Review

The Educational Value of Artificial Intelligence in Higher Education: A Ten-Year Systematic Literature Review

Agostino Marengo * , Alessandro Pagano , Kamal Soomro , Jenny Pange

Posted Date: 2 November 2023

doi: 10.20944/preprints202311.0055.v1

Keywords: AI; artificial intelligence; higher education; learning; teaching; systematic review

Review

The Educational Value of Artificial Intelligence in Higher Education: A Ten-Year Systematic Literature Review

Agostino Marengo [1,*], Alessandro Pagano [2], Kamal Soomro [3] and Jenny Pange [4]

[1] Department of Human Science, University of Foggia, Foggia, Italy
[2] Department of Economics, University of Bari, Bari, Italy
[3] Department of E.C. Education, University of Ioannina, Ioannina Greece and
[4] Department of Education, Government College University Hyderabad, Hyderabad, Pakistan

Abstract: With the emergence of artificial intelligence (AI), many aspects of our lives, from how we work to how we interact with each other and the world around us is showing dramatic changes. Education is one of the key areas that may be impacted by the rise of AI. Although a large number of studies have been conducted in recent years to shed light on how AI may influence various dimensions of education, a very little work has been carried out to consolidate and synthesis empirical studies on the application of AI in higher education. The present study reviewed empirical studies published between 2013 and 2022 to 1) examine the characteristics of published research in the field, and 2) to present thorough insights on the promises and challenges of this dramatic technology in higher and professional education. This review included 44 empirical studies published as peer-reviewed journal articles. The results indicated that there is rapid increase in the publications focusing on AI in higher education in last a few years. However, a big proportion of these publications are technically theoretical and conceptual proposals for AI intervention. The areas of AI applications in higher education that are supported by evidence based research are presented. Imperative implications are also highlighted for future research and implementation of AI based interventions in higher education.

Keywords: AI; artificial intelligence; higher education; learning; teaching; systematic review

---

Lay Description

What is already known about this topic

- AI has been a rapidly evolving field with numerous applications across various industries.
- The potential of AI in transforming education, particularly in higher education, has been widely recognized.
- Prior studies have explored AI's theoretical applications in education, highlighting its promise but often lacking empirical evidence.

What this paper adds

- Provides a comprehensive systematic literature review spanning a decade (2013-2022) focused specifically on AI in higher education.
- Offers a detailed analysis of 44 empirical studies, shedding light on the current state of AI implementation in higher education.
- Identifies a significant increase in publications related to AI in higher education in recent years, reflecting the growing interest and relevance of this topic.
- Distinguishes between theoretical and evidence-based research, emphasizing the need for empirical validation of AI interventions in education.
- Presents a synthesized view of the promises and challenges of AI in higher education, consolidating existing knowledge on this subject.

 doi:10.20944/preprints202311.0055.v1

Implications for practice and/or policy

- Highlights the importance of evidence-based research in guiding the integration of AI technologies into higher education settings.
- Provides educators, administrators, and policymakers with insights into the areas where AI applications in higher education have demonstrated effectiveness.
- Suggests the need for ongoing collaboration between researchers, educators, and technology developers to harness the full potential of AI in higher education.
- Recognizes the potential for AI to enhance teaching and learning experiences, but also underscores the importance of addressing ethical and pedagogical concerns.

Lay Description

- Our study explores how artificial intelligence (AI) is changing the landscape of higher education over the past decade.
- We reviewed 44 research papers to understand how AI is being used in universities and colleges.
- We found that there has been a significant increase in studies about AI in higher education recently.
- However, many of these studies were more like theoretical ideas rather than practical applications.
- We identified specific areas where AI has been proven to be useful in higher education, and we also highlighted the challenges.
- This research can help teachers, school administrators, and policymakers make informed decisions about using AI in education.
- We believe that AI has the potential to improve teaching and learning, but it needs to be based on solid evidence and careful planning to be effective and ethical.

Introduction

Artificial intelligence has advanced swiftly, not only in fiction with the use of robots to portray AI and humanlike characteristics but also AI has developed to deliver countless amazing benefits in almost every aspect of life (Tahiru, 2021). It is having a significant impact on our lives, from improving healthcare and transportation to transforming the way we work and learn (Dogan et al., 2023). As an innovative technological revolution, the artificial intelligence has impressively changed the ecosystem in economics, finance, society, and education (Kaur et al., 2022). AI-oriented tools such as virtual assistants, chatbots, and recommendation engines are becoming increasingly ubiquitous, providing personalized and efficient experiences in various domains. Further, it is also impacting the job market, automating certain tasks and creating new opportunities in fields such as data science and robotics (Colombo et al., 2019).

Artificial intelligence is also transforming multiple dimensions of education including higher education (Tahiru, 2021). According to Popenici and Kerr (2017), the future of higher education is distinctively connected with developments of emerging intelligent technologies. Development of personalised and adaptive learning systems, which use AI algorithms to adjust education to the needs and talents of specific learners, is one important area of change (Tang et al., 2020). In the area of assessment and evaluation, where AI-powered systems can analyse enormous volumes of data to deliver more precise and nuanced feedback on student performance, there is another dimension (Zawacki-Richter et al., 2019). Additionally, AI is being utilised to provide immersive and interactive learning environments, such as simulations of virtual and augmented reality, which may engage students in ways that weren't previously conceivable (Chen et al., 2020).

However, the widespread adoption of AI in education is also raising several concerns particularly of ethical and social nature. The ethical issues of AI applications in education have become a hot topic in the field of education for past a few years. One of the major concern is about privacy and security, as the use of AI technologies in education may lead to the collection and storage of sensitive student data, which could be vulnerable to cyber attacks or used for unauthorized purposes (Nguyen et al., 2022). The utilisation of student data, algorithmic decision-making, and the

 doi:10.20944/preprints202311.0055.v1

influence of technology on education have all sparked ethical questions (Zhang et al., 2022). Another issue is transparency, since using AI may make decision-making processes less transparent, making it more difficult for students and instructors to comprehend how decisions are made and resulting in a lack of accountability. To guarantee that AI is utilised ethically and responsibly and helps all students, it is crucial to address these issues.

Because of the significant benefits that AI can bring to education, many experts in the fields of education including researchers, policymakers, and educators are focusing on how to integrate AI into the teaching and learning process. Chiu et al. (2023) argue that one of the most pressing concerns in educational research is employing the role that artificial intelligence may play in fostering a new generation of pedagogical methods and curricular initiatives. The significance of this field of research is also highlighted by Ouyang et al. (2022). While there is a significant increase in the research on this topic during the last a few years in particular (Chiu et al., 2022; Ng et al., 2022; Tahiru, 2021; Zawacki-Richter et al., 2018), there is very little effort towards the consolidation of evidence-based works to portray a holistic picture about the potential as well as concerns of artificial intelligence integration to higher education and professional development. Therefore, to fill this knowledge gap, we attempted to review empirical studies in order to analyse and synthesize their findings. The results of this review can be used to take informed decisions for efficient application of AI in higher education settings.

This article is organized as follows: The first section presents the introduction and very brief background to the study. Next section presents a detailed background of the study, followed by a section that explains the research methodology for the present study. Then, the results of the specific question that guided this systematic review are reported. Following to the results section, implications of the findings are discussed. The paper ends with a conclusion section and a discussion of the limitations of the present study.

Research Background

The growing trend of artificial intelligence (AI) is significantly reshaping the labour market where education serves, thus raising concerns about what to teach and how to teach the next generations (Zhai, 2022). AI-enhanced tools large language models (LLMs), intelligent tutors, and learning analytics platforms are enabling personalized learning experiences for students, providing immediate feedback and customized support. Intelligent grading systems and plagiarism detectors are streamlining the grading process, freeing up time for educators to focus on teaching and providing more detailed and constructive feedback to students. Moreover, AI-supported tools can be used to enhance accessibility in education, providing support for students with learning disabilities and language barriers. It is also transforming the way educators approach curriculum development and instruction, helping them to identify areas of student difficulty and providing insights into effective teaching strategies.

Starting from the history of artificial intelligence, the following section provides a comprehensive overview of the potential of AI application in education particularly in university and professional development settings. The challenges associated with its implementation within higher education settings are also discussed.

Artificial Intelligence (AI) – An overview

Artificial Intelligence (AI) is defined as the ability of a digital system to perform tasks commonly associated with the intelligence of humans (Chiu et al., 2023). In the words of Popenici and Kerr (2017), it refers to computing systems that have capability to engage in human-like processes like learning, adapting, synthesizing, self-improvement and utilization of data for multifaceted processing tasks. Similarly, Ng et al. (2022) recognize AI as a type of computing technology that is able to learn and solve problems in an analogous way to a human brain. AI is maturing and finding use in a wide variety of contexts at an unprecedented rate, eventually becoming embedded in our routines. (Tahiru, 2021). Its history dates back to the 20th century, when technological advancements and new scientific disciplines paved the way for the creation of intelligent machines. Some key

 doi:10.20944/preprints202311.0055.v1

milestones in the history of AI include the development of artificial neural networks in 1943, the proposal of the Turing Test by Alan Turing in 1950, the Dartmouth Conference in 1956 which is considered the birthplace of AI as a field of study (Tahiru, 2021), and the creation of ELIZA, one of the first examples of natural language processing (Sharma et al., 2017).

Throughout the years, AI has experienced various breakthroughs in different areas such as expert systems, machine learning algorithms, and deep learning, leading to countless practical applications in industries ranging from healthcare to entertainment. Today, AI continues to rapidly evolve, and researchers are constantly pushing the boundaries of what is possible with intelligent machines. The most popular and one of the latest tools of AI is ChatGPT – a general-purpose conversation chatbot released Open AI in November 2022. It would not be wrong to see that the release of ChatGPT as an open to all free tool has truly roared the trend of artificial intelligence in general public. While offering amazing service for almost every field, it has got great uses for education sector too.

Artificial Intelligence (AI) in Education

Artificial intelligence is presently developing more quickly, and this has already had a major influence on the services provided by higher education (Popenici & Kerr, 2017). Using AI-based technologies can support education in respect of various dimensions. For example, these technologies can play a critical role in creating and implementing adaptive learning environments that is designed to adapt and adjust to the unique learning needs and preferences of individual students, by providing the necessary data analytics and personalization tools. Adaptive learning environment is considered to be a critical requirement to enhance the teaching quality and the user performance throughout the learning process (Marengo et al., 2015).

Artificial intelligence offers platform facilitation for the injection of intelligent transformation for education reform and innovation in all levels of education including at schools, colleges, universities, and other venues for vocational and professional developments. As an intelligent tutor, AI-based technology may monitor and assess students' learning processes and outcomes while giving teachers a break from mundane, time-consuming duties.

Probably the discussion on the use of artificial intelligence in education would remain incomplete if we do not mention ChatGPT – a chatbot by Open AI. ChatGPT, a large language model (LLM) is considered to provide significant benefits for education by offering a user-friendly and interactive tool for students and educators to access comprehensive and accurate information. Zhai (2022) argue that the impact of this natural language processing (NLP) on education is enormous as the its capacity may drive changes to educational learning goals, learning activities, and assessment and evaluation practices. With advanced language processing features, ChatGPT helps students enhance their writing and linguistic talents via individualized comments and assignment guidance. Thanks to ChatGPT, teachers have simplified access to instructional resources and can craft bespoke lesson strategies. However, at the same time, the introduction of LLMs like ChatGPT brings several challenges to the use of technology in higher education. Credibility of sources, evaluating information, preventing plagiarism, and maintaining academic integrity are central concerns (Rudolph et al., 2023).

Common Functions of AI in Education

AI-based technologies are increasingly being used in education to enhance teaching and learning experiences. According to Dogan et al. (2023), personalized learning is among the most popular applications of intelligent technology in education. Through analysis of student data, AI can create customized educational programs that better meet the needs of each student. Personalized learning paths and assessments creation is possible through (van der Vorst & Jelicic, 2019). It helps to ensure that students learn at their own pace and in a way that is best suited for them, ultimately resulting in improved academic outcomes and increased engagement in the learning process.

Evidence that AI solutions create a new vista of possibilities for teaching and learning in higher education is consistent (Popenici & Kerr, 2017). Artificial intelligence in education often plays a part

 doi:10.20944/preprints202311.0055.v1

in automating grading and evaluations. With AI grading systems, instructors can dedicate more hours to essential responsibilities by delegating the evaluation of homework and tests to quick and precise algorithms. Addressing these issues through targeted interventions, AI can help teachers spot areas where students are struggling. Likewise, Ouyang et al. (2022) found that among various functions of education that may be supported by the AI-based technologies, predictions of learning status, performance or satisfaction is on the top of the list, followed by resource recommendation, automatic assessment, and improvement of learning experience.

Challenges of Using AI Technologies in Education

While artificial intelligence-based technologies have the potential to revolutionize education, it also presents several challenges. Firstly, It's critical to remember that education is fundamentally a human endeavour and not a technological problem (Popenici & Kerr, 2017). Further, one major challenge is the need for data privacy and security. As an intelligent system collects and analyses large amounts of student data, it is essential to ensure that this data is protected from unauthorized access and use. There is also a risk that AI systems may reinforce existing biases and inequalities in education. For example, if AI algorithms are based on biased data or assumptions, they may provide unequal opportunities for students or perpetuate discrimination.

Since the beginning of the 21st century, with the continuous innovation of artificial intelligence (AI) and its integration into educational process, some educators hug this innovative technology with anxieties, especially about its possible harms to students (Zhang et al, 2022). It is argued that the integration of AI into education may lead to several ethical issues including weakening teachers' professional identity, violating students' freedom, widening educational gaps, suppressing positive values of education, and arrogating the common good of education (Zhang et al., 2022). Nguyen et al. (2022) have also shown concerns on increasing ethical risks about several dimensions of education such as personal data and learner autonomy.

Need for Systematic Review on Artificial Intelligence in Higher Education

Systematic reviews present synthesized form of the state of knowledge in a field that is helpful to identify future research priorities. They can also identify issues in primary research that should be addressed in follow-up studies and address questions that individual studies would not otherwise be able to address (Page et al., 2021). While preparing for the conduct of this systematic review, we did a needful effort to check if any similar reviews are available in the literature. Although we found a number of reviews on educational use of artificial intelligence, the focus for many is education in general and they do not concentrate on a specific educational setting such as higher education (Chiu et al., 2023; Ji et al., 2022; Tahiru, 2021).

For example, Tahiru's (2021) systematic review is predominantly aimed at analysing the opportunities and challenges of artificial intelligence in education while not focusing on any specific educational setting. Similarly, Chiu et al. (2021) conducted a review of studies to explore the benefits of AI in a mix of educational settings including primary, secondary, and higher education levels. We believe the opportunities as well as challenges of using AI varies depending on the level of education it is used in. So, the synthesized results of AI application in specific educational setting would provide more insightful information on the topic. Although a review by Zawacki-Richter et al. (2018) specifically paid attention on the application of AI within higher education, they focused on the studies published between 2007 to 2018, lacking the inclusion of empirical evidence from more recently published articles (post 2018). Since, the field of artificial intelligence has made a dramatic impact in the last a few years, a more recent and comprehensive systematic review is needed to present the synthesized information from the empirical studies published in the recent ten years.

Purpose of the Study

Artificial intelligence (AI) has grabbed extraordinary attention recently as a potential tool to transform education. On one hand, AI applications in higher education are on the rise. While, on the

 doi:10.20944/preprints202311.0055.v1

other hand, new ethical implications and risks come in with the development of its applications in higher education. As an effort to further understand AI in higher education, a systematic review of empirical research published in reputed journals during last ten years (2013 to 2022) was conducted. The purpose of the proposed review was two-folded. Firstly, it was aimed to examine the characteristics of published research on AI in higher education in terms of its nature, year, journal, and countries. The second primary purpose of this review was to analyse and synthesize the findings regarding the promises and challenges of using AI to support various aspects of higher education such as learning, teaching, assessment, and administration.

More specifically, this systematic review was guided by the following specific questions:

(1) What are the demographics (year, journal, and countries) of the published research on artificial intelligence in higher education?
(2) What is the nature (methods) of the published research on artificial intelligence in higher education?
(3) What aspects of higher education (such as learning, teaching, assessment, and administration) are supported by the use of artificial intelligence?
(4) What challenges of using artificial intelligence in higher education are reported in the published research?

Methodology

To develop a comprehensive understanding on the use of artificial intelligence in higher education, the methodology used in this systematic review is primarily based on guideline suggested by the PRISMA 2020 statement (Page et al., 2021). The PRISMA 2020 statement provides a trustworthy methodological and reporting guidance for systematic reviews that mirrors advances in methods to identify, select, appraise, and synthesise scientific research. The following sections describe the systematic review procedures for the current study.

Database Search

In order to identify the relevant research studies, we conducted the systematic search within major electronic journal databases including Springer, Science Direct, IEEE Xplore, Taylor & Francis, and ERIC (Education Resources Information Center). These databases contain works that are thought to present high-calibre, significant-impact scientific knowledge. We did not include conference proceedings in this review because of their inadequate archival value and relatively limited peer-review in comparison to peer-reviewed journal articles. Moreover, Google Scholar was also searched to minimize the risk of omitting relevant peer-reviewed empirical articles. We used advanced search features to get the results that provide studies published during 2013 to 2022 only. The selected period not only reflects the most recent period of ten-years when this review is conducted but it is also the period when the industry of artificial intelligence drove a histrionic technological advancement.

Search Terms

We used multiple search terms in different combinations to reach maximum (if not all) relevant empirical papers on the topic of interest. The used search terms and operators included: (("Artificial Intelligence" OR "AI" OR "Intelligent technology" OR "Intelligent Systems" OR "AIEd" OR "machine intelligence" OR "expert system" OR "deep learning" OR "catboat") AND ("higher education" OR "tertiary education" OR "university" OR "adult learning" OR "professional education" OR "professional development" OR "universities" OR "learning" OR "teaching" OR "education")). The above-mentioned search terms and their possible combinations were searched in the title, keywords, and abstracts of the papers. We also used snowballing technique to identify additional relevant papers that meet the inclusion criteria for this review study. Snowballing involved using the citations and references of the searched articles to reach further papers.

Inclusion and Exclusion Criteria

 doi:10.20944/preprints202311.0055.v1

There were a large number of papers collected and inspected full text before being rejected as they did not meet the study's inclusion requirements. We included only empirical papers that employ systematic collection of material and/or analysis of data as the way to generate knowledge (Dan, 2017). Non-empirical papers that are based on personal observations, reflection, or the experience of the author are not included. Concept paper, editorials, prefaces, book chapters, and previous literature reviews were not included in this systematic review rather we focused on original research articles.

Moreover, we encountered several articles which focused on teaching of AI related courses but they did not investigate any area of AI integration into higher education or professional education. Such articles were not included in the review as they did not serve the primary aim of this systematic review. Both quantitative and qualitative (as well as mixed methods) studies were found to be suitable for this review. Table 1 highlights the key criteria for inclusion and exclusion of research papers in the present study.

Table 1. Inclusion/Exclusion Criteria for Papers.

Inclusion Criteria	Exclusion Criteria
○ Focus on application of AI in higher education or professional training	○ Teaching of AI as a subject/course
○ Empirical studies/evidence-based	○ Editorials, concept/theoretical papers, prefaces, book chapters, and previous reviews
○ Peer-reviewed journal articles	○ Conference papers, presentations/abstracts
○ Published in English language	○ Published in other languages
○ Published during 2013 and 2022	○ Published before 2013 or after 2022

The Screening Process

The systematic search was realized in the end of January and beginning of February 2023. The initial search yielded 2,884 articles. In the pre-analysis step, we reviewed titles, keywords, and abstracts to identify relevant research studies that adhere to the exclusion criteria, resulting in 301 potentially relevant articles. The duplicate articles were also removed at this stage. In the next step, we analysed the full texts and excluded irrelevant ones following the exclusion criteria thus removing the editorials, literature reviews, conceptual papers, commentaries, conference papers, or any sort of paper that was not focused on the application of artificial intelligence in higher education. A further 257 articles were removed based on these criteria.

Article screening was performed by each author. In order to determine the level of agreement amongst raters, we took the total number of ratings for each item and divided it by the number of total ratings, then multiplied the result by 100. The overall inter-rater reliability for screening of abstracts was 92.84, which showed a good level of agreement. The agreement was reached to 100% after the discussion. After that, full-text screening was done, and there was strong agreement amongst researchers (inter-rater reliability = 82.8%). The agreement was reached to 100% after discussion among the all authors. At the final stage of article screening, 44 studies were selected for inclusion in the current study. Please see Figure 1 for a flow diagram of the systematic search and screening of the relevant articles for this study.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 November 2023 doi:10.20944/preprints202311.0055.v1

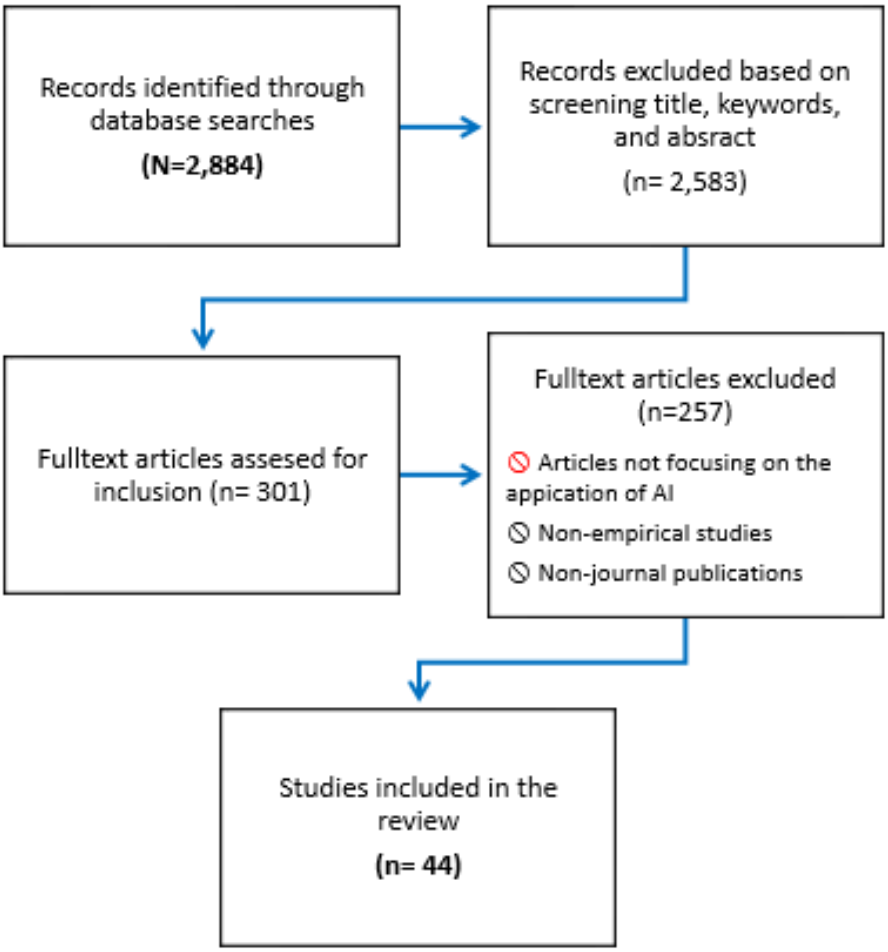

Figure 1. A flow diagram of the screening of relevant articles for the study.

Coding and Analysis

In the next step, the researchers coded the 44 articles. Coding categories were identified to answer the proposed research questions by inductive approach (Thomas, 2006). The authors first attempted to code the selected papers independently. Then, they had a collective virtual meeting to discuss and confirm the coding approaches and findings. All of the authors discussed the results and made decisions by consensus if the findings were unclear. Detailed information about each selected paper was recorded in an Excel sheet, including name of the author(s), publication information (year of publication, journal name, and the countries where the research was conducted), source of searching (databases), title of the paper, purpose of the study, research method, basic information about the study participants, and key research findings/outcomes. Finally, the required information was synthesized to address the four research questions of the current study.

Results

Forty four (44) empirical/evidence-based journal articles, all of which used quantitative, qualitative, or mixed methods of research, met the suitability criteria and were reviewed in this systematic literature review focusing on the integration of artificial intelligence in higher education. The 44 studies involved a combined total of 13,629 participants (consisted of university students, teachers, or librarians) with the minimum sample size of 4 and maximum sample size of 3545. The papers finally included in this review were published in 30 different peer-reviewed journals. Based on the information extracted, we consolidated findings in respect of four research questions, which is presented question-wise in the following sections:

 doi:10.20944/preprints202311.0055.v1

RQ1: Publication Information

In this section, publication's demographic information (i.e., year of publication, journals, and countries where these studies were conducted) of the 44 selected studies is presented. As mentioned in the methodology section, we focused on empirical/evidence based papers that cantered around AI integration into higher education settings. As shown in Figure 2, we did not find any empirical study meeting the inclusion criteria of this system literature review during the years from 2013 to 2018. Only two studies belonged to the year 2019, followed by 7 empirical publications in the year 2020 and 16 publications for 2021. The highest number of publications (n=19) that met the inclusion criteria for this study were published in the year 2022. This clearly shows an increasing patterns of empirical publication in the field of AI in higher education.

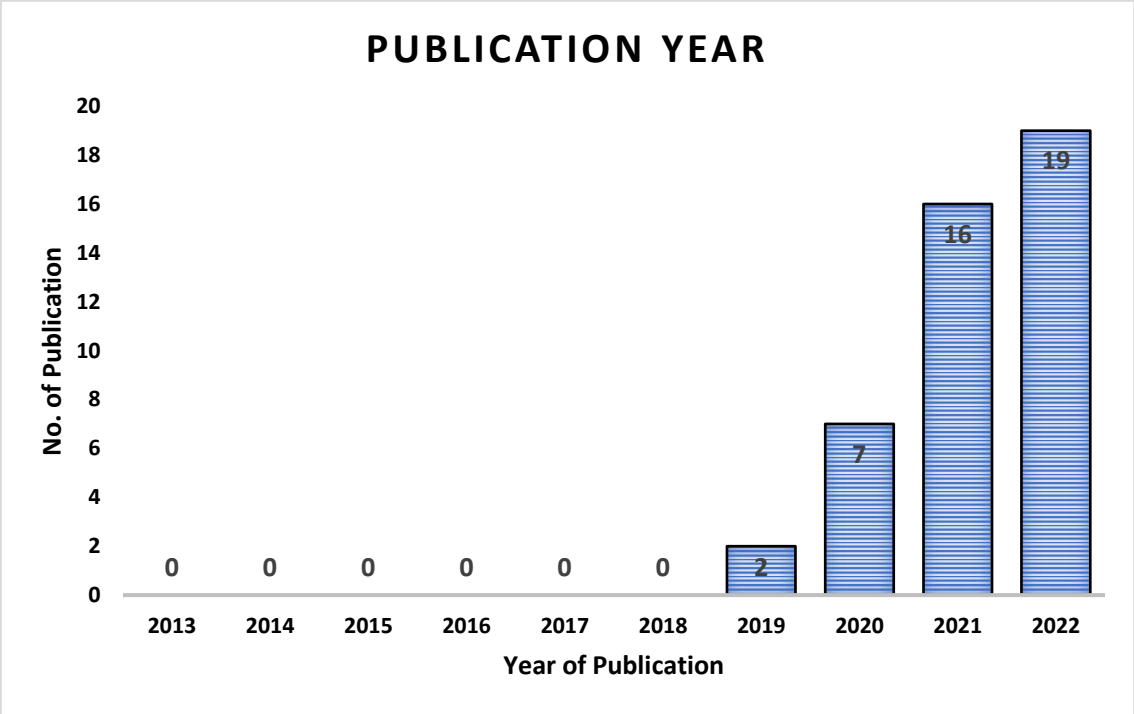

Figure 2. Year-wise Publications.

We also examined the country where the selected studies were conducted. This actually showed the origin of participants or data. Among the 44 selected articles, we were able to identify the specific country for all articles. In order to streamline our categorization, we assumed that all study participants belonged to the country where the investigation took place or from where the authors come from. Based on our coding of the 44 empirical studies, we found that China and United States dominated the selected empirical studies with 7 and 6 publications respectively that is about 29.54 percent (n=13) of the total studies. The next in-line were South Korea, Taiwan, Turkey, and UK, with three publications each that is about 7% of total selected papers. Then, India, Iran, Oman, and Serbia had two (n=2, 4.54%) publications each. The rest of the countries (Ukraine, Nigeria, Nepal, Malaysia, Ireland, Indonesia, Ghana, Finland, Canada, and Australia) had only one (2.27%) publication. It also needs to be noted here that one of the empirical study reviewed in this study involved participants from multiple countries (Lebanon, Greece, and Turkey). Figure 3 provides a glimpse of the publication distribution across the countries.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 November 2023 doi:10.20944/preprints202311.0055.v1

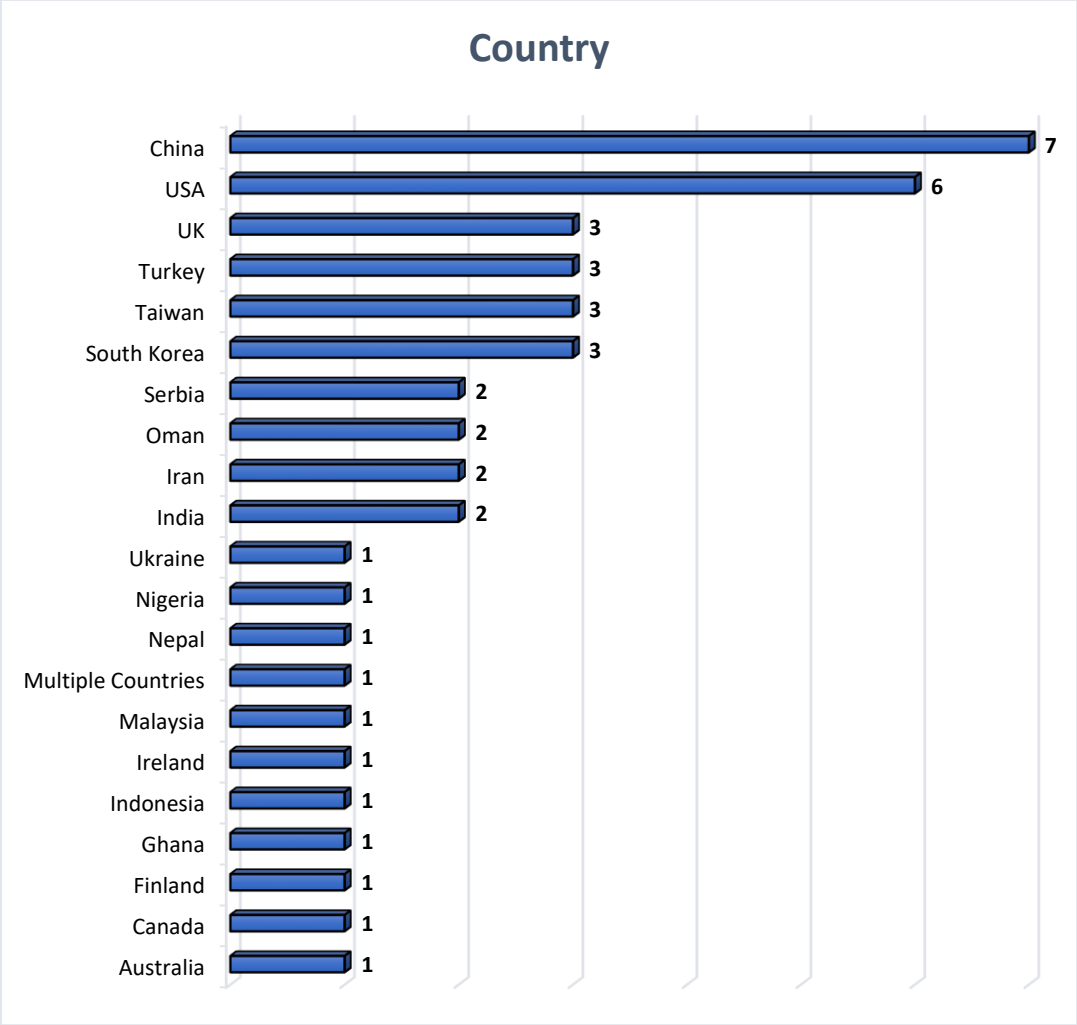

Figure 3. Country of Research Context.

This systematic review found that the empirical studies included were published in 30 different journals belonging to a variety of academic areas. The greatest number of articles (n=4, 9%) were published in two journals each – Interactive Learning Environments and BMC Medical Education. This followed by two (n=2) publications (4.54%) in four journals each - International Journal of Educational Technology in Higher Education, International Journal of Artificial Intelligence in Education, IEEE Access, Educational Technology & Society, and Education and Information Technologies. The rest of the journals, from different fields, carried only one publication for each. See Figure 4 for publication distribution across different journals.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 November 2023 doi:10.20944/preprints202311.0055.v1

Figure 4. Research Journals.

RQ2: Methodology

In this section, analysis of 44 articles with empirical data is described. In terms of research methods, we found that about 64% (n=28) of the studies followed quantitative research methods where many of the studies were surveys and experimental in nature (see Figure 5). Only four article (9%) were purely qualitative which employed interview as the primary source of data collection. Rest of the articles (n=12, 27%) were mixed-method studies. Mixed method studies employed various research designs including surveys.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 November 2023 doi:10.20944/preprints202311.0055.v1

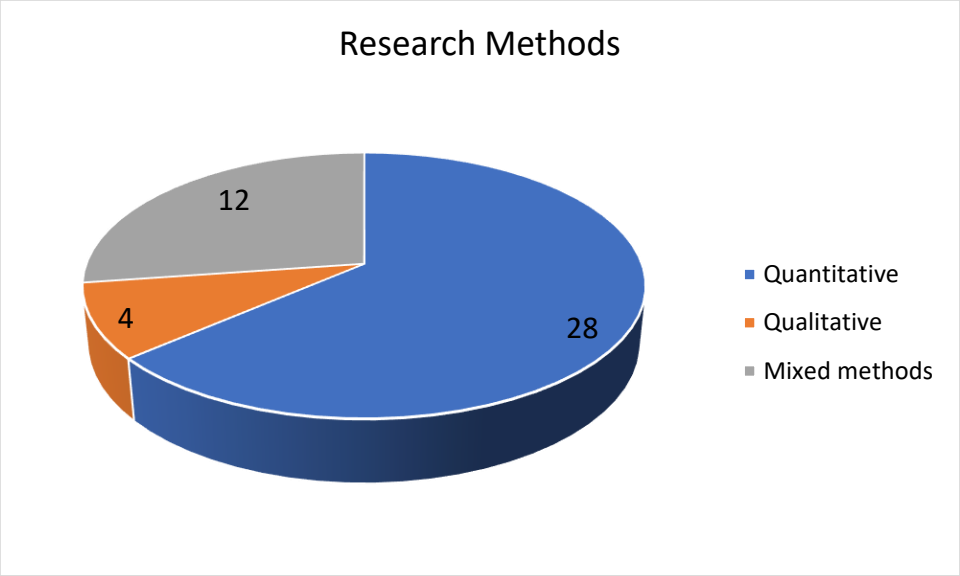

Figure 5. Research Methods of Empirical Studies included in the Review.

RQ3: AI-Supported Functions of Higher Education

The results of this systematic literature review showed that AI technologies are helpful to support various dimensions of higher education and professional training. More prominently, we found that artificial intelligence technologies are helpful in improving the teaching and learning processes in a variety of fields including medical and healthcare education (Banerjee, 2021; Cheng et al., 2020; Connolly, 2022; Jha et al., 2022; Pucchio et al., 2022; Venter et al., 2022), English language (Demir, 2020; Divekar et al., 2021; Ebadi & Amini, 2022; Nazari et al., 2021; Sumakul et al., 2022; Zhang & Xu, 2022), engineering (Bosman, 2020; Deo et al., 2020; Jia et al., 2022), accounting (Damirji & Salimi; 2021), and art learning (Chiu et al., 2022).

The results from this study particularly supported the aspect of personalized learning (Ak-badi et al., 2022; Kuleto et al., 2021; Seo et al., 2021). In terms of specific AI-based tool, we found that the use of Chatbot was the most supported by the evidence (Essel et al., 2022). AI algorithms can analyse vast amounts of data on students' learning patterns, preferences, and performance, and use this information to adapt the learning process to each individual student. By providing customized content, intelligent tutoring, and real-time feedback, AI can help students learn at their own pace and in a way that suits their individual needs. AI can also assist teachers by providing insights into students' progress and identifying areas where they need additional support.

Another major dimension of higher education that can be supported by applying artificial intelligence is predicting students' learning performance in a variety of fields (Deo et al., 2020; Jia et al., 2022; Wang et al., 2022). AI can be used to predict students' learning performance by analysing data on their past academic achievements, learning behaviours, and other relevant factors. AI-based algorithms can identify patterns and correlations between various data points, and use this information to make predictions about students' future performance.

Some empirical studies also supported the positive results of AI technologies in automation processes (Elhajjar et al, 2021), career guidance (Westman et al., 2021) and library management (Abayomi, 2021). These technologies are helpful for automation in education in a variety of ways. In the education sector, AI-powered tools can automate administrative tasks such as grading assignments, tracking attendance, and managing student records. In library management, AI can assist with tasks such as cataloging books, recommending relevant materials to patrons, and managing inventory levels. AI-powered chatbots can provide immediate assistance to library users, answering questions and directing them to relevant resources.

RQ4: Challenges of AI Use in Higher Education

 doi:10.20944/preprints202311.0055.v1

By coding the 44 empirical studies on AI integration in higher education in a bottom-up approach, we were able to identify some concerns regarding the use of artificial intelligence in higher education. These concerns were related to ethical risks (Civaner et al., 2022; Jha et al., 2022) fear of loosing jobs (Abayoni et al., 2020) and violating social boundaries (Seo et al., 2021), that the study participants feel may be encountered while integrating AI-oriented technologies. For example, the participants from Civaner et al. (2022) thought that the knowledge and skills to be able to prevent and solve ethical problems must be an essential part of any educational endeavour. One of the significant challenges is the potential for AI systems to perpetuate bias and discrimination. AI systems are only as unbiased as the data they are trained on, and if the data contains inherent biases, then the system will perpetuate those biases, potentially discriminating against certain groups of students.

Similarly, the participants in another study were of the opinion that AI raising new social and health equity challenges (Jha et al., 2022). Artificial Intelligence technologies have the potential to exacerbate existing social and health equity challenges. One of the significant concerns is that AI algorithms may reflect and perpetuate existing biases in society. AI algorithms could result in disparities in care and outcomes for marginalized communities, as algorithms are only as accurate as the data they are trained on, and data from historically marginalized groups may be underrepresented or biased.

Discussions

The field of artificial intelligence technologies in higher education has grabbed intensive attention of researchers during the years last a few years (Ouyang et al. 2022). In this systematic literature review, we analyzed and synthesized findings regarding the AI integration in higher education and professional development settings. We analyzed the implications of the 44 empirical studies from four perspectives guided by our research questions.

Surprisingly, we had a very hard time getting empirical studies meeting our inclusion criteria. While searching for the relevant paper, we realized that most of the publications in the area of investigation (AI in higher education) published in the last decade is conceptual or theoretical nature in contrast to what we were interested in i.e., empirical research. Conceptual or theoretical research papers are academic works that focus on developing and advancing ideas, theories, and concepts in a particular field of study. They typically aim to contribute to the knowledge and understanding of a specific topic by proposing new theories, models, frameworks, or conceptualizations. In contrast to empirical research papers, which involve collecting and analyzing data, conceptual or theoretical research papers are more concerned with synthesizing existing information and generating new ideas. They may draw on a wide range of sources, including primary research studies, literature reviews, and theoretical works, to develop their arguments and support their claims.

Although we found and reviewed empirical studies that were published in the last three years, more empirical-based investigations are needed in the area of AI integration in higher education for several reasons. Firstly, the use of AI in higher education is a relatively new phenomenon, and there is still much to learn about how best to integrate AI into teaching and learning environments. Since the findings in empirical-based investigations, come from evidence and data, they are more reliable and can help to identify the most effective ways to implement AI in higher education and determine the factors that contribute to successful AI integration (Dan, 2017).

Most of the reviewed articles were quantitative investigations, which often followed an experimental approach. Due to the prevalence of software and expert systems used in the research, it comes as no surprise that many of them were experimental studies designed to evaluate the viability of AI-oriented technologies. These studies often involved a pre-test post-test design. While the studies with experimental design tended to have an extended research period (Seo et al., 2021), the exploratory studies usually relied on participants' perceptions about the possibility of AI-based intervention (Kuleto et al., 2021).

Regarding the scatter-ness in the research on AI use in higher education across the globe, it seems that China and the United States are the most researched countries in the selected empirical

 doi:10.20944/preprints202311.0055.v1

studies, followed by UK, Turkey, Taiwan, and South Korea. The remaining countries had only one to two publication each, except for one study that involved participants from multiple countries. It is interesting to note the dominance of China and the United States in the selected empirical studies. This may be due to the fact that these two countries are major players in various fields of research and innovation, and thus attract a lot of attention from researchers around the world.

The findings from this review suggested that the use of AI in higher education may bring many benefits in terms of teaching and learning, predicting students' learning performance through predicting modeling, and automation of educational processes. The use of predictive modelling is helpful since it allows for foresightful decision-making and provides reliable answers to concerns pertaining to education. Similarly, the automation of educational processes such as in grading of formal courses offered in university and professional development settings would not only help avoid biasness in the assessment practices but also save teachers' time so that they may use their precious time in focusing more on their teaching (Zawacki-Richter et al, 2019). Our results regarding the AI integration in teaching and learning are consistent with previous research suggests that the use of AI in education has enormous potential to improve learning, teaching, assessment, and educational administration by offering students more personalized and adaptive learning, fostering teachers' understanding of students' learning process, and providing anywhere anytime machine supported queries and immediate feedback (Chiu et al., 2023).

Limitations

While this systematic review provides valuable and integrated information on artificial intelligence in higher education, there are several limitations to consider. Firstly, this review included only published articles in English. A systematic review that solely considers English-language publications may have drawbacks because it can introduce linguistic bias and overlook significant studies that were published in other languages. It's likely that pertinent studies published in languages other than English might offer unique viewpoints, findings, or methodological stances that weren't covered in the review. Moreover, papers published in other languages may provide further insights on the integration of artificial intelligence within higher education and professional development settings.

Another primary limitation of the present systematic review was regarding the search words. Although we used the keyword list suggested by the previous literature to search for the relevant papers, we might have left out some published papers as different words might have been used by some empirical studies while focusing on the use of AI in higher education. Lastly, this systematic review focused on empirical studies that published as peer-reviewed journal articles. Other forms of publications such as conference proceedings and book chapters were not included in this research. Future research review may also concentrate on the left-over forms of studies to broaden the scope of literature considered in the field of AI in education.

Conclusion

In this systematic literature review, we analysed and synthesized empirical studies on the integration of artificial intelligence in higher education and professional development settings. We have encountered 44 studies published in peer-reviewed journals between 2013 and 2022. The results of this work suggest that the rapid progression of artificial intelligence technology brings not only opportunities, but also some challenges in its integration in higher education settings. Seemingly, much of the empirical literature on AI in higher education supports the dimensions of teaching and learning, prediction of students' learning performance, and automation of educational processes. As a result of this systematic review, we also recognised a number of research prospects. We believe a more evidence-based empirical research is needed in the field instead of merely relying on conceptual and theoretical papers.

Disclosure statement: No potential conflict of interest was reported by the authors.

 doi:10.20944/preprints202311.0055.v1

References

1. Abayomi, O. K., Adenekan, F. N., Abayomi, A. O., Ajayi, T. A., & Aderonke, A. O. (2021). Awareness and perception of the artificial intelligence in the management of university libraries in Nigeria. *Journal of Interlibrary Loan, Document Delivery & Electronic Reserve*, *29*(1-2), 13-28.
2. Al-Badi, A., & Khan, A. (2022). Perceptions of Learners and Instructors towards Artificial Intelligence in Personalized Learning. *Procedia Computer Science*, *201*, 445-451.
3. Banerjee, M., Chiew, D., Patel, K. T., Johns, I., Chappell, D., Linton, N., ... & Zaman, S. (2021). The impact of artificial intelligence on clinical education: perceptions of postgraduate trainee doctors in London (UK) and recommendations for trainers. *BMC medical education*, *21*(1), 1-10.
4. Bosman, L., Kotla, B., Madamanchi, A., Bartholomew, S., & Byrd, V. (2022). Preparing the future entrepreneurial engineering workforce using web-based AI-enabled tools. *European Journal of Engineering Education*, 1-18.
5. Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*, 75264-75278
6. Cheng, C. T., Chen, C. C., Fu, C. Y., Chaou, C. H., Wu, Y. T., Hsu, C. P., ... & Liao, C. H. (2020). Artificial intelligence-based education assists medical students' interpretation of hip fracture. *Insights into Imaging*, *11*, 1-8.
7. Chiu, M. C., Hwang, G. J., Hsia, L. H., & Shyu, F. M. (2022). Artificial intelligence-supported art education: a deep learning-based system for promoting university students' artwork appreciation and painting outcomes. *Interactive Learning Environments*, 1-19.
8. Chiu, T. K., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 100118. https://doi.org/10.1016/J.CAEAI.2022.100118.
9. Civaner, M. M., Uncu, Y., Bulut, F., Chalil, E. G., & Tatli, A. (2022). Artificial intelligence in medical education: a cross-sectional needs assessment. *BMC Medical Education*, *22*(1), 772.
10. Colombo, E., Mercorio, F., & Mezzanzanica, M. (2019). AI meets labor market: Exploring the link between automation and skills. *Information Economics and Policy*, *47*, 27-37.
11. Connolly, C., Walsh, J. C., Worlikar, H., Ryan, L., Murray, A., O'Connor, S., ... & O 'Keeffe, D. T. (2022). Exploring new frontiers of education using humanoid robots–a case study of patient centred innovation in digital health education. *Irish Educational Studies, 41*(1), 107-115.
12. Damerji, H., & Salimi, A. (2021). Mediating effect of use perceptions on technology readiness and adoption of artificial intelligence in accounting. *Accounting Education*, *30*(2), 107-130.
13. Dan, V. (2017). Empirical and non-empirical methods. In *International Encyclopaedia of Communication Research Methods (pp.* 1-3). Hoboken, NJ: Wiley.
14. Demir, Ü. (2020). The effect of using negative knowledge based intelligent tutoring system evaluator software to the academic success in English language education. *Pedagogies: An International Journal*, *15*(4), 245-261.
15. Deo, R. C., Yaseen, Z. M., Al-Ansari, N., Nguyen-Huy, T., Langlands, T. A. M., & Galligan, L. (2020). Modern artificial intelligence model development for undergraduate student performance prediction: An investigation on engineering mathematics courses. *IEEE Access*, *8*, 136697-136724.
16. Divekar*, R. R., Drozdal*, J., Chabot*, S., Zhou, Y., Su, H., Chen, Y., ... & Braasch, J. (2022). Foreign language acquisition via artificial intelligence and extended reality: design and evaluation. *Computer Assisted Language Learning*, *35*(9), 2332-2360.
17. Dogan, M. E., Goru Dogan, T., & Bozkurt, A. (2023). The use of artificial intelligence (AI) in online learning and distance education processes: A systematic review of empirical studies. *Applied Sciences, 13*(5), 3056. https://doi.org/10.3390/app13053056
18. Ebadi, S., & Amini, A. (2022). Examining the roles of social presence and human-likeness on Iranian EFL learners' motivation using artificial intelligence technology: a case of CSIEC chatbot. *Interactive Learning Environments*, 1-19.
19. Elhajjar, S., Karam, S., & Borna, S. (2021). Artificial intelligence in marketing education programs. *Marketing Education Review*, *31*(1), 2-13.
20. Essel, H. B., Vlachopoulos, D., Tachie-Menson, A., Johnson, E. E., & Baah, P. K. (2022). The impact of a virtual teaching assistant (chatbot) on students' learning in Ghanaian higher education. *International Journal of Educational Technology in Higher Education*, *19*(1), 1-19.

21. Jha, N., Shankar, P. R., Al-Betar, M. A., Mukhia, R., Hada, K., & Palaian, S. (2022). Undergraduate Medical Students' and Interns' Knowledge and Perception of Artificial Intelligence in Medicine. *Advances in Medical Education and Practice*, 927-937
22. Ji, H., Han, I., & Ko, Y. (2022). A systematic review of conversational AI in language education: focusing on the collaboration with human teachers. *Journal of Research on Technology in Education*,*55*(1), 48-63. https://doi.org/10.1080/15391523.2022.2142873
23. Jiao, P., Ouyang, F., Zhang, Q., & Alavi, A. H. (2022). Artificial intelligence-enabled prediction model of student academic performance in online engineering education. *Artificial Intelligence Review*, 1-24.
24. Kaur, D., Uslu, S., Rittichier, K. J., & Durresi, A. (2022). Trustworthy artificial intelligence: a review. *ACM Computing Surveys (CSUR), 55*(2), 1-38. https://doi.org/10.1145/3491209
25. Kuleto, V., Ilić, M., Dumangiu, M., Ranković, M., Martins, O. M., Păun, D., & Mihoreanu, L. (2021). Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. *Sustainability*, *13*(18), 10424.
26. Marengo, A., Pagano, A., & Monopoli, G. (2015). Automatic Learning Path Design: development and implementation. *WSEAS Transactions on Advances in Engineering Education*, 12, 1-8.
27. Nazari, N., Shabbir, M. S., & Setiawan, R. (2021). Application of Artificial Intelligence powered digital writing assistant in higher education: randomized controlled trial. *Heliyon*, *7*(5), e07014.
28. Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2022). A review of AI teaching and learning from 2000 to 2020. *Education and Information Technologies*, 1-57.
29. Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B. P. T. (2022). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, 1-21.
30. Ouyang, F., Zheng, L., & Jiao, P. (2022). Artificial intelligence in online higher education: A systematic review of empirical research from 2011 to 2020. *Education and Information Technologies*, *27*(6), 7893-7925.
31. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International journal of surgery*, *88*, 105906. http://dx.doi.org/10.1136/bmj.n71
32. Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning, 12*(1), 22. https://doi.org/10.1186/s41039-017-0062-8
33. Pucchio, A., Rathagirishnan, R., Caton, N., Gariscsak, P. J., Del Papa, J., Nabhen, J. J., ... & Moraes, F. Y. (2022). Exploration of exposure to artificial intelligence in undergraduate medical education: a Canadian cross-sectional mixed-methods study. *BMC Medical Education*, *22*(1), 815.
34. Rudolph, J., Tan, S., & Tan, S. (2023). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education? *Journal of Applied Learning and Teaching, 6*(1). https://doi.org/10.37074/jalt.2023.6.1.9
35. Seo, K., Tang, J., Roll, I., Fels, S., & Yoon, D. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. *International journal of educational technology in higher education*, *18*, 1-23.
36. Sharma, V., Goyal, M., & Malik, D. (2017). An intelligent behaviour shown by chatbot system. *International Journal of New Technology and Research*, *3*(4), 263312.
37. Sumakul, D. T. Y., Hamied, F. A., & Sukyadi, D. (2022). Artificial Intelligence in EFL Classrooms: Friend or Foe?. *LEARN Journal: Language Education and Acquisition Research Network, 15*(1), 232-256.
38. Tahiru, F. (2021). AI in education: A systematic literature review. *Journal of Cases on Information Technology (JCIT)*, *23*(1), 1-20.
39. Tahiru, F. (2021). AI in education: A systematic literature review. *Journal of Cases on Information Technology (JCIT)*, *23*(1), 1-20.
40. Tang, Y., Liang, J., Hare, R., & Wang, F. Y. (2020). A personalized learning system for parallel intelligent education. *IEEE Transactions on Computational Social Systems*, *7*(2), 352-361.
41. Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American journal of evaluation*, *27*(2), 237-246. https://doi.org/10.1177/1098214005283748
42. van de Venter, R., Skelton, E., Matthew, J., Tarroni, G., Hirani, S. P., Woznitza, N., ... & Malamateniou, C. (2022). A postgraduate introductory module in artificial intelligence for radiographers: experiences of students and educators. *Journal of Medical Imaging and Radiation Sciences*, *53*(4), S7.
43. van der Vorst, T., & Jelicic, N. (2019). Artificial Intelligence in Education: Can AI bring the full potential of personalized learning to education?. In 30th European

44. Conference of the International Telecommunications Society (ITS): "Towards a Connected and Automated Society", Helsinki, Finland.
45. Wang, S., Sun, Z., & Chen, Y. (2022). Effects of higher education institutes' artificial intelligence capability on students' self-efficacy, creativity and learning performance. *Education and Information Technologies*, 1-21.
46. Wang, S., Wang, H., Jiang, Y., Li, P., & Yang, W. (2021). Understanding students' participation of intelligent teaching: an empirical study considering artificial intelligence usefulness, interactive reward, satisfaction, university support and enjoyment. *Interactive Learning Environments*, 1-17.
47. Westman, S., Kauttonen, J., Klemetti, A., Korhonen, N., Manninen, M., Mononen, A., ... & Paananen, H. (2021). Artificial Intelligence for Career Guidance--Current Requirements and Prospects for the Future. *IAFOR Journal of Education*, *9*(4), 43-62.
48. Xia, Q., Chiu, T. K., Zhou, X., Chai, C. S., & Cheng, M. (2022). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 100118.
49. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators?. *International Journal of Educational Technology in Higher Education*, *16*(1), 1-27. https://doi.org/10.1186/s41239-019-0171-0
50. Zhai, X. (2022). ChatGPT user experience: Implications for education. *Available at SSRN 4312418*.
51. Zhang, L., Fu, K., & Liu, X. (2022, February). Artificial Intelligence in Education: Ethical Issues and its Regulations. In *Proceedings of the 5th International Conference on Big Data and Education* (pp. 1-6).
52. Zhang, Z., & Xu, L. (2022). Student engagement with automated feedback on academic writing: a study on Uyghur ethnic minority students in China. *Journal of Multilingual and Multicultural Development*, 1-14.