SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2024
ORGANIZATION AND MANAGEMENT SERIES NO. 195

# THE ROLE OF ARTIFICIAL INTELLIGENCE IN DIGITAL EDUCATION

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**Purpose:** The article presents a bibliometric analysis of studies in the artificial intelligence field, with the principal source of scientific articles selected being the academic platform Scopus.
**Design/methodology/approach:** The content of 3365 open access research articles has been taken into consideration from 2019 and 2024 years. The search documents related to "artifical intelligence" "in" "education" issue in title, abstract and keywords. The analysis was performed using the VosWiever program.
**Findings:** The study showed that AI assesses students' skills and requirements using machine learning, and then utilizes the findings of that analysis to develop and disseminate personalized or tailored information that improves learning via increased retention and uptake. AI improves learning for students by providing them with possibilities for experiential or hands-on learning, particularly when paired with other technologies like virtual reality, 3-D, gaming, and simulation.
**Research limitations/implications**: The first limitation of the study is a result of the papers and reviews that were selected that deal with artificial intelligence. Since a broad variety of scientific fields are included in the field of artificial intelligence, findings may vary if publications from other domains are completely taken into account. Consequently, one should use extreme caution when extrapolating the study's conclusions to the vast domain of artificial intelligence. Another limitation is the research timeline (2019-2024); future results may vary since we anticipate that new topics, concepts, and techniques will emerge in the expanding field of artificial intelligence, which will significantly change the outcomes of our study. Finally, since the study's data came from Scopus, it's possible that this research is impacted by some of Scopus's restrictions.
**Practical implications:** The manuscript can be a guide for universities on what students need for AI as well as how to improve the didactic process.
**Originality/value:** Manuscript fills the gap in the analysis of what is the main role of AI in the education area from the student life-cycle and university effectiveness.
**Keywords:** digitalization, education, artifical intelligence, Wosviewer analysis.

> The real power that AI brings to education is connecting our learning intelligently to make us smarter in the way we understand ourselves, the world and how we teach and learn. For the first time we will be able to extend, develop and measure the complexity of human intelligence – an intellect that is more sophisticated than any AI. This will revolutionise the way we think about human intelligence.
> *Luckin, Holmes, 2016*

## 1. Introduction

The educational process may be enhanced by digital technologies like artificial intelligence (AI), the Internet of Things (IoT), and other developments in information and computer technology (ICT) (OECD Education Working Papers, 2024; Rosak-Szyrocka et al., 2022b; Santos et al., 2022). "Artificial Intelligence" (AI) is being pushed as a means of enhancing education via more individualized, adaptable, inclusive, and captivating learning when it comes to the abundance of real-time data (Big Data) (Bhutoria, 2022; Halagatti et al.). Governments, the education sector, and technology organizations have been investigating the introduction of AI tools and platforms to deliver educational system monitoring that is more effective (with timely, accurate, and informative indicators) and efficient (with less administrative burden) than in the current educational system in order to realize these benefits (Rosak-Szyrocka, 2024). "The ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings" is the definition of artificial intelligence (Vries, Bliznyuk, Pinedo, 2023). Artificial Intelligence in Education is one of the newest areas of educational technology, according to several worldwide studies (Zawacki-Richter et al., 2019; Rosak-Szyrocka et al., 2024; Rosak-Szyrocka et al., 2022a). "Computers which perform cognitive tasks, usually associated with human minds, particularly learning and problem-solving" is the broad definition of artificial intelligence (Baker et al., 2010). They clarify that the term AI does not refer to a particular technology. It's a catch-all word for a variety of tools and techniques, including algorithms, machine learning, data mining, neural networks, and natural language processing. Intelligent virtual reality, intelligent assistance for collaborative learning, and personal tutors are the three types of AI software solutions in education that are now accessible (Holmes et al., 2022; Luckin, Holmes, 2016).

In order to select the most relevant studies in the artifical intelligence field, bibliometric analysis was used, with the principal source of scientific articles selected being the academic platform Scopus. The content of 3365 open access research articles has been taken into consideration from 2019 and 2024 years. The search documents related to “artifical intelligence” “in” “education” issue in title, abstract and keywords. In order to highlight the structure of the scientific field a content analysis was used, inspecting the most common words and the relationships between words. Additionally, a network of co-occurrences was taken into

account. The analysis was performed using the VosWiever program. Manuscript main aim is to respond to the following main research question by exploring the valuable information the world's clouds provided:

1. Which are the most common all keywords found in the full scientific articles on artificial intelligence in education?
2. What are main key words used by authors?
3. What does network visualization look like between co-authorships network and countries? There are many studies on artificial intelligence (Abduljabbar et al., 2019) but they usually concern the challenges or opportunities that existed before this term (Bholat, Susskind, 2021; Hwang et al., 2020; Luckin, 2017; Navarro-Espinosa et al., 2022; Alam, 2021; Abulibdeh, Zaidan, Abulibdeh, 2024; Mao, Chen, Liu 2024), applications (Venkateswaran et al.; Suresh Babu, Dhakshina Moorthy, 2024; Techniques and applications…, 2024) or ethics aspect (Mhlanga, 2023; Abulibdeh, Zaidan, Abulibdeh, 2024). Some recent relevant studies concerning issues related to AI are summarized in Table 1. The manuscript fills the research gap because it analyzes the issue AI from the perspective of education nowaday and its future. Therefore, the study is novel.

**Table 1.**
*Chosen studies concerning issues related to AI*

| Author(s) and year | Methods | Analysis aspects |
|---|---|---|
| (Hinojo-Lucena et al., 2019) | A bibliometric study of 132 scholarly works on artificial intelligence in higher education that were indexed between 2007 and 2017 in the Web of Science and Scopus databases. | The aim of this study is to examine the current state of production, examine the correlation between the quantity of authors and publications, and identify the primary sources, authors, organizations, and nations that have produced the most scientific research on artificial intelligence in higher education. |
| (Garg, 2020) | Position paper: guidelines for medical educators to ensure appropriate AI preparation. | To assist medical educators prepare for the new opportunities and demands, this section will outline the general ideas of artificial intelligence (AI), discuss how AI is affecting medicine, and highlight how AI directly affects the style and content of medical education. |
| (Zhai et al., 2021) | A total of 100 publications were chosen from the Social Sciences Citation Index database's education and educational research category between 2010 and 2020. Of these, 63 empirical papers (74 studies) and 37 analytical papers were included. | The study offered a content analysis of research papers with the goal of revealing the ways in which artificial intelligence (AI) has been used in the field of education and investigating future directions and obstacles in AI research in this field. |
| (Sanusi et al., 2022) | A total of 605 students contributed insightful answers to the WarpLS software study. In order to comprehend the link between the chosen variables used in the research, structural equation modeling was done. | Using data from Nigerian secondary school pupils, the study looks at the competences needed to be literate in artificial intelligence while taking gender variance and school ownership type into account. |

Cont. table 1.

| | | |
|---|---|---|
| (Roopal Shrivastava, 2023) | Five-fold Cross-Validation with 206 students from Delhi NCR and outside is beneficial for the classification algorithms SVM, Naive Bayes, and Random Forest. | A study looks at how, over the last 150 years, globalization has drastically changed human civilization. The study evaluates existing literature and makes predictions about the near future of artificial intelligence and education (AIED) research based on three applications of educational process models. |
| (Ivanashko et al., 2024) | The research combined quantitative (survey and statistical analysis) and qualitative (interviews, focus groups, and classroom observations) methodologies. Every study process was set up in accordance with the moral guidelines for gathering and analyzing data. In order to provide a thorough overview of the research subject and assess it from many angles, more than fifty contemporary scientific papers were chosen. 56 individuals, who represented teachers from various Ukrainian higher education institutions, participated in the research. | The study's objective is to characterize artificial intelligence's place in education by examining its advantages and disadvantages. |

Source: own study.

## 2. Literature review

Over the last ten years, one of the key forces behind innovation in classroom instruction has been digitalization (Vincent-Lancrin et al., 2019). The majority of innovation has been on using computers and the internet more in the classroom, but the next wave will be centered on artificial intelligence (AI) or on combining AI with other technologies. Numerous economic areas, including finance (Bholat, Susskind, 2021), healthcare (Eggmann et al., 2023; Yu, Beam, Kohane, 2018), and transportation (Abduljabbar et al., 2019; Wu et al., 2022). The International Journal of Artificial Intelligence in Education was first published in 1989, and the International AI in Education Society (IAIED) was founded in 1993, indicating that "AI in education" has been a cohesive area of academic study at least since the 1980s. The AI Group of Experts at the OECD described an artificial intelligence (AI) system in 2019 as a machine-based system that can make predictions, suggestions, or judgments impacting actual or virtual environments for a specified set of human-defined goals. Different degrees of autonomy are built into AI systems. Phases of an AI system's lifespan include: 1) planning and design, gathering and analyzing data, and creating and interpreting models; 2) validation and verification; 3) deployment; and 4) operation and monitoring (Artificial intelligence in society, 2019). Machine learning (ML), which is defined as a collection of methods that enable computers to learn automatically via patterns and inferences rather than through explicit

instructions from a human, is one of the most promising AI approaches. The "neural network" technology, which powers machine learning, is made possible by advances in computing power and the availability of large datasets, or "big data" (OECD skills…, 2019). Applications for language learning in education, for instance, depend on ML. The idea that AI offers strategic relevance for education has gained traction (Seldon, Abidoye, 2018; Loeckx, 2016; Gruševá, Blašková, 2022).

According to Loeckx, artificial intelligence (AI) has the potential to be a useful teaching tool that relieves instructors of some of their workload while providing students with engaging learning opportunities. There are many of chances for the development of AI applications in education, especially when combined with contemporary educational reforms like gamification, digitization of instructional materials, and tailored learning experiences. For instance, by using intelligent tutoring systems (ITS) to create personalized learning environments in place of a teacher shortage, the modeling capability of AI approaches has been methodically used to create reactive and adaptable tutorials (Du Boulay, 2016). ITSs provide individualized learning experiences via four primary methods: keeping an eye on students' input, assigning activities that are suitable, giving constructive criticism, and using interfaces for human-computer interaction (Seldon, Abidoye, 2018). The goal of modern artificial intelligence (AI) is not to create computational "superintelligences" or "strong AI," but rather to build machines that can learn from their own mistakes, adapt to their environments and purposes, enhance their own performance, create new algorithms, make predictions, and perform automated tasks without the need for human supervision or control (Alpaydin, 2021; Mackenzie, 2017). It is possible to replicate one-on-one private tuition using intelligent tutoring technologies. They may decide which material to choose for a student's learning route, give cognitive scaffolding, and facilitate interaction with the student based on learner models, algorithms, and neural networks. Since human one-on-one tutoring is impractical at large-scale distance learning institutions that conduct modules with thousands of students, intelligent tutoring technologies hold great promise. But supervised and encouraged online communication is required (Salmon, 2008; Williamson, Eynon, 2020). By enabling online group interactions, supporting adaptive group formation based on learner models, or summarizing discussions that a human tutor can use to direct students toward the course's goals, artificial intelligence in education can support collaborative learning. Lastly, intelligent virtual reality is used to engage and mentor students in real-world virtual worlds and game-based learning environments, relying on intelligent tutoring systems as well. For instance, in remote or virtual laboratories, virtual agents may take on the roles of peers, instructors, or facilitators (Perez et al., 2017). Just-in-time evaluation and feedback may be given via Artificial Iintelligence. Artificial Iintelligence in education may be included into learning activities for a continuous assessment of student success, as an alternative to stop-and-test methods. High accuracy predictions of a student's likelihood of failing an assignment or dropping out of a course have been made using algorithms (Bahadir, 2016). Three approaches are used by Baker and Smith (Educ-AI-tion rebooted?..., 2019) in their most

recent study when discussing educational AI tools: a) learner-facing, b) teacher-facing, and c) system-facing artificial intelligence in education. Learner-facing AI tools are programs, such as personalized or adaptive learning management systems, that students utilize to acquire knowledge. Teacher-facing technologies automate administrative, assessment, feedback, and plagiarism detection procedures to help teachers and lessen their burden. Artificial intelligence is being used in educational technologies to provide teachers proactive help and advice when required by giving insight into students' learning progress. Artificial intelligence solutions in education that are system-facing provide managers and administrators institutional-level information, such as tracking trends in faculty or college turnover. The idea of the student life-cycle is used in the context of higher education as a framework to explain the many AI-based services on an institutional and administrative level that are more general, as well as to assist the academic teaching and learning process in a more focused sense (Navajas et al., 2024) (Fig. 1).

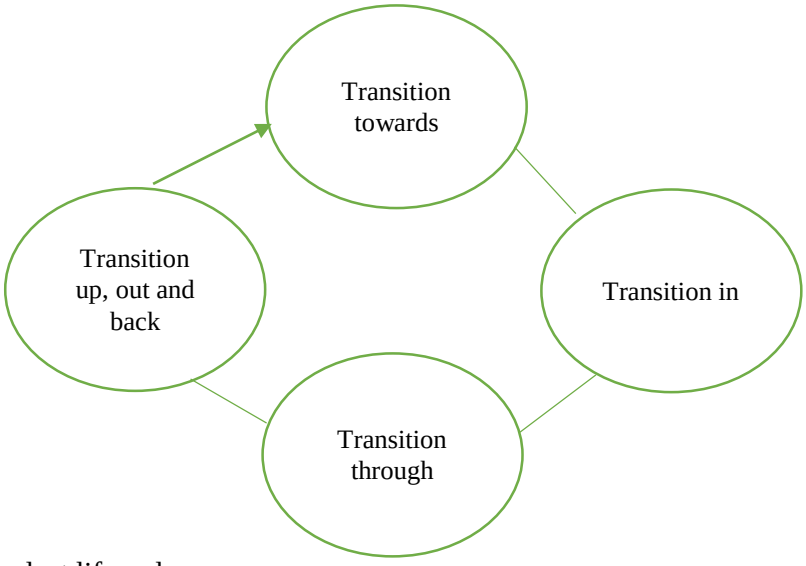


**Figure 1.** The student lifecycle.

Source: Own study basis on: (Bates, Hayes, 2017).

The first phase, called transition towards, pertains to students prior to commencing their studies and encompasses their goals and research before determining the course of study (Student lifecycle…, 2012). Transition in is the second stage. Beginning students dedicate themselves to their academics at this point. Transition through, the third step, is all on keeping pupils in school. Students work for academic accomplishment throughout this phase. The last phase, known as transitions up, out, and back, is when graduates and alumni concentrate on their next successes and how they might stay connected to the institution (Student lifecycle…, 2012).

Artificial intelligence (AI) has been widely applied in educational practices with the advancement of computing and information processing techniques. Examples of AI applications in education include intelligent tutoring systems, teaching robots, learning analytics dashboards, adaptive learning systems, and human-computer interactions (Chen et al.,

2020). Artificial intelligence is woven throughout numerous technology advancements in education that provide learning analytics, suggestions, and diagnostic tools in a variety of formats and for a range of uses. AI applications are often still in their infancy and are implemented locally or in experimental settings rather than on a large scale at the system level. However, there are several instances of potential applications that target various stakeholders, including students, teachers, administrators, parents, and policy makers, and hint at how AI can change education in the next decades. These examples occur both in the classroom and at the systemic levels. SDG 4, "Ensure inclusive and equitable quality education and promote life-long learning opportunities for all", is one of the global education objectives that AI may be especially helpful in achieving (OECD Education Working Papers, 2024).

More so in less wealthy nations, giving all children more comprehensive access to education has proven to be a recurring difficulty for most nations. One of the global goals outlined in SDG Goal 4 is inclusive education, specifically aiming to provide equitable access to all educational levels for all people, including those with impairments. Artificial intelligence systems have shown their efficacy in facilitating the educational process for individuals with disabilities, such as those involving vision, hearing, or social skills deficits (communication and language). Wearables with AI capabilities, for instance, may assist visually challenged students in learning and socializing in their communities by enabling them to recognize people and read books. Systems specifically intended to help kids with various types of impairments have been developed. Robotics, augmented and virtual reality (AR/VR), and other AI-powered technologies help kids with mental health problems and physical disabilities study and participate in class. Certain technologies, such as text-to-speech or speech-to-text apps, assist in getting around some of the challenges, while other solutions are grounded in research and have encouraging outcomes. For instance, while engaging and working together with virtual characters and digital things in a classroom, kids with autism may explore and enhance social skills (OECD Education Working Papers, 2024). Additional AI applications that make use of pattern recognition to provide personalized recommendations to parents, instructors, or students have been created for:

- Online and blended learning: instructors and students may access learning metrics via chatbots that are driven by artificial intelligence agents.
- Classroom dynamics: Various sensors and cameras monitor student participation and classroom dynamics to provide instructors immediate or retrospective feedback and ideas.
- AI functionalities like voice recognition and analysis, pronunciation correction, and foreign language acquisition aid instructors in teaching foreign languages.

The greatest area of potential for revolutionary change in education provided by artificial intelligence is probably assessment. But this isn't evaluation in the sense that it's usually understood. Compared to typical assessments, AI-enabled assessments involve radically different objects and methods, some of which we will now outline. In fact, AI may mean the

end of conventional exams and their replacement, which would mean a change in educational procedures. Select and supply response tests are unique and atypical artifacts used in traditional assessments for summative, retrospective sampling. In contrast, recursive feedback systems—which are essential to learning itself—can be supported by artificial intelligence. All recordable activities that take place throughout the learning process, such as using computer-mediated content resources, interacting with peers and instructors, and producing student work as knowledge representations, may be included in the dataset instead of sampling (Cope, Kalantzis, Searsmith, 2021).

## Voswiever analysis

In order to select the most relevant studies in the artifical intelligence field, bibliometric analysis was used, with the principal source of scientific articles selected being the academic platform Scopus. The content of 3365 open access research articles has been taken into consideration from 2019 and 2024 years. The search documents related to “artifical intelligence” “in” “education” issue in title, abstract and keywords. In order to highlight the structure of the scientific field a content analysis was used, inspecting the most common words and the relationships between words. Additionally, a network of co-occurrences was taken into account. The analysis was performed using the VosWiever program. To respond to the following main research question by exploring the valuable information the world's clouds provided:

1. Which are the most common all keywords found in the full scientific articles on artificial intelligence in education?
2. What are main key words used by authors?
3. What does network visualization look like between co-authorships network and countries?

Specifically, Vosviewer can create maps with numerous publications, journals based on networks (co-citation), multiple item maps, country maps, and publication maps. It can also create keyword maps based on networks that are shared. Users may change how many keywords are used and remove phrases that aren't as important. To summarise, the Vosviewer programme enables the processing, clustering, and tagging of articles coming from scientific databases (Zhang, Quoquab, Mohammad, 2024). To study the contents, the author examined the distribution of all key words (Fig. 2). The keywords used by writers in their article titles, abstracts, and keywords sections are examined in this analysis. The word "co-occurrence" refers to the frequency with which two terms occur together. Researchers may locate understudied topics by using keywords to identify patterns in past works and predict future themes that may become popular. Keyword co-occurrence analysis of a study location may effectively reflect

research hotspots, adding to the body of data supporting scientific research. VOSviewer divided the keywords of artifical intelligence publications into six clusters (minimum number of occurences of a keywork: 20). Cluster 1 is blue colour (artificial intelligence, higher education, chatbots, chatGPT, computer science, AI education, computational thinking, academic integrity, language model, generative artificil inelligence, ethics, ethical tchnologies). Cluster 2 is green colour (personalized learning, learning systems, online systems, e-learning, learning process, computer aided instruction, intelligent tutoring systems, intelligent highway system, active learning, learning analytics, student learing, educational data mining, software engineering). Cluster 3 is red colour (virtual reality, engineering education, big data, internet of things, blockchain, internet security, 5G mobile communication system, edge computing, network architecture). Cluster 4 is yellow colour (algorithm, deep learning, image enhacement, decisions trees, forecasting, convolution, learning technology, machine learning, machine learning algorithms, diagnosis). Cluster 5 is violet colour (human, technology, education medical, social media, human experiment, internet).

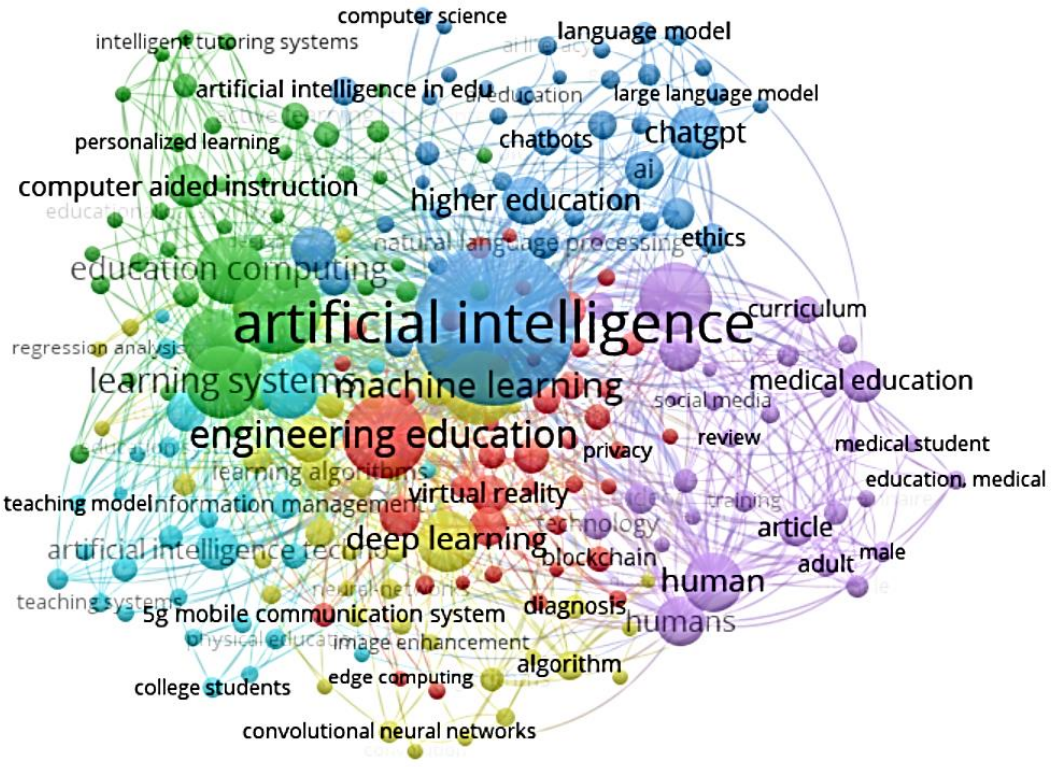


**Figure 2.** Co-occurrence all key words.

Source: own study.

Figure 3 shows the selected keywords with the highest total link strength.

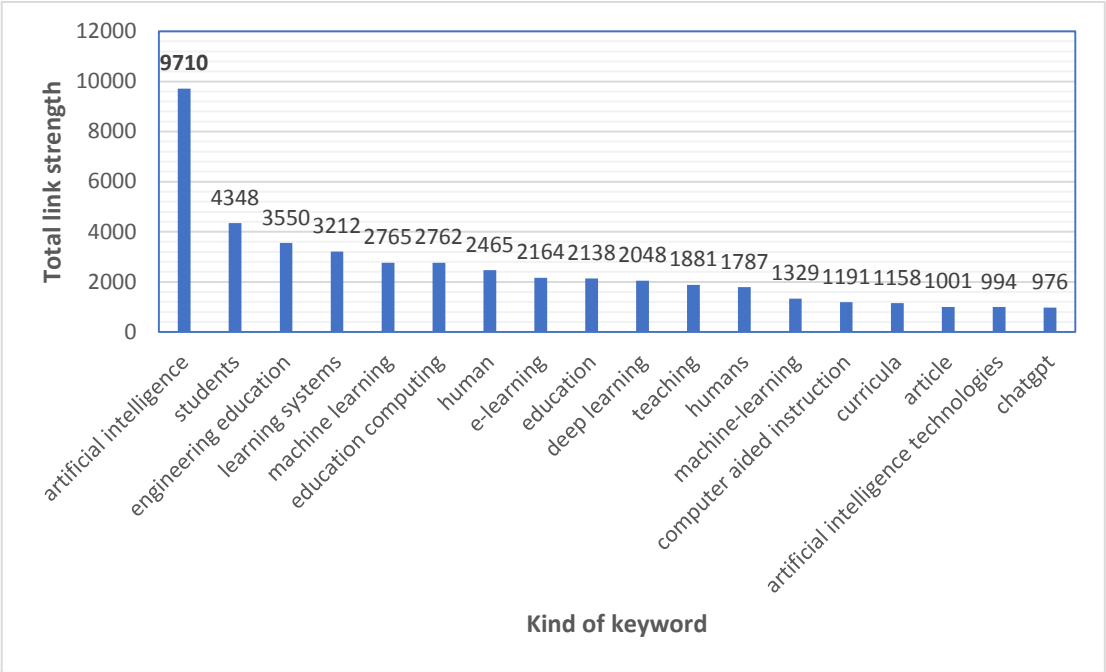


**Figure 3.** Kind of keywords, and total link strength.

Source: own study.

Figure 3 shows that artificial intelligence has the highest total link strength, followed by students, engineering education, learning systems and machine learning. By examining the useful data that the globe clouds offered, we attempted to address the following primary study question: In the whole scholarly publications on artificial intelligence in education, which terms are most frequently used? According to the empirical investigation, the following terms appear often across the whole of a few chosen articles: “learning system”, “decision support systems”, “internet of things”, “machine learning”, ”big data”, “teaching”, “deep learning”, “teaching model”, “student”, “higher education”, and “teachers” (Figure 4).

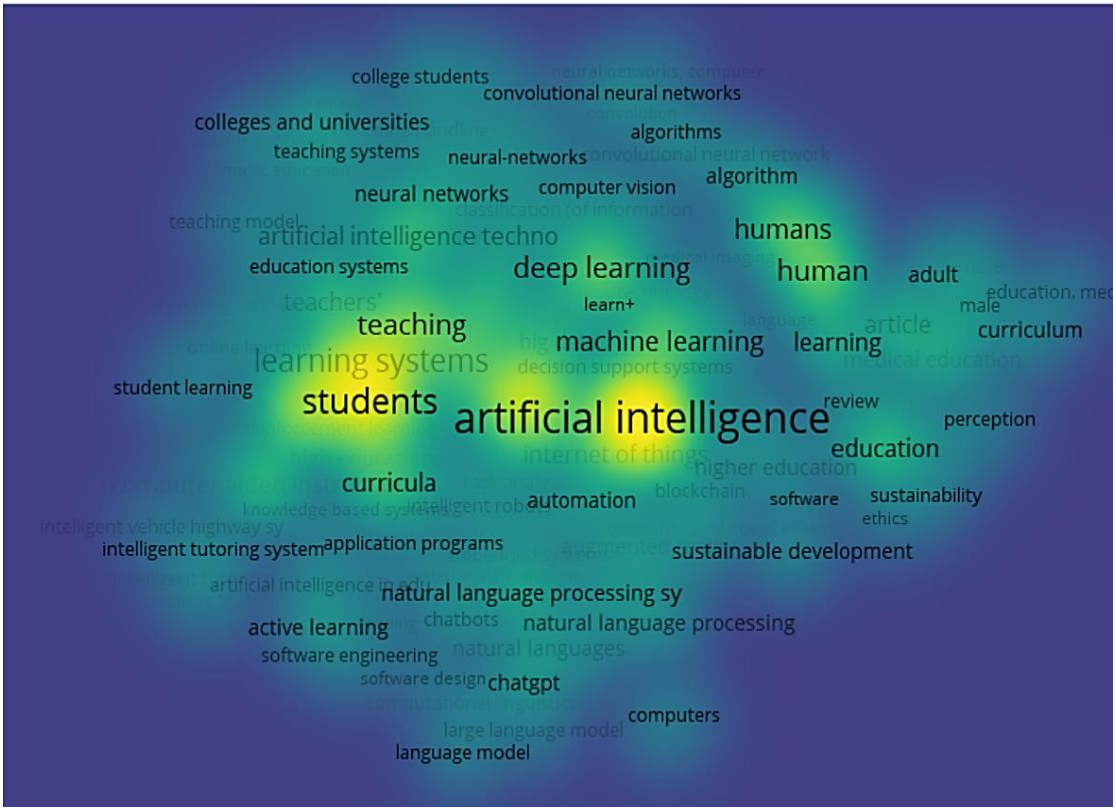


**Figure 4.** Most common words in scientific publications regarding artificial intelligence in education. Source: own study.

In order to illustrate the level of contact between nations and the leading nations in this subject, a country co-authorship study was carried out. Fig. 5 presents the country co-authorship network of artificial intelligence related publications with six clusters (minimum number of documents of a country: 20). Figure 5 has a variety of colors, indicating the diversity of research topics. The large nodes represent the influential countries. The links between nodes represent the cooperative relationships among countries. The distance between the nodes and the thickness of the links represent the level of cooperation among countries. Saudi Arabia (2787 citations and 118 documents) and South Korea (1572 citations and 118 documents) are the leaders of the green cluster, which has the most significant number of countries: 11, including Jordan, Egypt, the United Arab Emirates, Pakistan, Malaysia, Indonesia, Japan, Vietnam, Qatar, Oman, and the and the Russian Federation. The United Kingdom (6701 citations and 329 documents) is a leader in the red cluster, covering 13 countries: Finland, the Netherlands, Germany, Italy, Norway, Switzerland, Turkey, France, Denmark, Austria, South Africa, Morocco, and Greece. China (5086 citations and 668 documents) is a leader in blue, which includes: India, Poland, Hong Kong, Philippinianness, Taiwan, and India. Spain (2264 citations and 184 documents) is the leader in the yellow cluster, which includes Mexico, Brazil, Portugal, Romania, and Ecuador. The USA (8582 citations and 572 documents) is a leader in the violet cluster, which includes only two countries: Ireland and Thailand. The azure cluster is the last one presented through Canada and Iran.

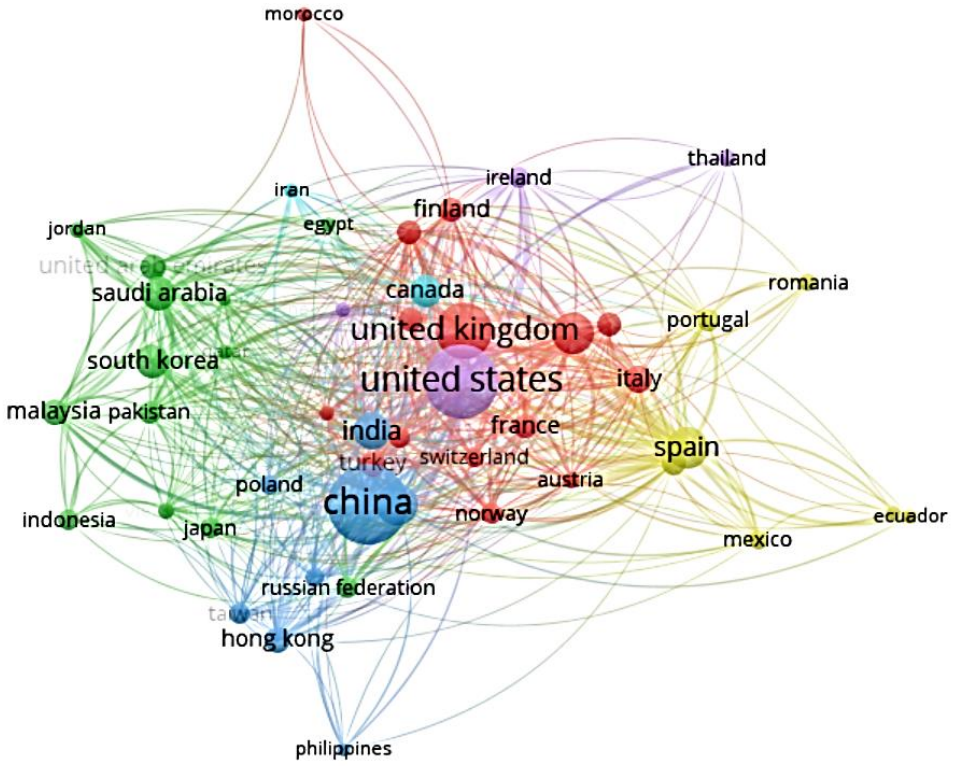


**Figure 5.** The country co-authorship network of artificial intelligence.
Source: own study.

## Discussion

Artificial intelligence is a rapidly developing technology that has the potential to significantly improve education (The Role of Artificial Intelligence…, 2024; Wolniak, 2023; 2024). Artificial Intelligence (AI) has been seen as a potent instrument that may help create new paradigms in educational research, technology development, and instructional design that would not be able to create in more conventional educational settings (Holmes et al., 2022; Hwang et al., 2020). AI has opened up new possibilities, problems, and opportunities for educational breakthroughs. Some of these include the shift to individualized learning, the difficulty of the instructor's position, and the creation of intricate educational systems (Educ-AI-tion rebooted?..., 2019; Holmes, Bialik, Fadel, 2019; Holmes et al., 2018; Ouyang, Jiao, 2021). AI has the potential to completely transform a number of societal spheres, including education (Adiguzel, Kaya, Cansu, 2023). By offering individualized, real-time feedback and adjusting to different learning styles, artificial intelligence (AI) may improve student learning (Luckin, 2017). Universities may assist educate students to be active participants in the development and use of AI technology, ensuring that it benefits society as a whole, by teaching

them about AI (Chan, 2023). Creating an AI curriculum for higher education is crucial to preparing students for the future. Because AI technology is developing so quickly, it will probably become more and more significant in society in the years to come. Universities can help guarantee that graduates are prepared to contribute to the development of AI and to manage the ethical, social, and economic concerns that are anticipated to emerge as AI becomes more widely used by offering instructors and students training in the field. Additionally, with this kind of instruction, students ought to be able to utilize AI responsibly and competently in their everyday lives (Aoun, 2017). Accordance with authors (Alam, 2021-2021) Artificial Intelligence (AI) and related technological developments will replace some professions (didactics will not be necessary), drastically change other professions (didactic materials will need to be updated), and create a large number of new professions (new-fangled didactics must be constituted). AI will both reform and facilitate the work of education, changing the nature of education and the division of labor. Personalized learning and automated assessment are two possible uses of AI-driven technology in education (Lin, Huang, Lu, 2023). AI is employed to improve teacher-student communication and provide a customizable learning environment, claim Kamalov et al. (Kamalov, Santandreu Calonge, Gurrib, 2023). Additionally, it offers adaptive learning, which encourages a more personalized learning experience (Gligorea et al., 2023), and real-time support is provided by AI-powered tutoring systems (Lin, Huang, Lu, 2023). According to (Ruiz-Rojas et al., 2023), artificial intelligence (AI) makes virtual classrooms easier to use by enabling active learning, adaptive content distribution, and attendance monitoring. AI enhances teaching methodologies, maximizes teaching resources, and supports data-driven decision-making via the use of data analytics (Rahmani et al., 2021). Additionally, learning management systems (LMS) powered by AI are made to simplify administrative work, tailor learning pathways, or provide immediate feedback (FIRAT 2023). Authors (Da Tan & Cheah 2021) and (Yordanova 2020) discovered that artificial intelligence (AI) significantly influences gamification by enhancing the personalization and engagement of educational games. It is vital to note that artificial intelligence (AI)-driven technologies have been useful in emergency education, particularly when conventional education institutions are interrupted by war, pandemics, natural catastrophes, or other emergencies. Artificial Intelligence (AI) enables the deployment of remote learning systems that provide educational information to students impacted by catastrophes (Bakhov et al., 2021). The positive effects of AI tools on delivering personalized learning experiences are described by (Kamruzzaman et al., 2023). This is especially significant in emergency education, as students may have varying stress levels and different learning requirements. AI made education accessible during the COVID-19 epidemic via content distribution methods, educational applications, and virtual classrooms (Pantelimon et al., 2021). According to (Danylchenko-Cherniak, 2023), AI-based tools help create a "normal" educational process in the midst of the Ukrainian conflict. Chmyr & Bhinder (2023) claim that artificial intelligence (AI) may greatly improve military training effectiveness.

Consequently, it is imperative to acknowledge that artificial intelligence (AI) has a profound impact on modern education by disrupting established teaching and learning approaches. Gaining an understanding of the potential of AI-powered technologies will make it easier to integrate them into the teaching process, improve instructional strategies, and automate administrative duties. Furthermore, as artificial intelligence (AI) is incorporated more and more into the educational system, it is critical to recognize the difficulties it presents. This will help instructors and students make ethical decisions and guarantee that AI is used responsibly to influence education in the future.

## Conclusion

In order to select the most relevant studies in the artifical intelligence field, bibliometric analysis was used, with the principal source of scientific articles selected being the academic platform Scopus. Manuscript main aim is to respond to the following main research question by exploring the valuable information the world's clouds provided:

1. **Which are the most common all keywords found in the full scientific articles on artificial intelligence in education (Fig. 6)?** There are following: deep learning, human, chat GPT, higher education, computer aided instruction, learning analytics.

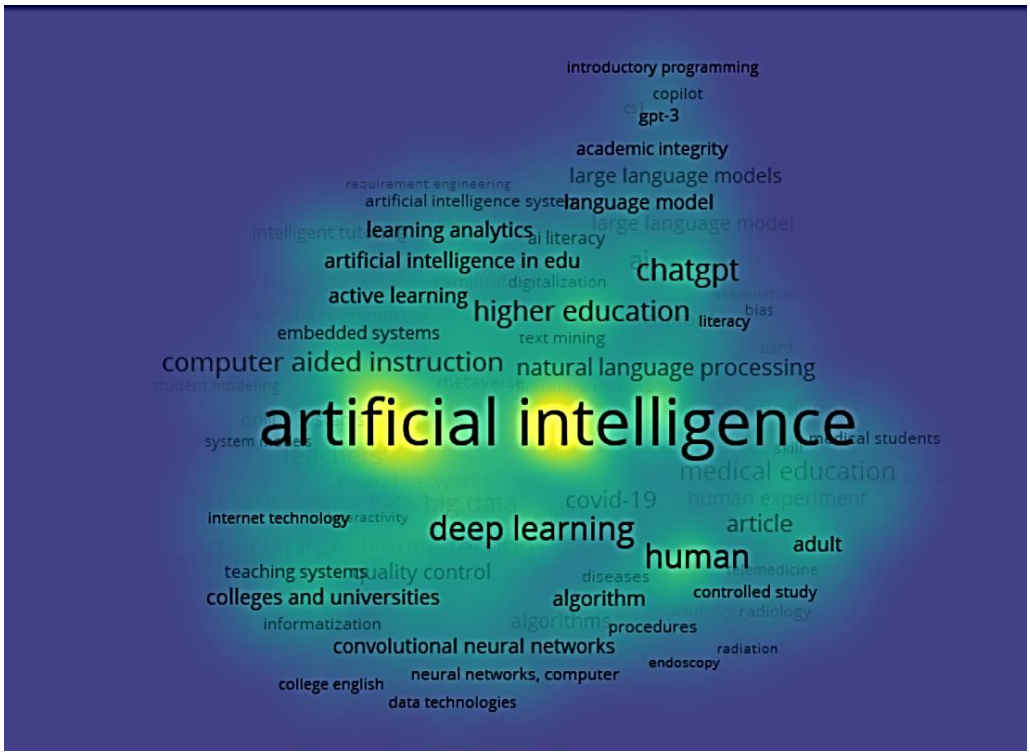


**Figure 6.** Co-occurrence all key words – density visualization.

Source: own study.

2. **What are main key words used by authors?** According to the empirical investigation, the following terms appear often across the whole of a few chosen articles: “learning system”, “decision support systems”, “internet of things”, “machine learning”, ”big data”, “teaching”, “deep learning”, “teaching model”, “student”, “higher education”, and “teachers”
3. **What does network visualization look like between co-authorships network and countries?** Data analysis based on the number of documents in 49 countries showed that the largest share is held by China (15.3%), the USA (13.2%), and the UK (7.5%). Figure 7 shows a radar chart for the selected nine countries with the largest number of documents.

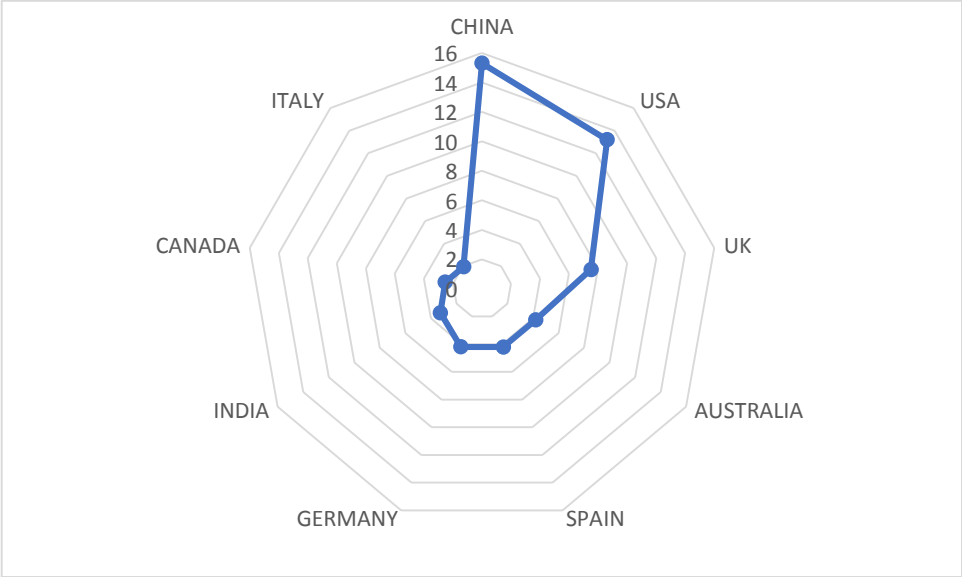


**Figure 7.** A radar chart for the selected nine countries with the largest number of documents.
Source: own study.

AI also changes the way intelligent material is used in education. It describes digital books, lecture notes, videos, and other virtual information. Because smart information may be accessed remotely, individually, or several times at once—unlike in a traditional classroom—it also facilitates access to education. It improves learning for students and helps professors impart information (Ahmad et al., 2022). Instructors and teachers may do more with more speed and effectiveness when using AI, even when it comes to administrative responsibilities like evaluating, grading, and giving feedback to students on work that they have turned in. Additionally, instructors may increase the quality of their training by using AI, or the many kinds of AI, such as chatbots, cobots, and web-based and online intelligent systems. Contrarily, students benefit from a better and more comprehensive learning experience thanks to AI's use of machine learning, as demonstrated by various studies. AI uses machine learning to evaluate students' abilities and needs, and then uses the results of that analysis to create and distribute individualized or customized content that increases learning through higher uptake and retention. Additionally, AI enhances students' learning experiences by giving them hands-on or

experiential learning opportunities, especially when combined with other technologies like virtual reality, 3-D, gaming, and simulation (Chen et al., 2020; Chen, Chen, Lin, 2020).

## Limitations

Like other review efforts, this one is not without limitations. The first limitation of the study is a result of the papers and reviews that were selected that deal with artificial intelligence. Since a broad variety of scientific fields are included in the field of artificial intelligence, findings may vary if publications from other domains are completely taken into account. Consequently, one should use extreme caution when extrapolating the study's conclusions to the vast domain of artificial intelligence. Another limitation is the research timeline (2019-2024); future results may vary since we anticipate that new topics, concepts, and techniques will emerge in the expanding field of artificial intelligence, which will significantly change the outcomes of our study. Finally, since the study's data came from Scopus, it's possible that this research is impacted by some of Scopus's restrictions. Thus, information from other sources—such as the Web of Science—should be included into subsequent studies. Additionally, this kind of researcher may use Altmetrics, a sophisticated and methodical bibliometric technique, to evaluate the academic and social value of study results. This combined with scientometric analysis may be used in novel research domains to enhance the clarity of field dynamics. Nonetheless, by providing a comprehensive and in-depth analysis of significant publications in the field of artificial intelligence research, the bibliometric data analysis conducted in this study contributes to the body of literature.

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