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Artificial intelligence and higher education: a systematic visualizations based review

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Abstract

Artificial intelligence (AI) is evolving quickly, and its applications are attracting attention on a global scale. They have the potential to revolutionize many dimensions of human life, including education. AI has reformed various teaching methodologies, assessment methods and by enhancing their competitiveness and adaptability. In the current era, after the pandemic most preferably the AI and Education have interwoven and is continued to grab the attention of Academicians, Tutors, Instructors, the government, and students so that the research keeps AI and education intermingled for the benefit of society at large. The goal of our work is to present a visualization in form of the research trends and bibliometric analysis of research on the implementation of AI in HE during the 20 years. The study involves various parameters to include and exclude the research articles, we assessed 314 publications written by scientists in 67 different countries over the course of the last 20 years and included in the Scopus database. The study used word analysis and a variety of bibliometric markers to look at emerging patterns. In order to visualize the prominent research trends by locating keywords utilized inside AI in HE, VOSviewer was used. The findings display the annual publication rate of AI publications, as well as their regional distribution, subject- and keyword-level analyses, and research trends. Computer science and engineering disciplines dominate the interdisciplinary research in AI. AI research in HE is expanding; in the last five years have produced 78%, compared to 22% over the first 15 years. China and the United States are at the forefront of AI development, which is dominated by nations with significant research expenditures. There is hardly any research coming from poor nations. This work illustrates the limitations of AI in education research as well as its current and future possibilities.

KEYWORDS: Artificial Intelligence, Higher Education, VoSviewer, Bibliometric Analysis.

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1. Introduction

Artificial Intelligence in Education (AIED) offers the potential to raise standards, boost productivity, and give all students more equitable access to education. The use of artificial intelligence (AI) in education will have a big impact on how education is offered in the future. A multitude of applications and evaluation platforms that help with skill development already use AI in education. The AIED educational solutions will bridge the

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knowledge and teaching gaps and augment the educational system and academicians to work more efficiently. AI imparts customization of the teaching-learning system and streamlines academic administrative processes, providing teachers the time and freedom to concentrate on the cognitive capacities of the human being which would else are sacrificed in the stereotypical educational system. The finest use of artificial intelligence (AI) in education is when professors and robots work together to get the best outcomes for students. Another cutting-edge technology called artificial intelligence and machine learning is starting to change how educational tools and institutions work and what the future of education might entail, while educators, psychologists, and parents continue to debate the appropriate amount of screen time for children. As per the US Education Sector report on AIED in the time frame of 2017-2021, artificial intelligence in education will have an exponential rise by 47.5%. Even if the majority of experts believe that teachers' significant contribution is irreplaceable, there will be many changes to the teaching profession and the best practices in education.

2. Literature Review

This section covers a literature review to provide a review and brief of the existing research. It involves reviewing and evaluating scholarly articles, books, and other published works relevant to the topic at hand. The primary purpose of a literature review conducted is to provide a systematic overview with the help of the related work carried out earlier by various researchers and visualize it through various trends.

The section is composed of two subsections highlighting different aspects of the research review. The first sub-section generates a visualization of the research carried out and the second sub-section presents the combined journey of implementing AI in education.

2.1 Systematic Literature Review

To begin a literature study, similar publications are found, and a thorough scrutiny of the existing literature is conducted. The authors of this article are having studied the history of AIED and its involvement in multiple article types. A search query with Education and artificial intelligence OR AI for the span of 10 years was being generated which resulted into the list of documents generated.

To search the query IEEE Xplore was chosen, it has a total of 5917890 items to facilitate the user query. Millions of articles from the top technological journals, conference proceedings, and standards are available in IEEE Xplore, a digital library run by the Institute of Electrical and Electronics Engineers (IEEE) and its collaborators. It gives users access to full-text publications in a variety of relevant disciplines, including electrical engineering, computer science, and telecommunications. The search query was pertaining to 'education' or 'e-learning' or 'e-learning' and 'artificial intelligence' or 'AI' for the time span from 2012-2022 found in the publication title. A total of 2893, articles were being generated, out of which 2000 articles considered to be of more 'relevance' were being considered.

According to an analysis of the IEEE Explore research database, the notion was actually started booming in the year 2017 (Chen et al., 2022; Luan et al., 2020). The concept has gained momentum from the year 2000 and is popular in last few years; this same is visualized using the data set generated from IEEE explore Intelligence tool Figure 1. To show the adoption of artificial intelligence technology in the education sector the following line chart illustrates and is drawn using Tableau tool. The Tableau version considered is 2022.4.

In an attempt to find popular publication terms with respect to the current study, the top 25 publication topics were being considered and are being visualized. The few popular terms are: computer-aided instruction, educational courses, educational institutions, teaching, further education, computer science education, engineering education, Internet, distance learning, educational administrative data processing, virtual reality, software engineering, computer games, human factors, innovation management, learning artificial intelligence.

In an attempt to find popular states/Countries with respect to the current study, the top 25 publication topics were being considered and are being visualized. The top 5 countries' terms are Madrid, Spain; Uppsala, Sweden; Dubai, United Arab Emirates; Porto, Portugal; Vienna, Austria.

2.2 Related work

AI is one of the disruptive technology it focuses on smart machines, which are capable of observing their environment and acting in ways that will increase their chances of success (Shabbir & Anwer, 2018). The phrase "artificial intelligence" enabled system is computers with a tremendous amount of processing capacity, adaptive behavior to function more 'human like' behavior adapting the situation and taking decisions with cognitive abilities (Chen et al., 2020). In simple terminology, Artificial intelligence develops learning abilities through computer-created software and applications. Artificial intelligence to design and development of effective programs, methods, and algorithms to perform which else require human intelligence (Mitchell, 2019). In order words it is the act of simulating human intelligence by developing various functions, protocols, and standards is called artificial intelligence. AI-powered education comes along with its strengths, opportunities, and challenges since its initiation (Limna et al., 2021).

Over the last three decades and especially after the pandemic the growth of AI-based tools as more of virtual reality, virtual classroom environment, virtual

educators, and a mechanical evaluation system; the changes are tremendous (Roll & Wylie, 2016). The AIED depends highly on computational and information-processing tools (Ouyang & Jiao, 2021). AI in education opens up new possibilities, difficulties, and opportunities for educational methods (Alam, 2021). Several artificial intelligence concepts have been developed as a result of robotics research, and certain technologies can be applied to this field of study to create models of world states and explain how they change (Hwang, 2014). AIED education is student-centric providing students with a customized learning experience and assisting them as per their learning levels, priorities, and cognitive skills (Hwang et al., 2020). AI in education also aims to use AI to support the instructional process, which is crucial and where instructors' acceptance of AI is crucial. The instructors require computer-aided assistance for the collaborating education and provide predictive analysis through using data mining by generating various data patterns on the outcomes. But because AI is still a relatively new idea to instructors, they frequently have trouble responding quickly and effectively to insights from AI-enabled applications. As a result, they are less willing to adopt AI and are less open to it. Therefore, it seems crucial to increase instructors' acceptance of AI systems (Chen et al., 2022).To handle the new opportunities and opportunities provided by disruptive technologies such as big data, AI, machine learning, and soft computing; the various stakeholders' government, academicians, educators, policymakers, and professionals must collaborate and form an AI-based education eco-system. In this 21st century, where technology is available at the fingertip, all the aforementioned stakeholders must identify the KSA – Knowledge-Skills-Attitude component so that they get ready to be assimilated by the industry (Luan et al., 2020). These components are developed by using integrated learning systems, open education, effective and efficient grading systems, and immersive education tools (Yufeia et al., 2020; Owoc et al., 2019).

3. Bibliometric analysis

One of the most commonly used metrics in the bibliometric analysis is the citation count, which measures the number of times a paper has been cited by other researchers. This metric is often used as an indicator of the impact and influence of a particular paper or research output. Apart from citation count, h-index, i-index and journal's impact factor plays an important role to determine the quality of the research article publication and the publication journal too. The bibliometric analysis creates the clusters of the keywords, interrelation of authors, citation coupling, and interrelation of the publication country thus providing a 360-degree visualization of the dataset. This visualization is augmented by the analysis report showcasing the relevance, and occurrence count. It also creates the visualization in three forms Network, Overlay, and Density visualization to provide diverse and alternate views of the data pattern thus generated. Bibliometric analysis has become an important tool for research evaluation, funding allocation, and policymaking, but it is important to note that it has limitations and should not be used as the sole criterion for evaluating the quality or significance of the research.

3.1 Research themes and related literature

The most significant words 'keywords' as specified by the author in the research article are considered from the 'title/abstract fields' of papers on the literature related to education and AI with the least occurrence of 432 (70% of the minimum occurrences of the terms) from 30538 terms distributed in four clusters as shown in Figure 2:

1. The Cluster-1 (red) features 80 items and was organized alphabetically by the following topic: artificial intelligence, blockchain, big data, college, IoT, information technology, management, and platform.
2. The Cluster-2 (green) featured 67 items and was organized alphabetically by the following topics.: assignment, curriculum, engineering, educator, literature, gamification, project, programming, science,
3. The Cluster-3 (blue) featured 60 items and was organized alphabetically by the following topics: algorithm, device, engineering, experiment, project, science, simulation, video exercise, test,
4. The Cluster-4 (light green-yellow) featured 52 items and was organized alphabetically by the following topics: adoption covid, class face, influence, learning, pandemic, questionnaire, and response.

The study thus affirms that the clusters thus created concentrate majorly on technology usage articles, pandemic impact articles, and teaching-learning-evaluation process-related articles.

3.2 The Citation map

The authors were also keen to know the citations of the AIED term, so a citation ma was being created using the CitationGecko website as shown in Figure 4.

4. Discussion

A few of the uses of AI that are being employed fast in educational contexts are customized learning applications, automatic evaluations, social media platforms, and predictive analytics tools (Akgun & Greenhon, 2021). (AI) tools have the promise of helping both educators and learners by providing instruction in blended classrooms, providing students and teachers with periodic reviews, guidance, and suggestions on their cognitive skills, and providing teachers the freedom of being available and accountable 24*7. This will help students as they study, analyze, communicate,

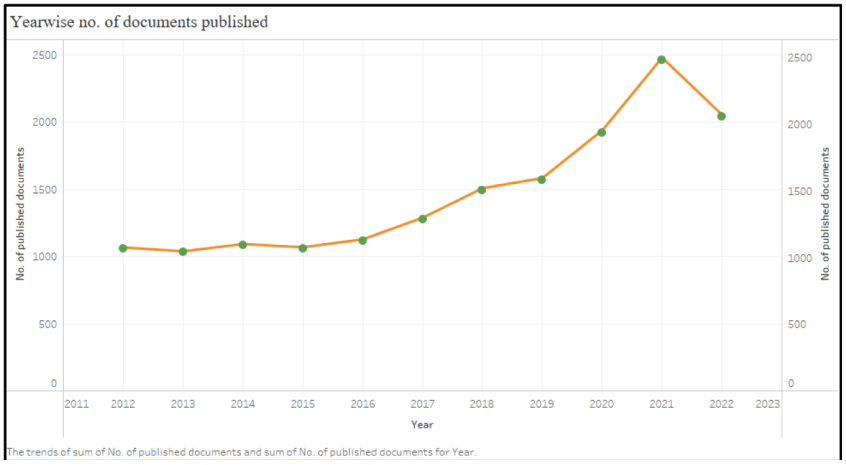

Figure 1 - Year wise publications w.r.t research query (education and AI) IEEE explore from 2012-2022.

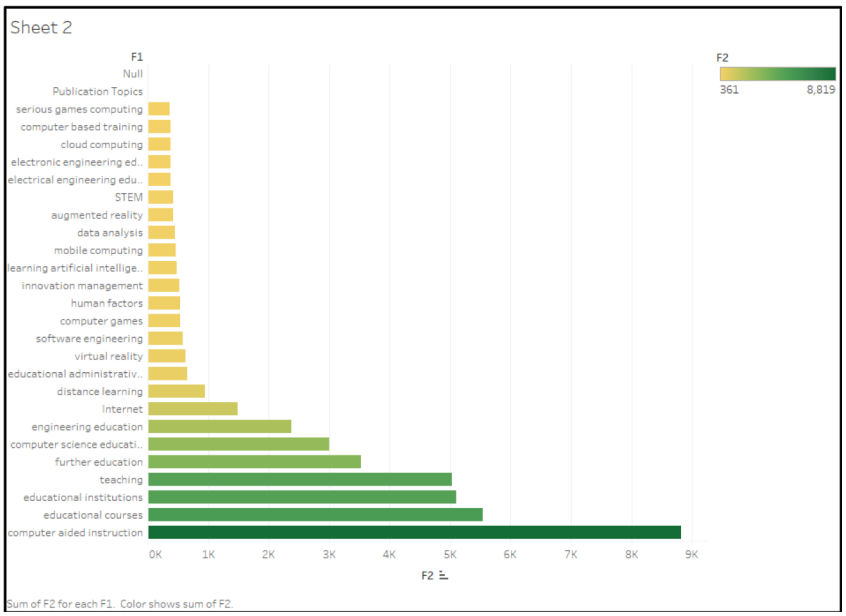

Figure 2 - Top 25 Publication topics w.r.t research query (education and AI) IEEE explore from 2012-2022.

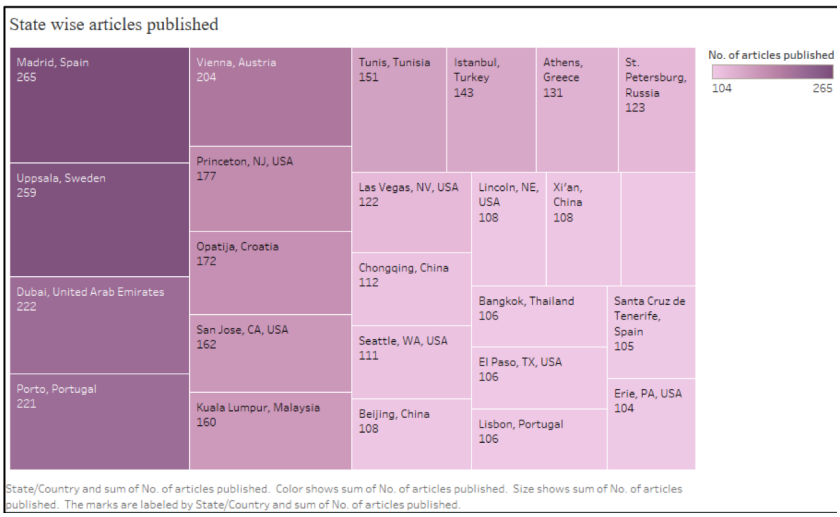

Figure 3 - Top 25 Countries w.r.t research query (education and AI) IEEE explore from 2012-2022.

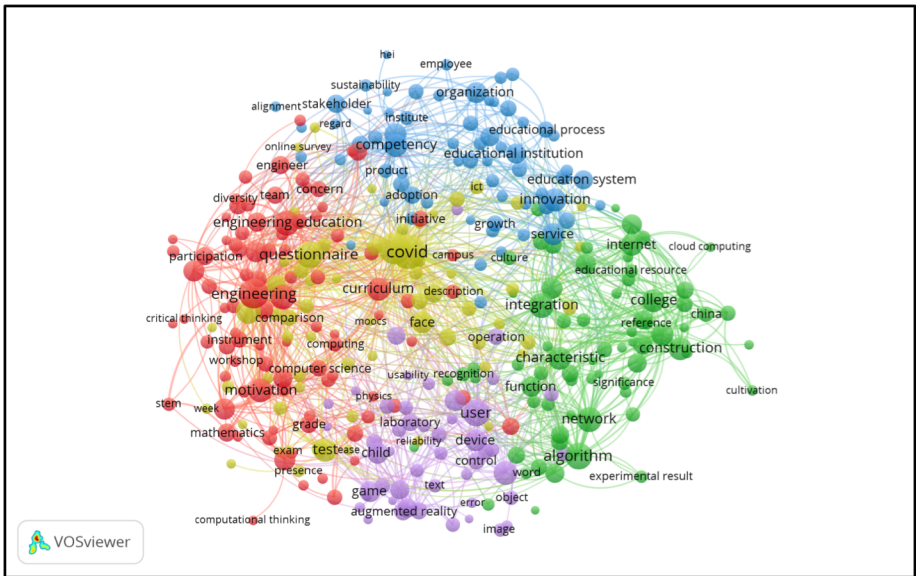

Figure 4 - Network visualization map of terms found in document title and abstract fields. The minimum number of times the phrases were used was 20. The Visualisation showcases four clusters in bibliometric analysis generated through VOSviewer.

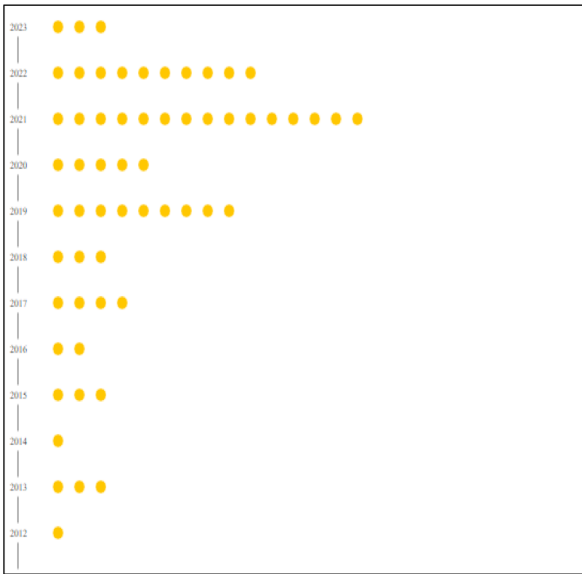

Figure 5 - Citation map.

and assemble information and represent it as part of their collaborative knowledge-building processes, and so on (Miao et al., 2021; Kim et al., 2019). Social networking sites use platforms like Facebook to link up students and teachers. The use of social media in the classroom can encourage students to actively learn, collaborate, and interact with networks outside of the classroom. Due to the varied AI systems and smart applications such as chatbots are found on social media platforms, e-learning portals, and institutes' websites (Tiwari, et al., 2022). Customized learning settings, also known as adaptive learning environments or intelligent tutoring environments, are common and helpful ways that artificial intelligence (AI) can help teachers and students. These intelligent tutoring environments allow students access to a variety of e-learning materials based on their areas of interest and technical operating systems. One of the most exciting uses of AI in education is adaptive learning. While the one-size-fits-all nature of the traditional classroom education approach persists, adaptive learning systems powered by AI are intended to maximize learning effectiveness. Notwithstanding these benefits, there are still valid worries. Privacy is one main issue. The two major concerns bought to the plate as an invasion of privacy and the unpredictability of ridesharing technology. The system of organizing, collecting, controlling, storing, using, archiving, and destroying data is the subject of data governance (Pabby & Kumar, 2017). A specialized program defined policies and processes, as well as communication from organizational leadership and

management, all work together to establish data governance. Generally speaking, the regulations must offer all required tools for upholding the general standards, which include audibility, security, completeness, accuracy, integrity, and accessibility. The effective use of big data analytics and AI depends on the application of the traits linked to each technology. It is possible for this person to apply substantial data analysis to support analysis and decision-making because they have the knowledge and analytical skills necessary (Tong-On et al, 2021). A recent study provides research on imparting AI in education. First, it is significant to know the implications of covid-19 coronavirus on the overall education system including the processes and persons as shown in the bigger 'bubble' at the central part of Figure 3. Future educators, governments, universities, policymakers, and other stakeholders need to understand the dynamics of education with the changing global scenario including the covid outbreak.

5. Conclusion

The development of AI technology has a lengthy history and is ongoing. Since the advent of computing and information processing technologies, AI has found widespread application in education because it presents new opportunities, problems, and possibilities for educational practises. Both good and negative effects of AI technology on teaching and learning are seen in the educational sector. AI in education has opened up new possibilities for designing learning environments and activities that make better use of technology. The use of AI technology in education is crucial for a number of reasons, including sautonomous grading, adaptive learning, and teacher feedback. Depending on their individual topic areas and learning demands, AI applications provide students with access to a variety of educational resources. When integrated with other intelligent systems, AI technology has the potential to assist and improve distant learning.

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