intelligent tutoring systems", which are ranked second and third according to the total number of citations, similarly create models or enable future studies by comparing existing methods. However, among these top 10 articles, the most noteworthy studies on "artificial intelligence" are "Artificial Intelligence and sustainable development" and "Adoption of Artificial Intelligence in higher education: a quantitative analysis using structural equation modelling". Although, as of 2023, they are behind in the total number of citations, they will probably catch others in the future with their average citation numbers of 24 and 18.75 per

year, respectively. Furthermore, considering that the first-ranked articles do not directly pertain to AI, it would be more suitable to follow these two publications and their authors.

Figure 8

Top 10 Most Cited Articles



Results and Discussions

This study aimed to identify the most active journals, authors, and most cited articles to guide future research on the subject of AI in education. For the future of societies, students, future business leaders, and policymakers need to be educated in AI (Goralski & Tan, 2020). These requirements led researchers to utilize the rapid advancement of computer technology and develop computer-assisted instructional systems that adopt AI (Hwang, 2003). AI is used for many different purposes and methods in education. For example, it is utilized in learning analytics, which enables the development of methods that utilize educational datasets to support the learning process (Chatti et al., 2012). It is also used in the individualization of teaching in determining the individual characteristics of students, such as learning preferences (García et al., 2007).

While the number of studies on AI in education has shown substantial growth in recent years, it is noteworthy that research in this field has a history spanning more than four decades, with a consistent increase in the number of studies over time. This remarkable surge of interest in AI related studies has been documented in the existing literature (Chen et al., 2020; Chen et al., 2021; Chng et al., 2023; Hinojo-Lucena et al., 2019; Zawacki-Richter et al., 2019). However, these studies only examined research conducted until 2019. In our review, we observed a further acceleration in the growth of publications on this topic.

When the studies of the authors who published the most publications were analysed, it was seen that these studies were published in the last three years. This suggests significant advancements in AI over recent years (Lund et al., 2023; Minh et al., 2022). In addition, this increase can be attributed to the increased use of AI in applications such as online learning and web-based learning (Peng et al., 2022). In particular, with the impact of the COVID-19 pandemic, when face-to-face education was not an option and distance education was mandatory, technology-enabled alternatives, including AI, have been studied in education (Treve, 2021). This result is supported when keywords used in the publications have been examined. It was seen that keywords such as covid and pandemic are used in the studies of the years in question.

It was seen that 94% of the studies in this field were published in English, even if they were conducted in different countries. This is to be expected when we consider the fact that major academic journals in education are published in English. This situation can be taken into consideration by researchers when conducting resource research and writing articles in studies to be conducted in this field.

On the other hand, when the keywords used in AI studies in education are examined in general, it is seen that the words "student" and "learning" are mostly used. This can be interpreted as studies focusing on learning and putting the student at the centre of AI studies in education.

Based on these results it can be suggested that student-centred AI applications are a critical aspect of modern education. By enhancing AI technologies that prioritize students' individual learning needs, we can provide personalized educational experiences that cater to each student's unique strengths and weaknesses. However, it is equally important to foster ethical considerations in the development and application of these technologies. After every new development in the field of AI there is a considerable jump in the amount of research that primarily focuses on that specific development. However, the importance of supporting ongoing research into the long-term impact of AI in education should not be forgotten. More research should investigate the long-term effects

of AI on student learning outcomes, cognitive development, and the overall educational experience. Although most of the publications are from a limited number of countries and mostly in English, fostering interdisciplinary collaborations can serve as a powerful driver of innovation in this field. Collaboration between education researchers, AI experts, and policymakers can lead to the development of ethically sound AI solutions for educational settings.

In conclusion, this study has helped identify research directions for the emerging topic of AI in education by providing an overview of the publications available in WoS database. Key authors and prominent journals have been identified so that interested readers may follow the work of these key contributors. The other important finding of this study is the growing focus on student learning and ethical considerations of the applications of AI. Although some key trends have been observed and the research direction is clarified, a more in-depth review of the subject for better comprehensive coverage is required because of the limitations of bibliometric analysis. One of the important limitations is the possibility of missing out on important publications that are available on different databases and/or publications that do not contain the search strings in the respective search fields.

Ethics Committee Permission Information: Since the research presented here involves a systematic review of existing documents, it falls under the category of exempt research, and therefore, ethics committee approval was not required.

Author Conflict of Interest Information: The author declares that there is no conflict of interest with any institution or person within the scope of the study.

Statement of Contribution Rate: The authors declare that they have made equal contributions to the article.

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Geniş Özet

Problem Durumu

Özellikle son yıllarda yapay zekâ alanında meydana gelen önemli gelişmelerle birlikte yapay zekânın kullanım alanının ve sıklığının arttığı görülmektedir. Birçok otoriteye göre yapay zekâ, eğitimde devrim yaratma potansiyeline sahip, hızla gelişen bir teknolojidir. Eğitimde yapay zekâ, öğretim kalitesini artırmaya yardımcı olabilecek güçlü pedagojik araçlar sunmaktadır. Yapay zekâyı eğitimde kullanmanın temel amacı, öğrencilerin öğrenme deneyimlerini etkili ve verimli yollarla geliştirmektir. Yapay zekânın eğitime potansiyel faydaları kısaca şu başlıklarla incelenebilir; kişiselleştirilmiş öğrenme, akıllı özel dersler, otomatik not verme ve değerlendirme, tahmine dayalı analitik, sanal asistanlar.

Yapay zekânın eğitime sağlayacağı bu gibi katkılardan faydalanmak ancak eğitimdeki paydaşların bu teknolojileri etkili ve verimli bir şekilde kullanması ile mümkün olabilir. Eğitimde yapay zekâ ile ilgili yapılan çalışmaların incelenmesi bu bakımdan önemlidir. Bu bakış açısından yapay zekâ çalışmalarının yıllar içinde nasıl değiştiği, bu çalışmalarda ele alınan konuların neler olduğu ve vurgulanan noktaların neler olduğunun ortaya konulması alanyazına katkı sunacaktır.

Bu çalışmanın amacı, eğitim alanında yapılmış yapay zekâ çalışmalarını inceleyerek bu çalışmaların yıllar içinde değişimini ortaya koymak, yapay zekâ ile birlikte ele alınan konuları belirleme ve yıllar içindeki değişimini ortaya koymak, en çok yayın yapan yazarlar ile atıf yapılan yayınları belirlemektir. Kısacası bu çalışmanın amacı eğitimde yapılan yapay zekâ çalışmalarının eğilimlerini ortaya koymaktır.

Yöntem

Bu çalışma sistematik literatür taraması olarak tasarlanmıştır. Sistematik literatür taraması çalışmaları, alanyazında var olan mevcut araştırmaları (örneğin, makaleler, konferans bildirileri, kitaplar, tezler) sistematik yöntem ve kurallar ile toplamak, tanımlamak ve eleştirel olarak analiz etmek için kullanılan bir araştırma metodolojisi olarak tanımlanmaktadır. Bu çalışmada uluslararası alanyazında en çok atıf alan ve kaliteli yayınların yer aldığı kabul edilen; araştırmacılara sistematik literatür çalışması yapabilmek için uygun verileri indirme ve analiz etme imkanı sunan Web of Science veritabanında sorgulama yapılması araştırmacılar tarafından tercih edilmiştir. Bu amaca yönelik olarak Web of Science (WoS) veritabanı kullanılarak "artificial intelligence" terimi ile “Topic” (WoS veritabanında “Topic” araması aranan kelimelerin WoS veritabanında yer alan makale, bildiri, kitap vb. dokümanların “author keywords”, “keyword plus”, “title” ve “abstract” alanlarında arama yapmaktadır) araması yapılmıştır. İlk arama sonucunda “131437” makaleye ulaşılmıştır. Daha sonra doküman türü “makale” olarak seçilmiş ve sayı “78371”e düşürülmüştür. Son olarak Web of Science kategorilerinden “Education Educational Research” seçilerek eğitim alanında yapay zekâ ile ilgili gerçekleştirilen “1097” makale verisi edinilmiştir.

Elde edilen veriler bibliyometrik analiz ile incelenmiştir. Bibliyometrik analiz, küresel bilimsel bilgi üretimini değerlendirmek, bilimsel araştırma faaliyetlerini karakterize etmek ve belirli bilimsel araştırma alanlarındaki eğilimleri belirlemek için bilimsel çalışmaların metin tabanlı verilerini kullanan bir analiz tekniğidir. Elde edilen verilerin bibliyometrik analizi pyBibX python kütüphanesi kullanılarak gerçekleştirilmiştir. pyBibX, araştırmacıların bilimsel yayınların

verilerini analiz etmesine olanak tanıyan Python programlama dilinde yazılmış ücretsiz bir Python kütüphanesidir.

Bulgular

Eğitim bilimlerinde "yapay zekâ" konusu, 1980 yılına kadar uzanan 40 yılı aşkın bir geçmişe sahiptir. 1980 ile 2023 yılları arasında arama kriterlerini karşılayan toplam 1164 yayın yapılmıştır. Yıllık ortalama yayın sayısı 29,85 iken, son beş yılda yayın sayısında önemli bir artış olmuştur. En yüksek yayın sayısı (467) 2022 yılında elde edilmiştir. 1980 ve 1983 yıllarında sadece bir yayın yapılmış ve eğitimde yapay zekânın ilk 15 yılında yıllık yayın sayısı 10'u geçmemiştir.

Makaleler 88 farklı ülkeden yazarlar tarafından kaleme alınmıştır. Bununla birlikte, makalelerin çoğu İngilizce olarak yayınlanmıştır (1074 / 1097). İngilizceyi 51 makale ile İspanyolca, 10 makale ile Rusça ve 8 makale ile Portekizce takip etmektedir. Yayınlara katkıda bulunan yazarların toplam sayısı 3053 olarak elde edilmiştir. Ayrıca, bu yayınlar arama tarihi itibariyle toplam 8127 atıf almıştır ve yayın başına yaklaşık 8 atıf ortalaması yakalanmıştır.

Yayınların dergileri incelendiğinde, teknoloji temasına odaklanan dergilerin ilk sırada yer aldığı görülmektedir. Education and Information Technologies (74), International Journal of Emerging Technologies in Learning (59), British Journal of Educational Technology (42), Educational Technology Society (41) en fazla yayına sahip dergiler olarak tespit edilmiştir. En çok yayın yapan yazarları incelediğimizde, son yıllarda yayın yaparak zirveye yükselen Tayvan, Çin ve Hong Kong gibi Asya kökenli yazarlarla karşılaşılmaktadır. En çok yayın yapan yazarlar sırasıyla Gwo-Jen Hwang, Thomas K. F. Chiu, Haoran Xie, Di Zou, Xielling Chen'dir.

Yazarların özetlerindeki kelime frekansları incelendiğinde, öğrenme temasının son yıllarda özellikle vurgulandığı ortaya çıkmaktadır. 'Yapay' ve ' zekâ' terimleri sorgularda anahtar kelime olarak kullanıldıkları için ilk sıralarda yer alırken, 'öğrenme' terimi özetlerde 2583 kez geçerek diğer tüm kelimeleri geride bırakmıştır.

Arama sonuçlarında en çok atıf alan ilk on makaleyi daha yakından inceleyebilmek için bu makalelere son beş yılda yapılan atıflar incelenmiştir. Toplam atıf sayısı ile ilk sırada yer alan "A reference model for learning analytics" makalesi, öğrenme analitiğinin ortaya çıkış yılı olan 2012'de yayınlanmış ve öğrenme analitiği için bir referans model önermektedir. Toplam atıf sayısına göre ikinci ve üçüncü sırada yer alan "Evaluating Bayesian networks' precision for detecting students' learning styles" ve "A conceptual map model for developing intelligent tutoring systems" makaleleri de benzer şekilde model oluşturmakta ya da mevcut yöntemleri karşılaştırarak gelecek çalışmalara olanak sağlamaktadır. Ancak bu ilk 10 makale arasında "yapay zekâ" konusunda en dikkat çekici çalışmalar "Artificial Intelligence and sustainable development" ve "Adoption of Artificial Intelligence in higher education: a quantitative analysis using structural equation modelling" çalışmalarıdır. Her ne kadar 2023 yılı itibariyle toplam atıf sayısında geride olsalar da, sırasıyla yıllık ortalama 24 ve 18,75 atıf sayılarıyla diğerlerine yaklaşmaktadır.

Sonuç ve Tartışma

Toplumların geleceği için öğrencilerin, geleceğin iş liderlerinin ve politika yapıcıların yapay zekâ konusunda eğitilmesi gerekmektedir. Bu çalışma, eğitimde yapay zekâ konusunda gelecekteki araştırmalara rehberlik etmek için alandaki eğilimlerin belirlenmesini amaçlamaktadır. Bu amaç için en aktif dergiler, yazarlar ve en çok atıf alan makaleler belirlenmiştir.

Eğitimde yapay üzerine yapılan çalışmaların sayısı son yıllarda önemli bir artış göstermiş olsa da, bu alandaki araştırmaların kırk yılı aşkın bir geçmişe sahip olduğu ve zaman içinde çalışma sayısında istikrarlı bir artış olduğu dikkat çekmektedir. Yapay zekâ ile ilgili çalışmalara yönelik bu kayda değer ilgi artışı, alanyazında tartışılmaktadır. Bu çalışmada 2019 yılından sonraki yayınlar da incelemeye dahil edilerek güncel bir inceleme gerçekleştirilmiştir.

En çok yayın yapan yazarların çalışmaları incelendiğinde, bu çalışmaların son üç yıl içinde yayınlandığı görülmüştür. Bu durum, son yıllarda yapay zekâ alanında önemli ilerlemeler kaydedildiğini göstermektedir. Ayrıca bu artış, çevrimiçi öğrenme ve web tabanlı öğrenme gibi uygulamalarda yapay zekâ kullanımının artmasına da bağlanabilir. Özellikle Covid19 pandemisinin etkisiyle, yüz yüze eğitimin bir seçenek olmadığı ve uzaktan eğitimin zorunlu olduğu zamanlarda, eğitimde yapay zekâ dahil olmak üzere teknoloji destekli alternatifler üzerinde çalışılmıştır. Yayınlarda kullanılan anahtar kelimeler incelendiğinde bu sonuç desteklenmektedir. Söz konusu yıllara ait çalışmalarda covid ve pandemi gibi anahtar kelimelerin kullanıldığı görülmüştür.

Bu alandaki çalışmaların %94'ünün, farklı ülkelerde yapılmış olsalar bile, İngilizce yayınlandığı görülmüştür. Bu durum araştırmacılar tarafından bu alanda yapılacak çalışmalarda kaynak araştırması yapılırken ve makale yazılırken dikkate alınabilir. Öte yandan, eğitimde yapay zekâ çalışmalarında kullanılan anahtar kelimeler genel olarak incelendiğinde en çok "öğrenci" ve "öğrenme" kelimelerinin kullanıldığı görülmektedir. Bu durum, eğitimde yapay zekâ çalışmalarında öğrenmeye odaklanan ve öğrenciyi merkeze alan çalışmalar yapıldığı şeklinde yorumlanabilir.

Sonuç olarak, bu çalışma, web of science veri tabanında bulunan yayınlara genel bir bakış sağlayarak eğitimde yükselişe geçen yapay zekâ konusu için araştırma eğilimlerinin belirlenmesine katkı sağlamıştır. İlgili okuyucuların alana önemli katkılar sunan yazarların çalışmalarını takip edebilmeleri için yazarlar ve önde gelen dergiler belirlenmiştir. Çalışmanın bir diğer önemli bulgusu, öğrencilerin öğrenmesine ve yapay zekâ uygulamalarının etik hususlarına giderek daha fazla odaklanılmasıdır. Çalışmanın sınırlılıklarından biri farklı veri tabanlarında yer alan önemli yayınların ve/veya ilgili arama alanlarında sorguda yer alan kelimeleri içermeyen yayınların gözden kaçırılma olasılığıdır. Bu nedenle konuya yönelik farklı veri tabanlarında derinlemesine incelemeler gerçekleştirilebilir.