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EDUCATIONAL TRANSFORMATION: A BIBLIOMETRIC AND SCIENTOMETRIC ANALYSIS OF AI IN HIGHER EDUCATION

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ABSTRACT
The usage AI in postsecondary educational settings has attracted a lot of scholarly interest recently. Through bibliometric and scientometric analysis, this study investigates this expanding subject by looking at publication trends, well-known authors and sources, and thematic landscapes. It's possible that the COVID-19 pandemic and the move toward online learning settings hastened the investigation of AI in the classroom. The main aim of this research is to evaluate the current knowledge state in this field. We conducted a bibliometric analysis on papers that we obtained from the extensive academic database Scopus. Relevant search terms like "artificial intelligence," "e-learning," "higher education," and possibly "covid-19" were used in the search strings. After extracting and cleansing the data, co-citation patterns, author productivity, and publishing trends were examined using scientometric approaches. To further illustrate the study landscape and pinpoint burgeoning or waning themes, thematic maps were also created. According to the analysis, there has been a remarkable upsurge in publications on AI in higher education starting in 2020. Keyword research revealed a concentration on the terms "artificial intelligence," "e-learning," "higher education," and "covid-19," indicating a focus on the use of AI in facilitating online learning during the pandemic. A power law distribution compatible with Lotka's Law was found in theauthorship study, showing a bigger group of writers with fewer publications alongside a small number of extremely productive authors. The authors and publications that received the most citations were determined, offering insights into significant studies conducted in the area. Bradford's Law was further supported by the study, which identified a core set of journals that
publish a high concentration of pertinent articles. Four major thematic clusters were found by thematic map analysis: niche themes (specialized subjects), core themes (important fields like artificial intelligence and higher education), motor themes (advancing research), and perhaps dwindling or developing themes.

Keywords: Artificial Intelligence; Higher Education; Bibliometric Analysis; VOSviewer; Biblioshiny.

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1. INTRODUCTION

The promise of AI to transform teaching, learning, and administrative procedures has made AIa hot topic in higher education. By automating administrative activities, enhancing personalised learning, and generating insightful data through data analysis, the integration of AI technologyin educational settings holds great potential (Chen and Wang, 2021). For this reason, a thoroughexamination of the effects of AI in higher education using bibliometric analysis is necessary tocomprehend present trends, pinpoint important areas for research, and consider potential futuredevelopments in this field (Smith and Johnson, 2022).

Living and working situations have obviously changed as a result of AI, which has also broughtabout a global systemic upheaval. Work and everyday routines, which are primarily related to artificial intelligence, have expedited the development of intelligent design and realisation of worlds' level change solutions (Kandlhofer et al. 2016; Sales 2019). Notably, throughout the course of the last 20 years, big data and machine learning have emerged as significant phenomena that have significantly influenced AI education. The increasing demand foreducation and the enactment of particular national policies have led to an expansion of the bodyof knowledge on educational artificial intelligence (EAI). These elements have also sparked the development of an exciting new area of study that integrates AI with education. The role of AI (Drigas and Ioannidou 2013), the global evolution of intelligent tutoring systems (Han etal. 2019), and the changing nature of teacher-student collaboration (Guilherme 2017) are a fewexamples of the varied perspectives and content that have been highlighted in studies on the current trends of AI in education (Roll et al. 2011).

According to (Christie and de Graaff, 2017), the overarching goals of AI are to build robots that can learn, reason, make decisions, and adjust to changes just like people. The three most popular AI applications in education are machine learning (ML), learning analytics (LAs), andeducational data mining (EDM). Big data, which is defined as complex and massive amounts of data that represent human behaviour, is collected by devices like scanners, telephones, cameras, and social media platforms. Processing big data necessitates the use of non-traditionalmethods (Riahi and Riahi, 2018). Big data analytics is used in the acquisition, analysis, and evaluation of complex and massive data sets because traditional data management techniques are unable to handle large heterogeneous data sets (Lazer et al., 2014). Less developed countries have to catch up to developed countries in order to deploy and embrace AI-driven applications because of insufficient infrastructure, a lack of technology, a lack of policies, anda lack of experience with data science. Ethical conundrums arise with the acquisition and storage of large amounts of data. There has been a surge in research on AI-driven educational applications during the past few decades. The out fashioned one-size-fits-all educational paradigm is gradually being substituted by AI-enabled precision learning. In order to maximizethe learning process, this strategy employs timely interventions, anticipates student performance, and takes into consideration learner variances and present learning circumstances(Tsai et al., 2020). Most research on AI in higher education is done in wealthier countries because most impoverished countries are still in the early phases of the field. As AI-based technologies are implemented in businesses and organizations, socioeconomic growth will be based on higher educations' successful acceptance of AI. Since higher education researches onAI has been steadily increasing, this bibliometric analysis looks at the field's current state, trends, and potential directions for future study. The preliminary work (Maphosa and

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Maphosa,2021) is expanded upon in this paper. A mini-review that provided an overview of AI research and higher education made up the conference work. This bibliometric analysis employs additional techniques to assess the status, trends, top contributors, and emerging hotspots. Theuse of AI in higher learning is now been comprehensively delved and used; this has been provedby the previous studies and quoted literature. The bibliometric analysis ponders on noteworthytrends, cited works, and collaborative communities within this field that is still evolving. In the past, there has been a huge number of publications especially around 2020-2022, due to Covid-19 researchers had to shift to the online.

2. LITERATURE REVIEW

The use of AI has vividly reformed the way of doing academic research by both innovation incase of methodology and shifts in research thoughts (Pal, 2023). Artificial Intelligence has its origin in the field of engineering and computer science which ignites and uses human's intellectual behaviour for fine decision making by the application of various theories and models (Naqvi et al., 2020). The espousal of smart phones, wireless technologies, and other dynamic technologies aids organizations accumulate and stock quantum's of data to assist decision-making. AI helps in automating the entire gamut of tasks related to speech and imagerecognition, applications in the area of drone, agriculture and manufacturing (Maphosa and Maphosa, 2023).

The incorporation of AI in education stimulates the student's decision-making ability by accessing available resources like e-books and virtual reality. Researchers have seen a surge inthe use of AI technologies, thereby resulting in its applications in the area of academics. This is expected to grow exponentially (Zheng et al., 2023). The higher education institutions (HEI)have been doing extensive research on AI applications and the success rate is a good sign for future researchers (Chatterjee and Bhattacharjee, 2020; Zawacki-Richter et al., 2019; Popenici and Kerr, 2017).

AI in the field of education advances the quality of the mentioned sector as its application creates an ease for the stakeholders like teachers and students to perform more of learning by doing plethora of activities in varied subjects (Kong, 2020), (Anagnostopoulou et al., 2020). Massive parallel research on AI in education has created a substantial pool of data related to its applications with respect to design, its efficacy and most importantly its outcomes (Chiu etal., 2023). Also, ample studies illustrate that AI has been an instrumental catalyst in reductionof human error while collecting data and analyzing that (Burger et al., 2023; Neyedli etal., 2011).

Scholars occasionally draw comparisons between AI that is strong and weak (Wells, 2023). Strong AI, usually referred to as artificial general intelligence, includes a wide range of humancompetencies such as cognitive and emotional responses, communication, and multitasking. Only human competencies are facilitated by weak AI, which uses algorithms to solve complexproblems like scam identification and sports-like competency. Now a days AI applications arecreated and improvised for strengthening teaching-learning accomplishments as content creation and broadcasting, collaborations and final assessments (Chassignol et al., 2018, Perrotta and Selwyn, 2020).

Academic studies on AI have emphasised the importance of human designers for AI applications (Andersen et al., 2022, Xu and Ouyang, 2022 and Ouyang & Jiao, 2021).Generative AI aims to support and immerse users in the complete job accomplishment processwhile developing applications for novices in senior headship roles (Ouyang & Jiao, 2021).

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Research questions

- What is the global trend of scientific publications on application of AI in highereducational institutions?
- What is the conceptual framework of study in this field?
- What are the future directions of study in this subject?

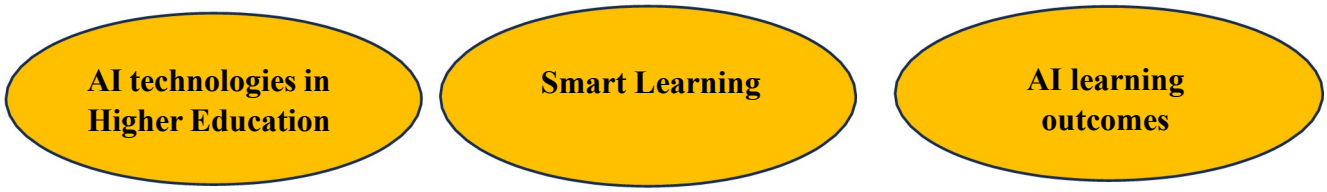
Research objective

- To map the current trends of research in the field of application of AI in highereducation institutions.
- To assess the conceptual structure of various research articles based on usage of AI inhigher education institutions.
- To identify future research directions on application of AI and Fintech for financialInclusion.

2.1 Conceptual Structure

AI and big data technologies can be applied to analyse and classify the massive amounts of data generated at higher education institutions. Institutions can create customized student profiles by combining data on engagement habits, academic choices, and performance to betterpredict and meet the requirements of their students. When compared to conventional techniques, this exact targeting increases the effectiveness of educational strategies (Yu, 2019).A solid framework for incorporating AI into personalized learning practices was presented by(Kumar et al., 2019). With this framework, educational institutions can use AI to evaluate student data and provide individualized learning experiences. Furthermore, school administrators can improve and optimize their services for students by utilizing AI's ability tolearn continuously.

By using AI, educational institutions may better segment their markets, anticipate the requirements and preferences of their students, and create individualized curriculum, marketingcampaigns, and cost plans. Ultimately, leveraging AI can foster greater inclusion within highereducation by addressing the needs of underserved or underrepresented student populations. Figure 1.0 illustrates the conceptual application of AI in the educational sector. Adoption of AI technologies by institutions can lead to smarter educational practices, reduced service deliverycosts, enhanced targeting of prospective students, improved risk assessment for academic decisions, better predictive modeling of academic performance, and the implementation ofcustomized educational approaches.



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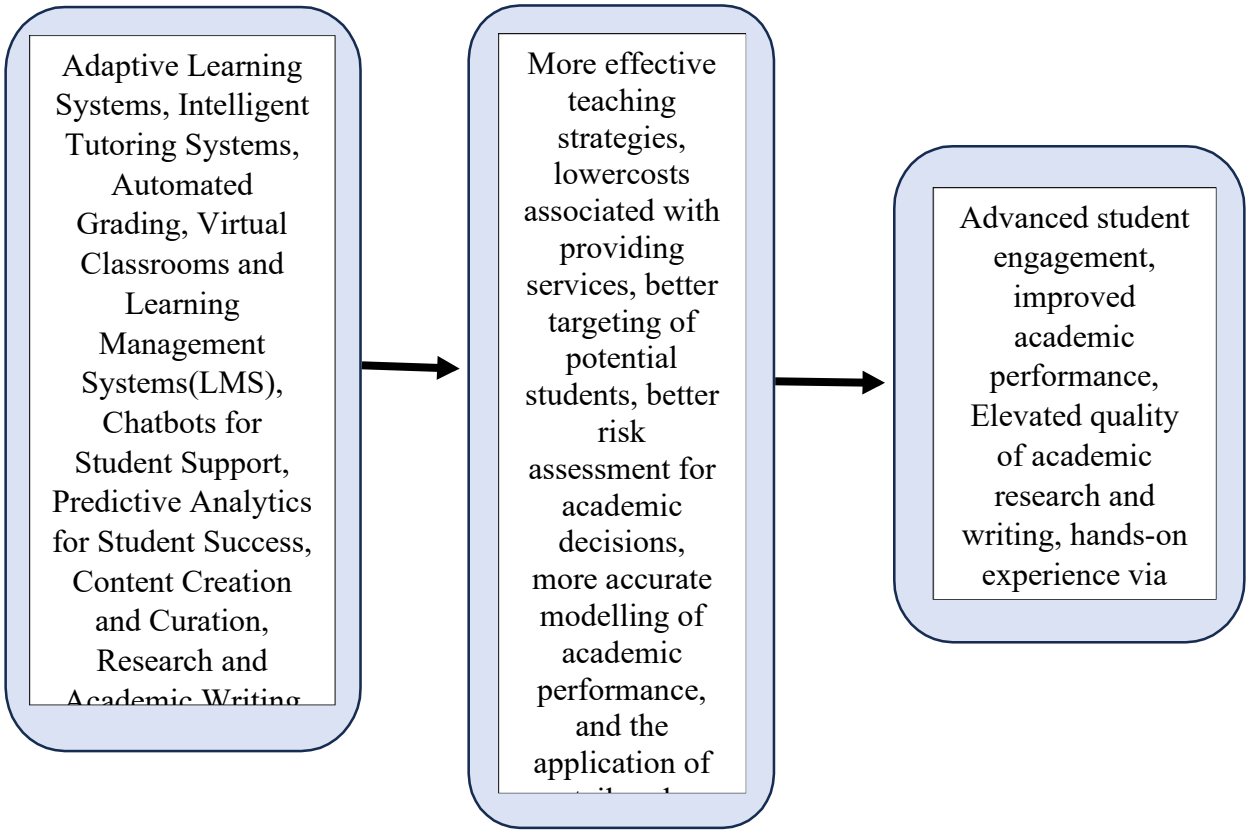

Figure 1. Conceptual model of application of AI in higher educational institution

3. METHODOLOGY

Bibliometrics is the quantitative process and analytical techniques used to bibliographic data. (Pritchard, 1969). The basic purpose of this analysis is to apply quantitative tools to translatescientific quality into something physical and meaningful (Wallin, 2005). These tools areunaffected by the writers' own ideas. The bibliometric technique consists of two types ofanalysis: performance analysis and science mapping (Cobo et al. 2011). Evaluation of theperformance of various research components (e.g., authors, institutions, nations, and journals)in the area is standard practice in reviews and allows the constituents to be identified.

The goal of science mapping, also known as scientometric analysis, is to identify key themes by analyzing patterns of similarity, such as the degree of shared references between two publications' content (Kessler, 1963; Wallin, 2005; Weinberg, 1974). Co-authorship analysis can be used to identify the subject's intellectual structure at the individual and national levels.

Research constituents are analyzed for intellectual exchanges and structural links using citationanalysis, co-citation analysis, bibliographic coupling, co-word analysis, and co-authorship analysis techniques. These techniques show the subject's intellectual and bibliometric structures when paired with network analysis (Baker et al., 2020; Tunger and Eulerich, 2018).

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The five processes of study design, data collecting, analysis, visualization, and interpretation make up the science mapping process (Aria and Cuccurullo, 2017) and analysis (Zupic and Cater, 2015). The study's research questions were developed after an assessment of the body of literature on artificial intelligence and higher education.

3.1 Data Collection: The research utilized the online Scopus database to obtain articles. (Okoliand Schabram, 2010) describe it as a multidisciplinary resource beneficial for information systems (IS) scholars, comprising works indexed and ranked by both the Institute for Scientific Information and Scopus.
The online Scopus database was retrieved using the principal keywords "Artificial Intelligence(AI)" and "Higher Educational Institutions" in order to retrieve the articles that describe the field and their connections. 414 publications that were discovered using the initial keyword search and published in the Scopus database.

3.2 Data Analysis: By using inclusion and exclusion criteria, 210 papers from the literature were chosen from the 414 retrieved articles at first. Because the study is addressing an issue that is still in its infancy, its scope was limited to the years 2009–2024. "Peer reviewed document type, English language, and the topic area of "Business, Management, and Accounting" and "Social Sciences" were the inclusion criteria used in the search procedure. India was the chosen country for affiliation. Conference papers and theses were not included in the analysis. 210 articles that satisfied the inclusion and exclusion criteria were taken into consideration for the full-text analysis final sample after the exclusion and inclusion criteria were applied.

3.3 Data Visualization and Interpretation: Data analysis was done using the VOSviewer and Biblioshiny application and the free and open-source statistical software R. Using R software and the Biblioshiny app to create figures and tables for the investigation, researchers carried out a descriptive and Scientometric bibliometric analysis in this stage. As part of the results analysis, the knowledge structure was visualized using the data reduction technique. Before analyzing the bibliometric results, the main bibliometric data are explained. The authors, document and author quality indicators, data trends, and journal citations are all considered during the evaluation. The annual scientific output, scientific sources, source growth, number of publications per author, per journal source, and author's keywords are among the criteria taken into consideration while thoroughly analyzing each of the categories. The most commonly occurring words, word clouds, subject dendograms created for the study, co-citationnetworks, and thematic analysis maps created with the Biblioshiny app were used to analyze the intellectual and conceptual framework. The most commonly occurring words, word clouds, subject dendograms created for the study, co-citation networks, and thematic analysis maps created with the Biblioshiny app were used to analyze the intellectual and conceptual framework.

4. RESULTS AND ANALYSIS

The below section presents the performance analysis of the sample papers selected for review.

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4.1 Citation Structure and Publications Trend

Figure 2.0 shows the annual scientific yield analysis and literature trend from 2009 to 2024. The research output has shown a remarkable increasing trend from 2020 onwards with the yearly growth rate in articles of 71% in the research area of AI, Education in higher educationbetween 2009-2024. Year 2023 showed the highest annual production of articles. Covid-19 canbe reason for the increasing rate of publishing articles after 2020. Because education back then got impacted significantly. Universities and colleges started using their resources online as well, they made use of AI in their teaching process for a smooth flow.

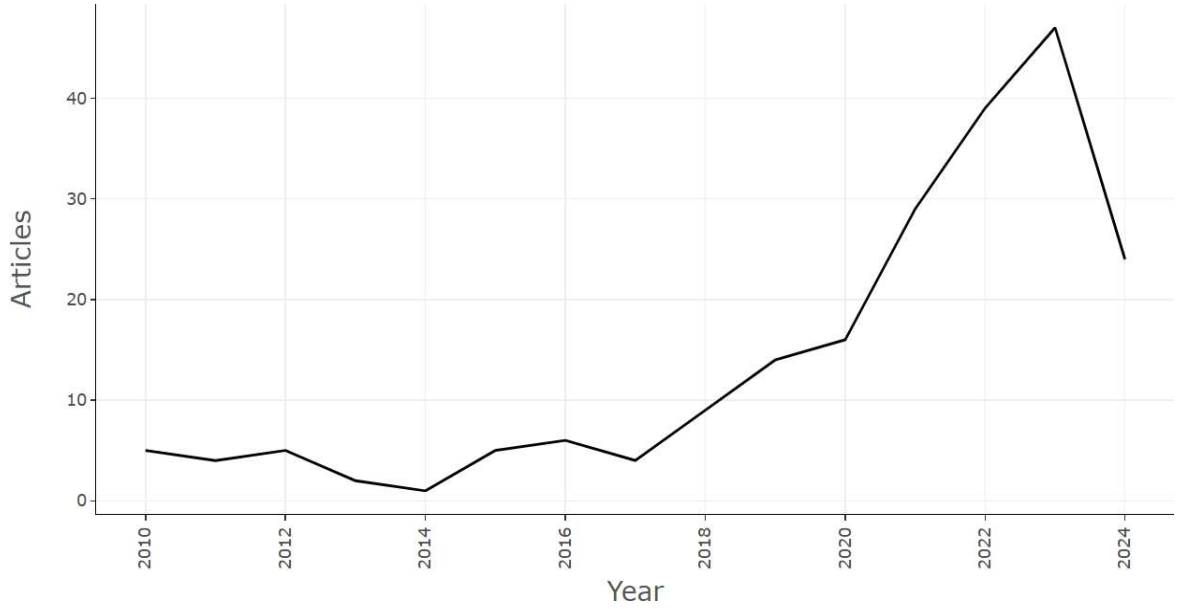

Figure 2. Yearwise Scientific Production

4.2 Average citation in a year

It is a bibliometric metric used to evaluate the impact and influence of a scholarly work, author,or journal over time. It represents number of citations a publication receives per year since itspublication on an average. This metric helps in assessing how frequently a work is referencedby other researchers, providing insight into its relevance and importance within its field.

According to Figure 3.0, research output has shown a remarkable increasing trend in 2016 onwards with yearly growth rate in articles of 71% in the research area of AI, higher educationin India. 2020 had the highest average citations of 12+ in this field (Figure 2.0). Average citations per year were highest in 202 after COVID-19 while annual scientific production peaked in 2023 but has shown a declining trend from 2024 onwards which points to the emerging nature of the subject with fluctuating interest and variable quality of the articles beingpublished in this period

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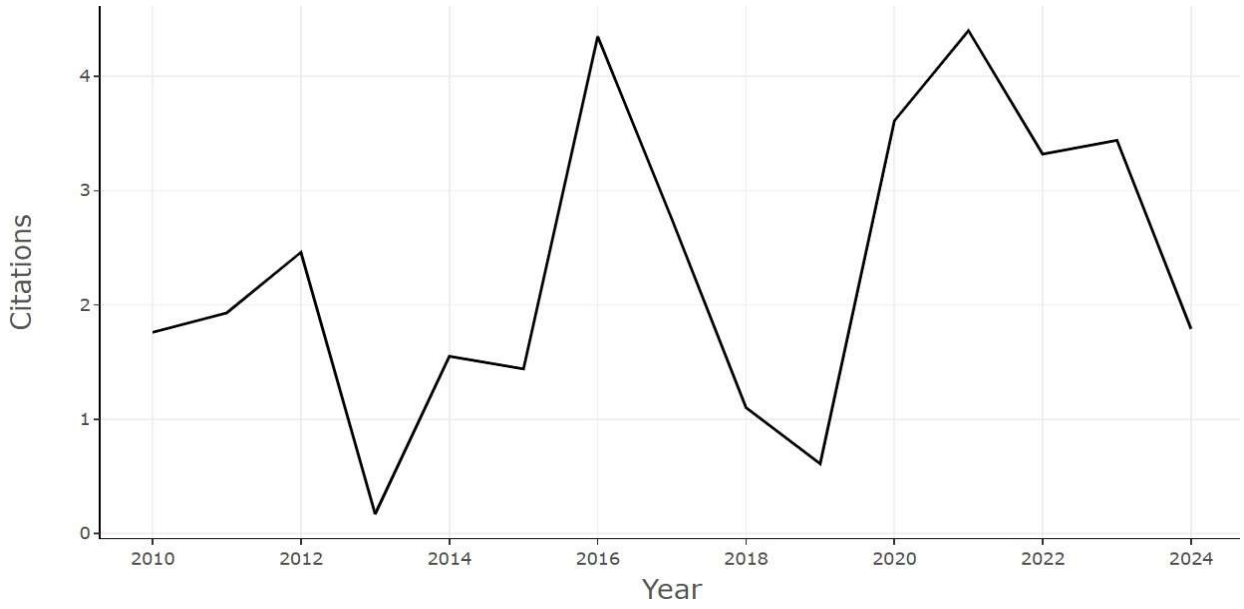

Figure 3. Average citations per year

4.3 Scientometric Analysis

A key element of bibliometric study is scientometric analysis, which is the quantitative evaluation of scientific literature using statistical and mathematical techniques. This kind of analysis provides a thorough grasp of research dynamics by measuring a variety of scientific research factors, including productivity, impact, and collaboration patterns. Two essential components are citation analysis, which counts the frequency with which publications are citedto assess the effect of research, and publication output, which counts the quantity of research articles published by authors, institutions, or nations. In their respective fields, highly cited books are usually regarded as more influential. The analysis of collaboration networks, whichlooks at co-authorship patterns to comprehend the structure of research collaborations and pinpoint critical hubs and networks, is another crucial component.

Furthermore, metrics such as the h-index and impact factor are used to measure the impact of journals and researchers in relation to research impact. By looking at the prevalence and co- occurrence of terms within scientific literature, keyword analysis also aids in the identificationof research themes, trends, and new subjects.

Scientometric analysis is used to follow the development of research topics, evaluate the effectiveness of researchers, institutions, and nations, and provide funding and resourceallocation information to funding agencies and policymakers. For the purpose of visualising and analysing bibliometric data, programmes like VOSviewer, CiteSpace, and BibExcel are frequently used. We have used VOSviewer and biblioshiny in our study. This analytical methodaids in assessing the overall effectiveness and significance of scientific endeavours as well as in spotting research trends. (Van Raan, 2005) claims that scientometric analysis can measure key elements of scientific research, such as performance and interdisciplinarity, whereas Hoodand (Hood et al., 2001) talk about the importance of scientometric analysis in comprehending bibliometric, scientometric, and informetric literature. Scientometric analysis thus offers valuable insights into the dynamics of scientific research, aiding researchers,

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institutions, and policy-makers in making informed decisions based on empirical data.

4.3.1 Keyword Co- occurrence Analysis

A technique called keyword co-occurrence analysis is used to find and examine the connectionsbetween terms in a dataset or a body of text. It entails analysing the frequency with which keyword pairs occur together in documents in order to gain insight into the organization and primary ideas of the text. Researchers can find patterns, trends, and linkages between various topics by visualising these co-occurrences. This study is especially helpful for mapping the intellectual structure of a research topic or identifying new trends and key concepts inbibliometric studies, content analysis, and text mining.

Co-occurrence analysis of all keywords

In this analysis we have summarized the occurrence of all keywords which have been used inthe scopus database papers. In this analysis, we have taken minimum number of occurrences of a keyword to be 5. Then out of 1229 keywords in total, only 27 met the threshold limit. Totallink strength was found to be 379 with 5 clusters and 146 links. The results depicted in figure
4. showed that the keyword “higher education” has been used 152 times followed by “artificial intelligence” with 59 times. There was total 5 clusters with different colours consisting of different keywords which can be seen in figure 4.
5.

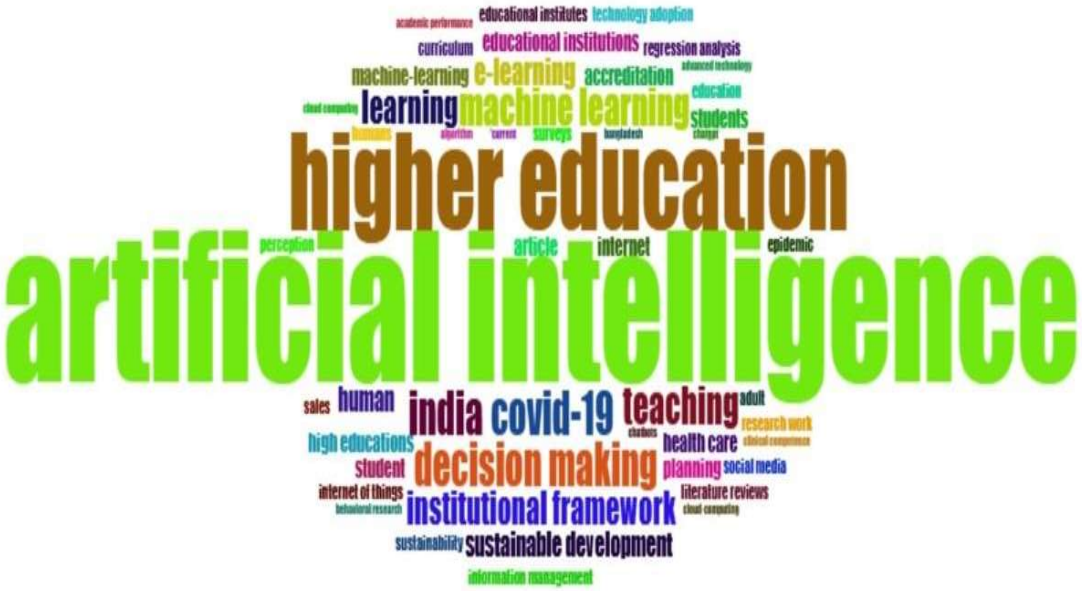

Figure 4. All keywords occurrence analysis

Co-occurrence Author keyword

This section lists the keywords that authors have used to identify research gaps, as well as research trends and conversations, on bibliometrics on AI in higher education in India. According to (Secinaro et al., 2021), the word cloud displays the authors' keywords along withthe terms that are most commonly used and their historical trends. The most common keywordsused by the writers are displayed in Figure

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5.0 (Word Cloud), which makes clear that important terms like "artificial intelligence," "higher education," "e-learning," and "covid-19" are heavilyused.

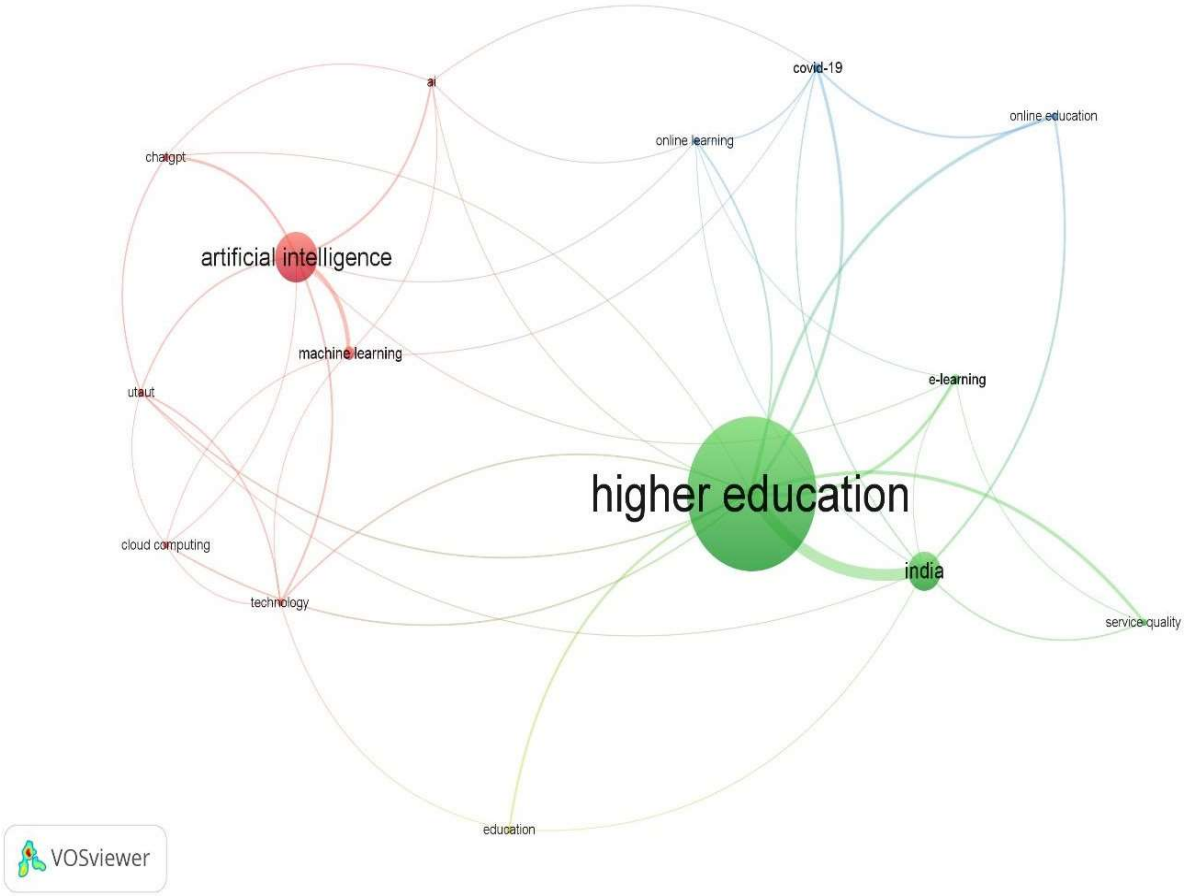

Figure 5. Co-occurrence Author keyword

4.3.2 Globally cited documents

The term "most globally cited documents" refers to academic publications that have been citedthe most by researchers worldwide. Because the quantity, calibre, and influence of the researchprovided are frequently reflected in the number of citations, these publications are regarded asextremely significant within their respective fields. In academics, citations are a crucialindicator of the acceptance and impact of research findings. High global citation counts are typically associated with landmark works that have advanced novel approaches, ground- breaking theories, or ground-breaking findings that are regularly cited by other scholars to complement or confirm their own research. The importance of these texts is highlighted by the way they have shaped current research trends globally and advanced knowledge. As depicted in (figure 6.) article Lund Bd, 2023 in journal of the Association for Information Science and Technology has the highest rank with 155 global citations followed by Teeroovengadum V. 2016 with 146 global citations in Quality assurance education journal and international journal of educational development with 135 global citations. The Journal of the Association for Information Science and Technology (JASIST) is a respected international forum for

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peer- reviewed information science research. For over 50 years, JASIST has shown intellectual leadership by publishing original research on the creation, discovery, recording, storage, representation, retrieval, presentation, manipulation, dissemination, use, and evaluation of information as well as on the tools and techniques related to these processes. The influential journals in this field are either disciplinary journals in education, AI and education, e-learningand higher education, and information systems, or cross-functional and multidisciplinary journals.

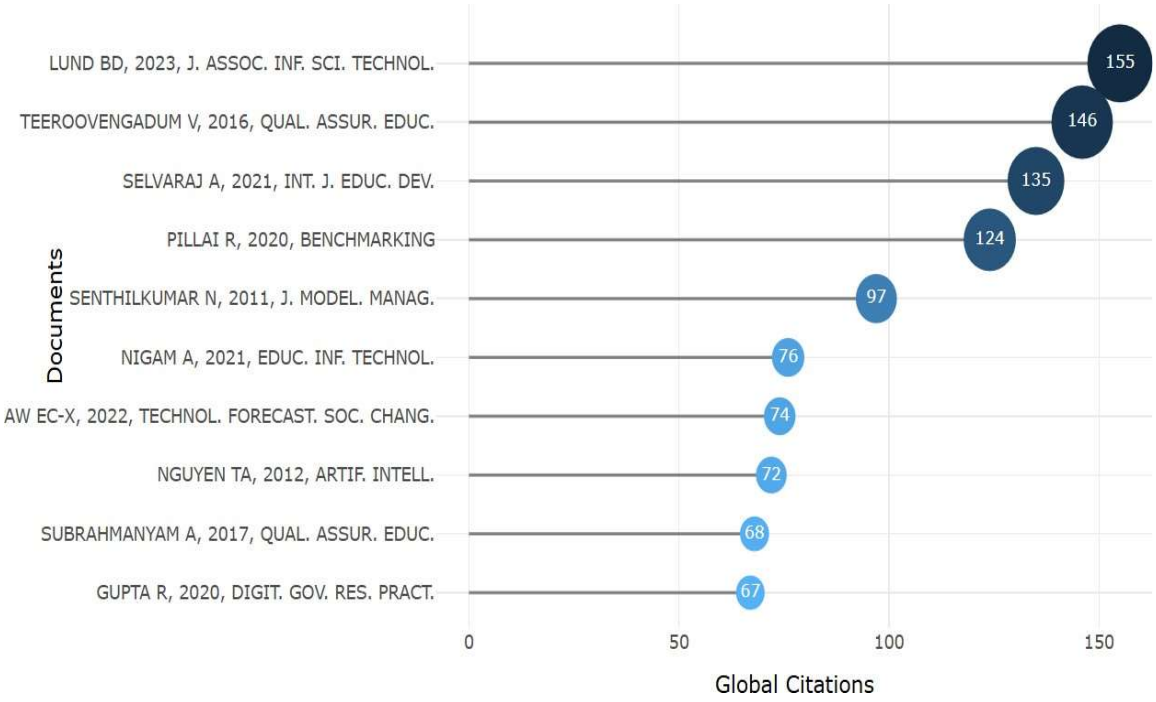

Figure 6. Most global cited documents

4.3.3 Most Relevant Authors

According to the frequency of articles in data analytics research from 2009 to 2024, the most productive authors are displayed in the (figure 7). This can also be seen in (Figure 8) that (Kumar A.) is the most relevant author with 6 articles on the topic. The next author in line is Kumar P with 5 articles. Followed by Baba MM, Das S, Kamalanabhan TJ. Kiran R, Kumar Sand Raman R all with 3 articles each in their basket of research on this particular topic.

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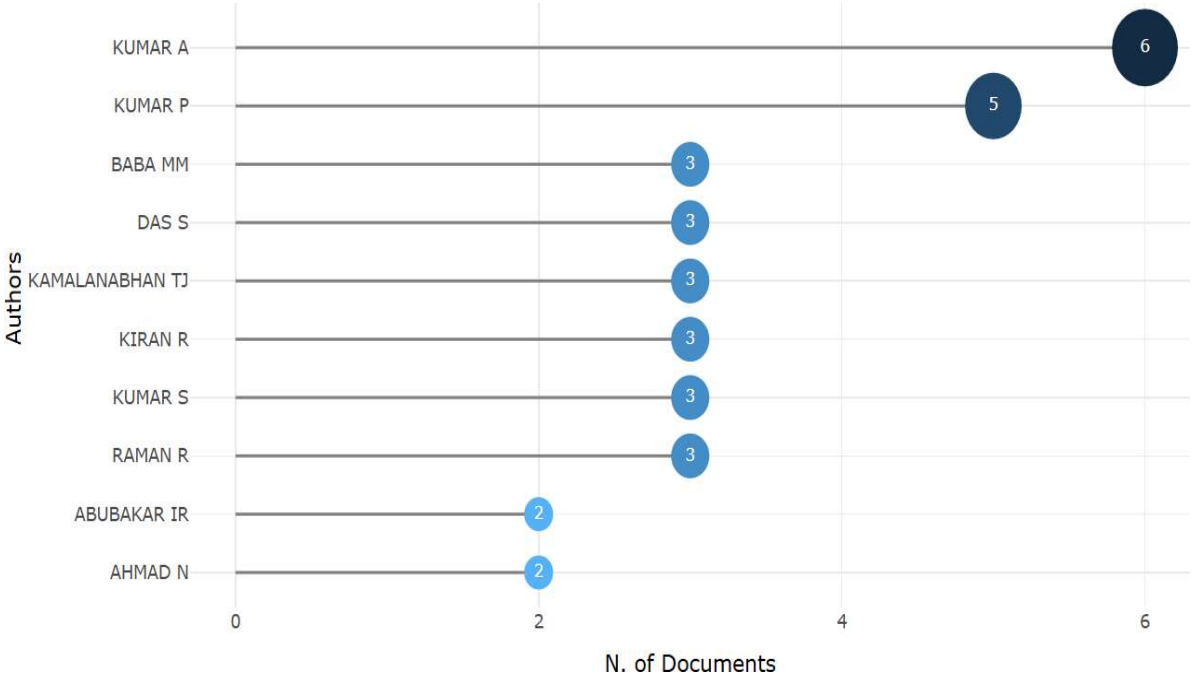

Figure 7. Most relevant author

4.3.4 Lotka Law

Another idea related to authorship trends in bibliometrics is Lotka's law, which bears Alfred J.Lotka's name. In contrast to Bradford's rule, which is specific to journals, this law defines howauthors are distributed within a given area. According to Lotka's law, there is a predictable pattern in the authors count who publish a certain paper count. There will be only a few of veryproductive authors, and a somewhat greater proportion of authors with fewer publications, saysSobrino et al.,(2009). As depicted in figure 8, there are approximately 2 documents which havebeen written by 75% of authors, which proves the lotka's law i.e there are many authors with less productivity of publishing articles and vice versa.

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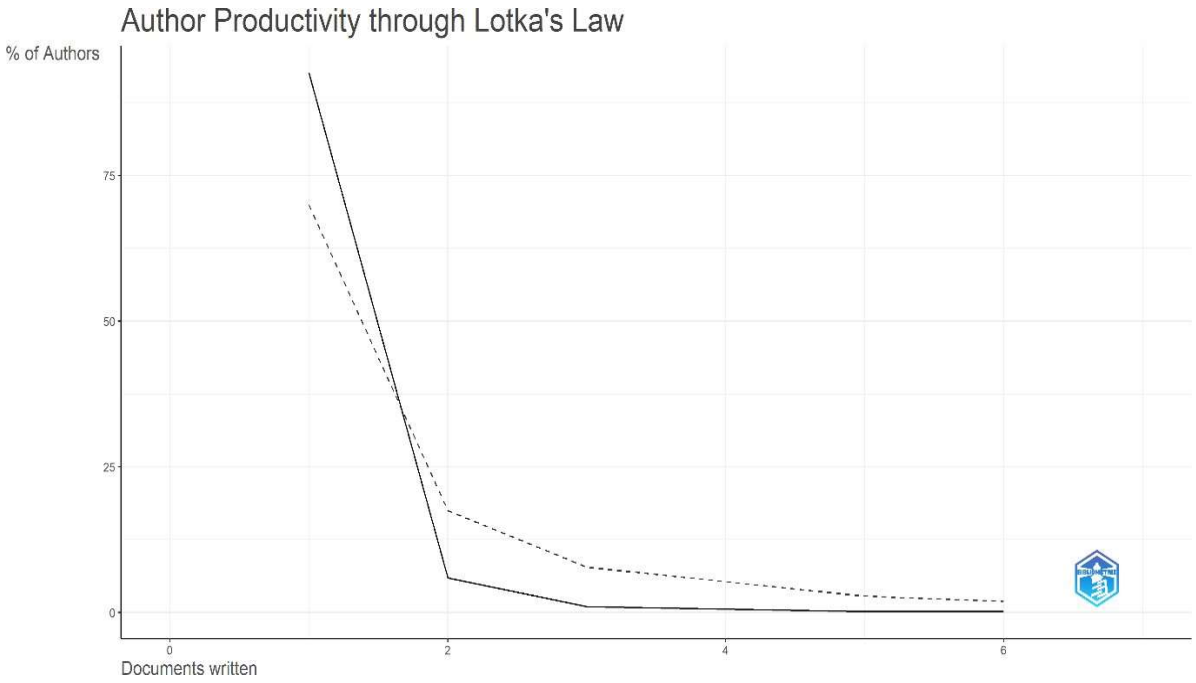

Figure 8. Lotka's Law

4.3.5 Most Relevant Sources

The top ten most pertinent sources from 2009 to 2024 are displayed in the Table 1. It demonstrates the breadth of research on AI and higher education institutions published in the journals Sustainability (8), Higher Education for the Future, Library Philosophy and Practice, and Technological Forecasting and Social Change (6), and Education and Information Technologies & Prabanbhan: Indian Journal of Management (5), which are the next three mostrelevant journals.

"Table 1: Most Relevant Sources"

"No."	"Sources"	"Articles"
1	SUSTAINABILITY (SWITZERLAND)	8
2	HIGHER EDUCATION FOR THE FUTURE	6
3	LIBRARY PHILOSOPHY AND PRACTICE	6
4	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	6
5	EDUCATION AND INFORMATION TECHNOLOGIES	5
6	PRABANDHAN: INDIAN JOURNAL OF MANAGEMENT	5
7	INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY AND ENGINEERING	4
8	QUALITY ASSURANCE IN EDUCATION	4
9	TQM JOURNAL	4

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Bradford's Law

Bradford's law is additionally referred to as Bradford's law of dispersing or scattering, is a principle used in bibliometrics to understand how scientific literature is distributed across journals in a particular field. It describes the phenomenon of information scattering, where relevant articles are spread across many sources, with a few core journals containing a high concentration of articles, and a much larger number of peripheral journals containing fewer relevant articles (Budd, 1988). As we can see in figure 9, there are 8 articles which are spreadacross two sources followed by 6 articles with 4-5 sources. Then, there are 1 or 2 articles whichcontain high concentration of journals.

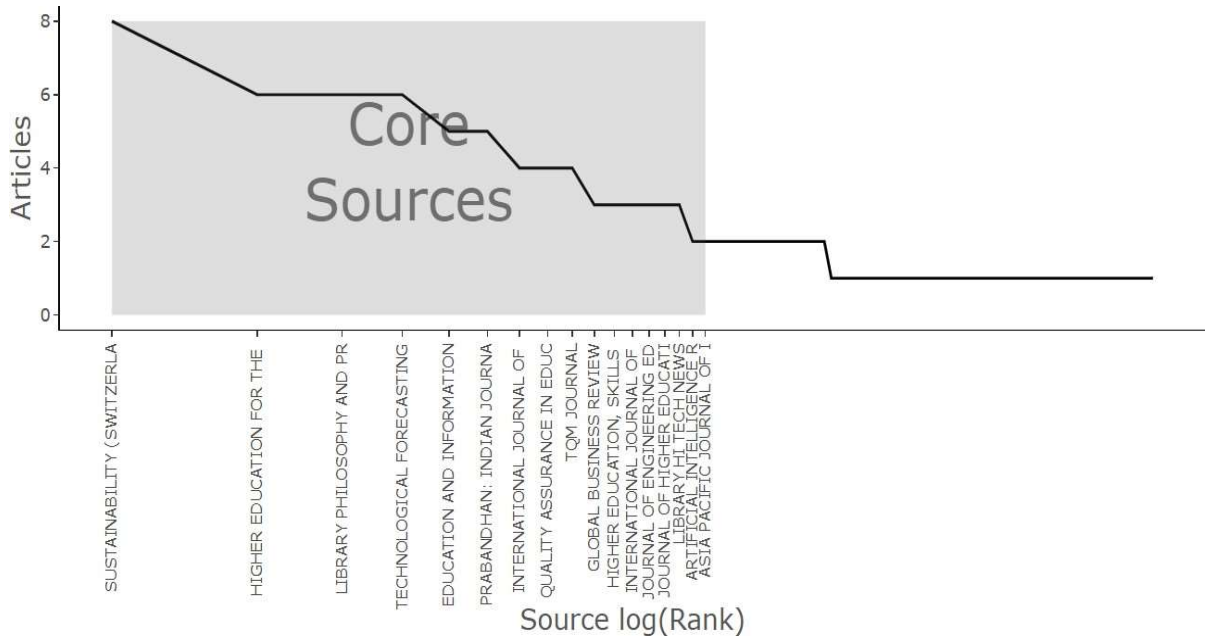

Figure 9. Bradford's Law

4.4 Conceptual Structure

Thematic Map

In bibliometric study, a thematic map is a visual aid that shows how scientific subjects, topics,or themes have developed over time within a corpus of literature. It aids in recognising and illuminating the essential ideas, their connections, and how they change over time. Researcherscan observe how many research fields are connected to one another and contribute to the largerfield by using thematic maps, which group comparable topics or keywords together to aid in figuring out a field's intellectual structure. Thematic maps provide vital points into thedynamics of scientific research by highlighting new trends, dominating study areas, and waningissues by visualising the evolution of themes across time. Thematic maps can also be used by academics to guide future research directions and funding priorities by looking at areas with little to no activity and identifying research gaps.

Co-word analysis, which looks at how frequently terms occur together from a collection of publications,

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is a common step in the building of theme maps. The steps involved in this approach are gathering data, Using a co-occurrence matrix to show the frequency with which keyword pairs appear together, grouping related keywords into themes, then Map these clustersin the space of two dimensions, so that the gap among clusters demonstrates their link. Thematic map creation is frequently done with the use of programmes like VOSviewer, CiteSpace, and Bibliometrix, which provide a variety of choices for data processing, clustering,and visualisation in order to produce thematic maps that are relevant.

The thematic map makes use of the Keywords Plus field to pinpoint the main themes within this field of study. With the use of a semi-automated system, editorial staff at Thomson Reutershave related these keywords, and the Keywords Plus field has been normalised in contrast to the authors' keywords. Four different theme typologies that were derived from the author's keywords of certain articles are shown in Figure 10. as part of the thematic mapping. A thematicmap is an effective visualisation tool used in bibliometric research that groups similar terms into distinct quadrants, each of which represents a particular kind of subject. This enables a study field's dynamics and structure to be shown. There are usually four quadrants on the map.Niche themes are represented by the upper left quadrant. These are highly specific and narrowlyconcentrated categories like "human," "epidemic," "article," and "adult." Despite not being extensively researched, many subjects have a great deal of depth in their own field. The field'score and well-developed motor themes are found in the upper right quadrant. Common and significant subjects in this sector are "healthcare," "information management," "COVID-19," "artificial intelligence," and "higher education." These themes are crucial for driving research forward and have strong interconnections within the research community. AI is a common mainstream theme in this field of study and has expedited the digitalisation of higher education.According to Zawacki-Richter et al. (2020), the pandemic has sped up the transition to digitallearning platforms, which could be advantageous for educational technology companies and their online education initiatives. Following the pandemic, countries with stricter COVID-19 regulations and lower levels of community movement saw a greater rise in the use of AI-driveneducational resources. (Lai and Widmar, 2021). This trend highlights the growing importanceand reliance on AI technologies in transforming educational practices and improving access tolearning resources.

The left side of lower quadrant emphasises declining or rising topics, which are becoming lessrelevant or just starting to gain attention. Examples include "students," "chatbots," "India," and"regression analysis." Monitoring these themes can provide insights into the shifting focus of research. Finally, the lower right quadrant contains basic themes, fundamental to the field but less complex. These include "accreditation," "India," "machine learning," and "e-learning." These themes form the foundational knowledge upon which more specialized and advanced research builds. Understanding the distribution and characteristics of themes within these quadrants helps researchers identify core areas, emerging trends, identify possible gaps in the literature, effectively directing further study efforts.

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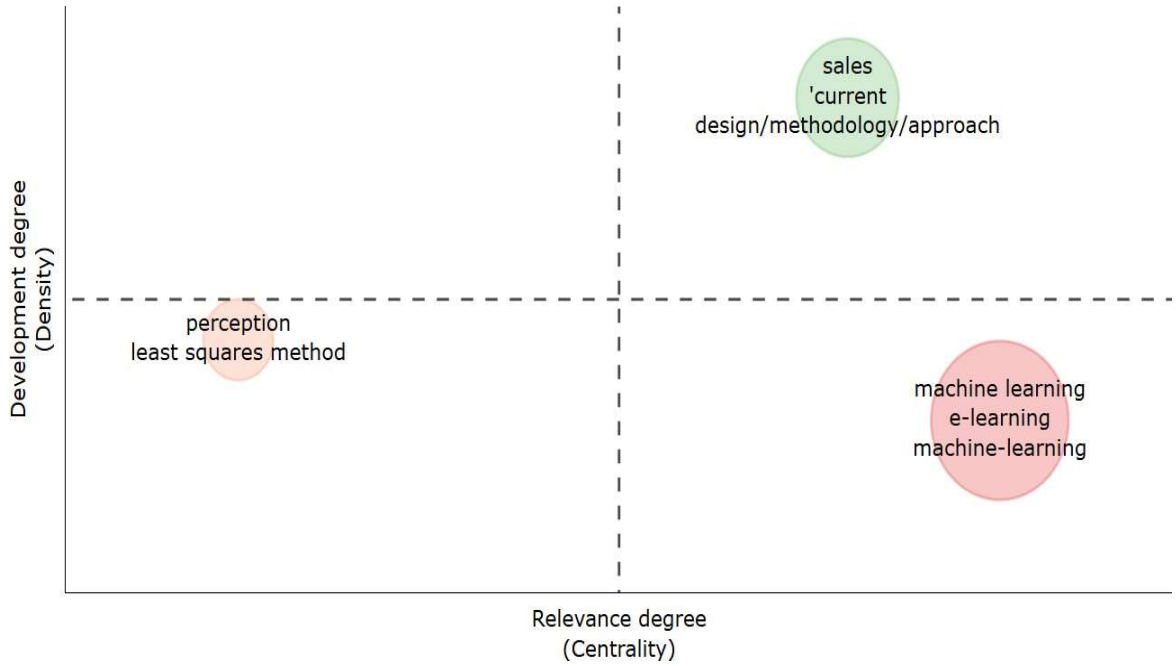

Figure 10. Thematic Map

4.5 Collaboration Network

A visual depiction of the connections among scholars, organizations, or even nations accordingto their academic output is called a collaboration network. It offers significant insights on patterns of research collaboration within a specific subject and maps these links using citationdata, (Hu et al., 2020). The figure displays a network graph, where nodes represent researchers.The size of a node indicates the author's productivity or prominence within the network as shown in figure 11. Authors with more citations from others would likely appear as larger nodes.

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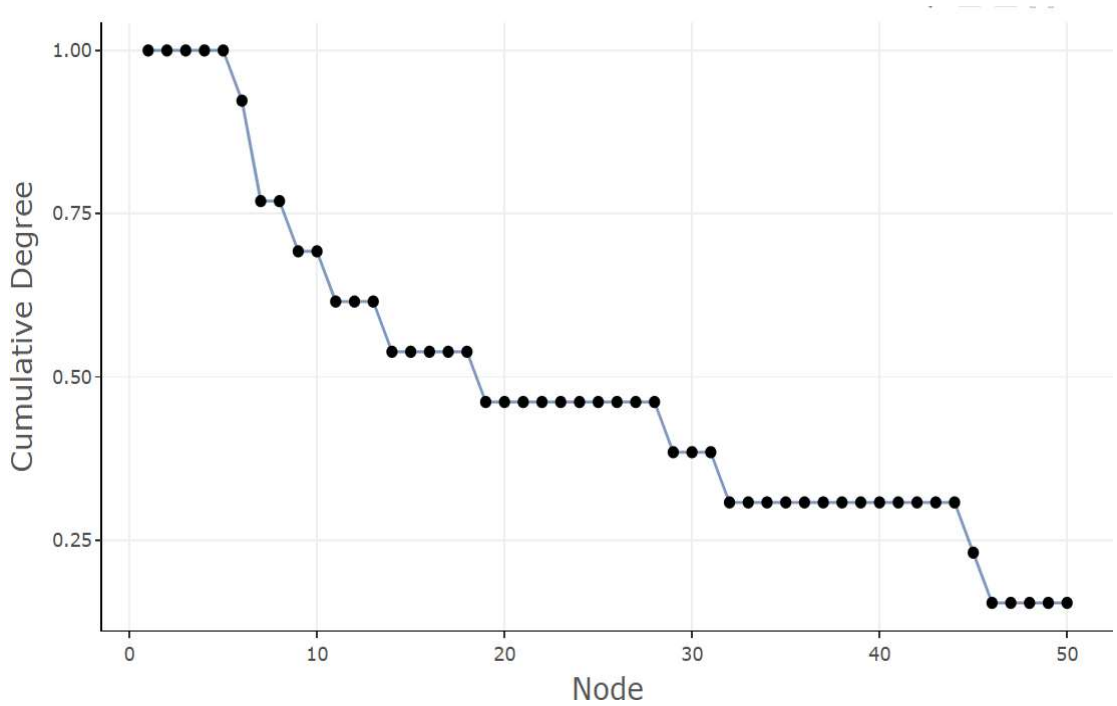

Figure 11. Collaboration network

6. DISCUSSION

This bibliometric analysis has shed light on the growing scope of AI in higher education. The research output has exhibited a substantial upsurge, particularly since 2020, reflecting the growing interest in connecting AI's potential to transform educational practices. The analysis delved into various aspects, including publication trends, influential authors, intellectualstructure, and collaboration networks. The significant rise in research publications on artificialintelligence in higher education over the previous ten years is among the most startling discoveries. There are a number of reasons for this spike, including: The expanding understanding of AI's revolutionary possibilities in education Numerous advantages are provided by AI technology, including intelligent tutoring programmes, automated administrative chores, and personalised learning. As educators and institutions grapple with challenges like increasing class sizes and diverse learning needs, AI emerges as a promising solution for enhancing educational experiences and outcomes.

The impact of the COVID-19 pandemic: The pandemic requires a swift shift to distance learning platforms. This has surely expedited the development and use of AI-powered educational solutions to facilitate remote learning and meet the changing needs of students in a virtual setting. The analysis also revealed a multidisciplinary nature in the research, with scholars from various fields like education, computer science, information technology, and social sciences contributing to the body of knowledge. This interdisciplinary approach is crucial for developing and implementing AI solutions effectively within the educationalcontext.

Furthermore, the bibliometric analysis identified prominent themes shaping the researchlandscape. These themes encompass:

Personalized Learning: Adapting learning opportunities to meet the needs of every single student and

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preferences is a central focus. Algorithms which are used in AI can easily analysestudent data to identify learning gaps, recommend personalized learning materials, and adjust instruction accordingly.
Tutoring Systems for the students: They help in utilizing AI to provide students with individualized support, mimicking the role of a human tutor. Students may especially benefit from this, who require additional assistance or prefer a self-paced learning approach.
Administrative Automation: AI can accelerate administrative duties such as scheduling, grading, and managing student records, giving educators more time to concentrate on better planning and interactive aspects of teaching.
COVID-19 impact: The Covid-19 has undoubtedly influenced the research, with studies exploring how AI can facilitate online learning, address the challenges of remote education, and ensure equitable access to quality education during disruptions. The analysis also highlighted emerging themes, such as the use of chatbots for student support. These areas present exciting avenues for future research. The identification of highly cited documents and influential authors provides valuable insights into groundbreaking research that has significantly impacted the field. By examining these works, Researchers can discover possibleresearch gaps and obtain a deeper understanding of the state of knowledge. While the analysisoffers a comprehensive overview, it is essential to acknowledge certain limitations. The Scopusdatabase was used for the data analysis, and the specific tools used for analysis may influencethe results. Future research could expand the dataset by incorporating additional databases andemploying a wider range of bibliometric techniques for a more exhaustive analysis.

7. CONCLUSION

This bibliometric analysis vividly depicts the dynamic and rapidly increasing field of artificial intelligence in higher education. According to the research, artificial intelligence (AI) has immense potential to improve student outcomes, personalise learning experiences, and alter the
ay education is provided. The explosion in research activity demonstrates the widespread acknowledgement of AI's transformative potential in education. As we move forward, severalkey considerations will shape the future higher education future with AI usage:
Ethical Considerations: The proper and ethical use of AI is essential. Data privacy, algorithmbias, and employment displacement in the education industry are all issues that must be addressed properly.
Faculty Development and Training: Educators require ongoing training and support to merge different AI techniques and tools effectively into their teaching methods and leverage their capabilities to enhance student learning.
Collaboration and Knowledge Sharing: Fostering collaboration between researchers, educators, technologists, and policymakers is very important for developing AI solutions that meet diverse needs of educational institutions and students across the globe.
In conclusion, AI holds enormous potential for the future of higher education. By ethically and strategically utilising its potential, we can provide more personalised, accessible, and successful learning experiences for all students. This bibliometric analysis serves as a valuablestarting point for further exploration and innovation in this exciting domain.

8. FUTURE RESEARCH DIRECTIONS

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The versatile area of using AI in higher educational institutions offers fertile ground for futureresearch. Our analysis of 210 Scopus-sourced papers unveils several promising avenues for exploration. Future research can delve into advanced adaptive learning systems that leverage AI to personalize educational content for individual learning styles and paces. The Investigation can be done on how AI can streamline administrative processes like enrolment, course scheduling, and resource allocation can enhance operational efficiency. AI-driven intelligent tutoring systems hold immense potential, offering personalized support and feedback to students, ultimately improving learning outcomes. Future research can address issues like algorithmic bias, data privacy, and transparency in AI decision-making. Researching the broader societal impacts of AI in the sector of education, including its influence on employment, educational equity, and access to learning opportunities, is critical for shaping policy and practice. Encouraging research that merges insights from computer science, education, psychology, and sociology can result in more comprehensive and creative AI applications in institutions of higher learning. The Longitudinal Studies can also be done, like Longitudinal studies that assess the long-term consequences of AI applications can providedata for continuous improvement. on student learning results, retention rates, and overall educational quality.

9. LIMITATIONS

While this bibliometric analysis offers valuable insights, acknowledging its inherent limitations is essential. The analysis is based on 210 Scopus papers, which, while substantial, might not capture all relevant research. Studies published in other databases or unpublished works couldoffer additional perspectives. Language bias may exist due to reliance on Scopus, predominantly including English-language papers and potentially overlooking valuable research in other languages. The analysis provides a snapshot of the research landscape at the time of data collection. Rapid advancements in AI and its educational applications necessitateacknowledging the field's continual evolution, with newer studies potentially presentingdifferent trends and insights. It focuses on quantitative measures like publication counts and citation analysis, because of which quality of research somewhere not shown properly. Citationlag exists, meaning recent influential studies might not yet appear prominently in citation analyses. The varying rates of AI technology adoption across different educational institutions can influence the generalizability of the findings. Institutions with advanced technological infrastructures may exhibit different trends compared to those with limited resources. By acknowledging these limitations and exploring the avenues for future articles, This report canserve as the foundation for a more in-depth understanding of how AI is transforming higher education.

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