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Generative AI for Learning: A Bibliometric Mapping of Global Scientific Publications

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ABSTRACT

The rapid advancement of Generative Artificial Intelligence (GenAI) has significantly transformed educational practices by introducing new possibilities for personalized learning, intelligent tutoring systems, automated feedback, and AI-supported knowledge creation. This study aims to explore the global research landscape of Generative AI for Learning through a bibliometric analysis of scientific publications indexed in the Scopus database. A comprehensive literature search was conducted to identify relevant publications, followed by performance analysis and science mapping using VOSviewer. The analysis examined publication trends, highly cited literature, keyword co-occurrence, citation networks, author collaboration, institutional contributions, and international research patterns. The findings reveal that research on generative AI in learning has experienced substantial growth, particularly following the emergence of ChatGPT and large language models. The intellectual structure of the field is dominated by three interconnected themes: technological advancement of artificial intelligence, educational integration of AI-based learning systems, and human-centered considerations including AI literacy, critical thinking, ethics, and responsible adoption. Influential publications highlight both the opportunities and challenges of generative AI, including improvements in learning effectiveness, academic transformation, assessment challenges, and potential cognitive impacts. Furthermore, collaboration analysis indicates that the United States plays a central role in global research networks, while contributions from countries across Asia, Europe, and other regions continue to expand. This study provides a comprehensive understanding of the evolution, current trends, and future directions of Generative AI for Learning research, emphasizing the importance of interdisciplinary collaboration and responsible AI implementation to support sustainable educational innovation.

Keywords: *Generative Artificial Intelligence, Generative AI, ChatGPT, Artificial Intelligence in Education, Learning Technology, Bibliometric Analysis*

1. INTRODUCTION

The introduction of artificial intelligence (AI) has revolutionized many areas of human activity, including medicine, finance, creative industries, and education. One of the most significant inventions in the sphere under discussion is generative AI, which stands for algorithms capable of creating new content, whether it be text, pictures, sounds, or simulations, based on certain patterns detected in previously existing databases [1], [2]. In regard to learning, generative AI presents numerous possibilities to make educational experience more personalized, automated, and provide learners with feedback according to their needs. The use of tools like large language models (LLMs), transformers, and diffusion models allows educators to tailor the learning content to the learners' level of skills and preferences, making the educational process more engaging and effective [3]–[5].

The application of AI in learning has developed significantly over the last ten years, starting from the rule-based intelligent tutoring system to advanced generative models, which can create content depending on the specific situation. The early systems were mainly designed to evaluate learners' knowledge and offer tutoring; however, there was not much flexibility in adjusting to different learning situations [6]. Generative AI is a paradigmatic breakthrough because it allows using software that not only shares information but also performs simulation, solving problems, and creating exercises on a wide range of topics. Some recent papers describe the use of generative AI

for creating graded exercises, simulations of laboratory exercises, and language learning through dialogue [7], [8].

Research on generative AI for learning in the global landscape has increased dramatically, both in terms of academic interest and industrial interest. Bibliometric analysis of the AI literature in education reveals a substantial number of papers published post-2018 in connection with the advent of transformer models like GPT and BERT that support sophisticated language processing and generation [9], [10]. These papers are distributed across various journals and conference proceedings, ranging from educational technology to cognitive science, human computer interaction, and machine learning applications. In addition, research contributions are geographically dispersed, with research hotspots in North America, Europe, and East Asia, reflecting a worldwide acknowledgment of the importance of generative AI for learning [11], [12].

Even with the quick expansion, the current state of scholarly inquiry into generative AI in education exhibits fragmentation due to differences in methodology, participants, and fields of application. There are those focusing on the potential use of natural language generation for providing feedback on essays and tutoring [13], and those dealing with content creation in the context of STEM simulations, scenarios, and skills assessment [14], [15]. The combination of many different points of focus, together with the growing body of publications, makes the task of getting an overview of the topic challenging for scholars and practitioners.

The methodology of bibliometric mapping offers a way of doing quantitative analysis of scientific literature, allowing one to illustrate intellectual structures, research areas, and citation networks [16]. As far as the topic of using generative artificial intelligence in education is concerned, the use of bibliometric methodologies will allow for tracking its development process, identifying key articles and scholars involved in the topic and underdeveloped research areas. It is important to look at patterns of collaboration among authors, co-occurrence of keywords and citations to analyze knowledge production and dissemination processes on a global scale.

Generative AI also raises ethical, pedagogical, and practical questions that are important in an educational context. Issues relating to bias in AI-generated material, academic misconduct, and interpretability and explainability of the results call for thorough investigation and regulation [17]–[19]. Moreover, incorporation of generative AI technology in the learning process demands the development of digital literacy among teachers, awareness of limitations of algorithms, and creation of curriculum with the use of AI-generated material. Thus, analyzing scientific literature on generative AI for learning would allow one to identify not only technical developments but also ethical and pedagogical approaches to its integration.

Despite many studies being conducted on generative AI in the education sector, no consolidated view of the scientific production in this area exists yet. Currently, there are few literature reviews on different aspects of AI applications in the education sector, such as language education or STEM simulations. Also, there is insufficient bibliometric information about key authors, organizations, and countries contributing to generative AI development and the themes that need further research in order to avoid the duplication of effort and ensure the effective use of existing knowledge. The objective of this study is to conduct a comprehensive bibliometric analysis of global scientific publications on the topic of generative AI for learning.

2. METHODS

The present research used the methodology of bibliometric analysis that aims at mapping and analyzing scientific papers on generative AI for learning around the world. Bibliometric analysis is a method that enables researchers to perform quantitative analysis of publication patterns, authorship, collaboration, and citations and thus get insights into the intellectual structure and development of the research field [16]. The scope of the research included only peer-reviewed journal articles, conference papers, and reviews that were indexed in the Scopus database that is well-known for covering scientific publications extensively. For data retrieval, a set of keywords related to generative AI and learning were used. These keywords included "generative AI," "artificial intelligence," "machine learning," "education," "e-learning," and "learning technologies."

Information extracted from Scopus comprised bibliographic details including year of publication, author name, affiliation, country, source title, document type, keywords, and citation count. After that, data cleaning was performed in order to filter out duplicates and irrelevant records from the extracted data set to ensure that publications which are concerned with generative AI within learning environment context are considered for the analysis. This helped in obtaining the proper representation of research output of the world. Bibliometric parameters like publication trend, authorship trend, institution-wise publication count, country-wise contribution, and keyword frequencies have been used to analyze the field.

The cleansed database was imported into VOSviewer, which is an application used for mapping bibliometric networks by creating co-authorship, co-citation, and keyword co-occurrence maps [16]. VOSviewer offered features related to network visualization that helped to identify research clusters, collaboration among authors and institutions, and themes in the field. Citation frequency and co-occurrence thresholds were set to focus on essential elements and reduce the impact of insignificant publications. The use of data from Scopus combined with the analysis carried out through VOSviewer allowed for a precise and systematic mapping of the intellectual structure of generative AI for learning.

3. RESULT AND DISCUSSION

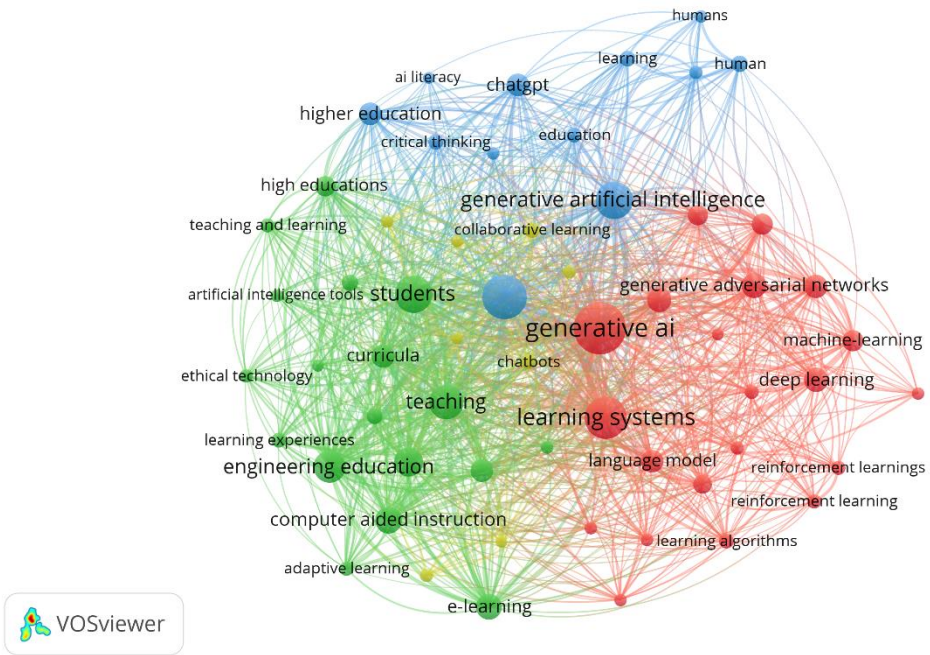

Figure 1. Network Visualization
Source: Data Analysis Result, 2026

The Figure 1 highlights the intellectual and thematic structures within the publications related to Generative AI for Learning globally. The network shows some connected clusters, suggesting that the research in this topic is multidisciplinary and covers educational technologies, artificial intelligence, machine learning, and learning sciences. Each node's size signifies the number of times the keyword has been mentioned in the literature while the connecting links signify the strength of relationship between two keywords. The central location of "generative AI", "generative artificial intelligence", "learning systems", and "students" keywords suggests that these topics form the core of research.

The cluster in red is the technological and computational basis of the study of generative AI for learning. The keywords like "generative AI," "machine learning," "deep learning," "language model," "reinforcement learning," and "generative adversarial networks" indicate that the literature base largely deals with the design and use of sophisticated AI structures. The cluster shows the research carried out in understanding how AI structures, especially language models and generative algorithms, assist in the process of learning through automatic content generation, intelligent systems, adaptive systems, and personalized educational solutions. The strong association between generative AI and machine learning keywords shows that technological progress is an essential factor in the field of education-based AI research.

The cluster named green emphasizes the educational application and the pedagogic aspects of generative AI technologies. Dominant keywords such as "teaching," "teaching and learning," "students," "curricula," "engineering education," "e-learning," "learning experiences," and "adaptive learning" suggest that more and more studies focus on the impact of AI on the instructional process and students' achievements. Thus, it is clear that the shift from technology development to practical implementation in educational settings occurs. The papers in this theme discuss AI-based teaching techniques, AI-based learning environment, curricula change, and educators' adoption of innovations.

The blue cluster captures the human, cognitive, and institutional dimensions of the adoption of generative AI in educational settings. The inclusion of such terms as "ChatGPT," "higher education," "AI literacy," "critical thinking," "education," "learning," and "human" reveals the increasing focus on the interaction between learners and generative AI systems. The fact that the present cluster focuses on the implications of AI use by students and educators is indicated by such terms as "digital competencies," "responsible AI use," "academic skills development," and "AI and higher education." The fact that such concepts as "AI literacy" and "critical thinking" emerge as relevant keywords demonstrates the concern about whether learners are capable of assessing and using AI-generated content effectively.

3.1 Overlay Visualization

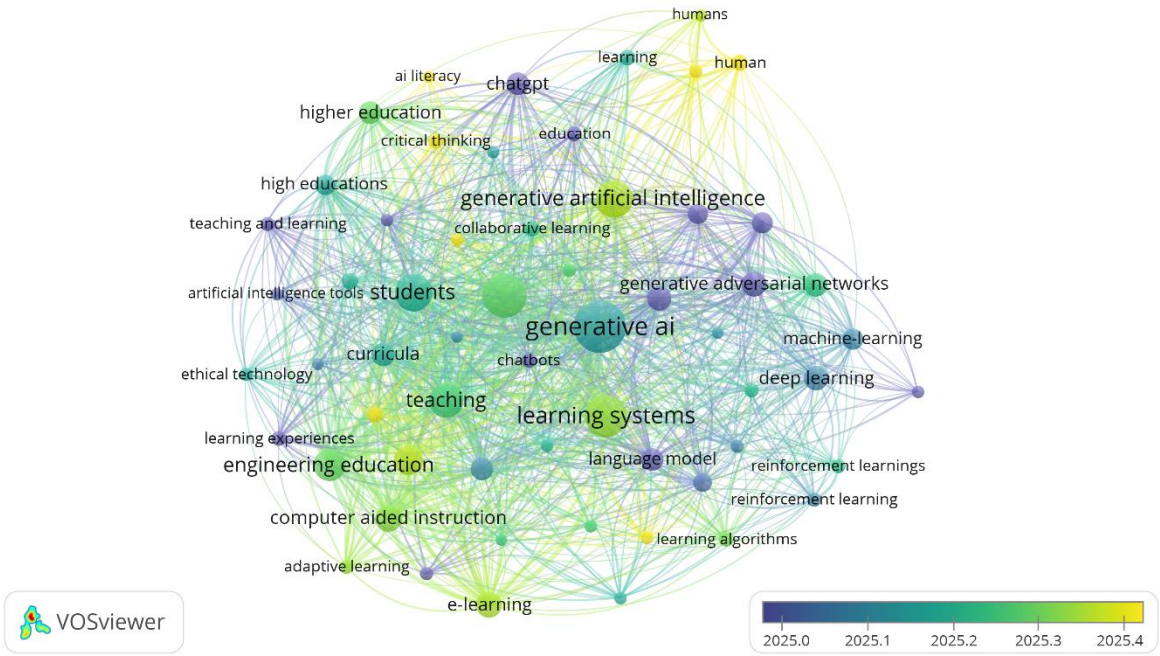

Figure 2. Overlay Visualization
Source: Data Analysis Result, 2026

Figure 2 depicts the evolution of research topics on Generative AI for Learning by the emergence of keywords from scientific publications across the globe. Here, the color scale indicates the average year of publication of the keywords, with the blue-purple color representing the older research topics (around 2025.0), whereas the yellow color represents the newer and emerging research topics (around 2025.4). From the figure, one can observe that the generative AI, learning systems, students, and machine learning terms are located at the center, which implies that these terms have high relevance in the literature.

These older research subjects, depicted through blue and purple colors, are concerned mainly with the technological bases of artificial intelligence such as machine learning, deep learning, generative adversarial network, language model, and reinforcement learning. These topics demonstrate the early interest in the creation of AI architectures and methods that allow for the creation of intelligent machines. On the other hand, green colored keywords like teaching, e-learning, adaptive learning, engineering education, curriculum, and learning experience show how research interests have shifted to the practical application of AI in education.

The latest trends in research, indicated through keywords in yellow color, are related to the increasing focus on the pedagogical and human-centric aspects of AI technologies. New trends like AI literacy, critical thinking, human interactions, higher education, and ChatGPT are indicative of how recent research has become increasingly focused on how learners and teachers adjust to AI-based educational scenarios. The latest trends point to future research directions involving responsible adoption of AI, critical evaluation of AI-generated content, ethics, and collaboration between humans and intelligent systems.

3.2 Citation Analysis

Table 1. The Most Impactful Literatures

Citations	Authors and year	Title
3925	[20]	"So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy
2549	[21]	Deep Learning: A Comprehensive Overview on Techniques, Taxonomy, Applications and Research Directions
1848	Chan C.K.Y.,Hu W. (2023)	Students' voices on generative AI: perceptions, benefits, and challenges in higher education
1590	Wang H.,Fu T.,Du Y.,... Bengio Y.,Zitnik M. (2023)	Scientific discovery in the age of artificial intelligence
1521	Rudolph J.,Tan S.,Tan S. (2023)	ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?
1192	Chan C.K.Y. (2023)	A comprehensive AI policy education framework for university teaching and learning
1163	Reed S.,Akata Z.,Yan X.,... Schiele B.,Lee H. (2016)	Generative adversarial text to image synthesis
1087	Zhai C.,Wibowo S.,Li L.D. (2024)	The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review
1047	Noy S.,Zhang W. (2023)	Experimental evidence on the productivity effects of generative artificial intelligence

Source: Scopus, 2026

In Table 1, the topmost impactful literature in the area of Generative AI for Learning according to citation performance from the Scopus database is presented. The results show that generative AI research has been highly impacted by multidisciplinary research works that have addressed generative AI's technology aspects, educational relevance, and social challenges. The most cited article is by Dwivedi et al. (2023), which has 3,925 citations; thus, the strong impact of research conducted to analyze the opportunities, challenges, and implications of ChatGPT and generative conversational AI is evident. The next article, by Sarker (2021), which is cited 2,549 times, provides a comprehensive review of deep learning technologies, applications, and future research directions. This article shows the significance of generative AI technologies to support the development of generative AI solutions. Additionally, the studies by Ray (2023) and Chan & Hu (2023) have attracted considerable attention with the emphasis on applications of ChatGPT, ethics, student attitudes toward it, benefits, and challenges in a higher education setting. Other highly cited articles are devoted to AI-powered scientific discovery, assessment system transformation, AI policy framework in universities, and the risks of AI dialog systems overuse.

3.3 Density Visualization

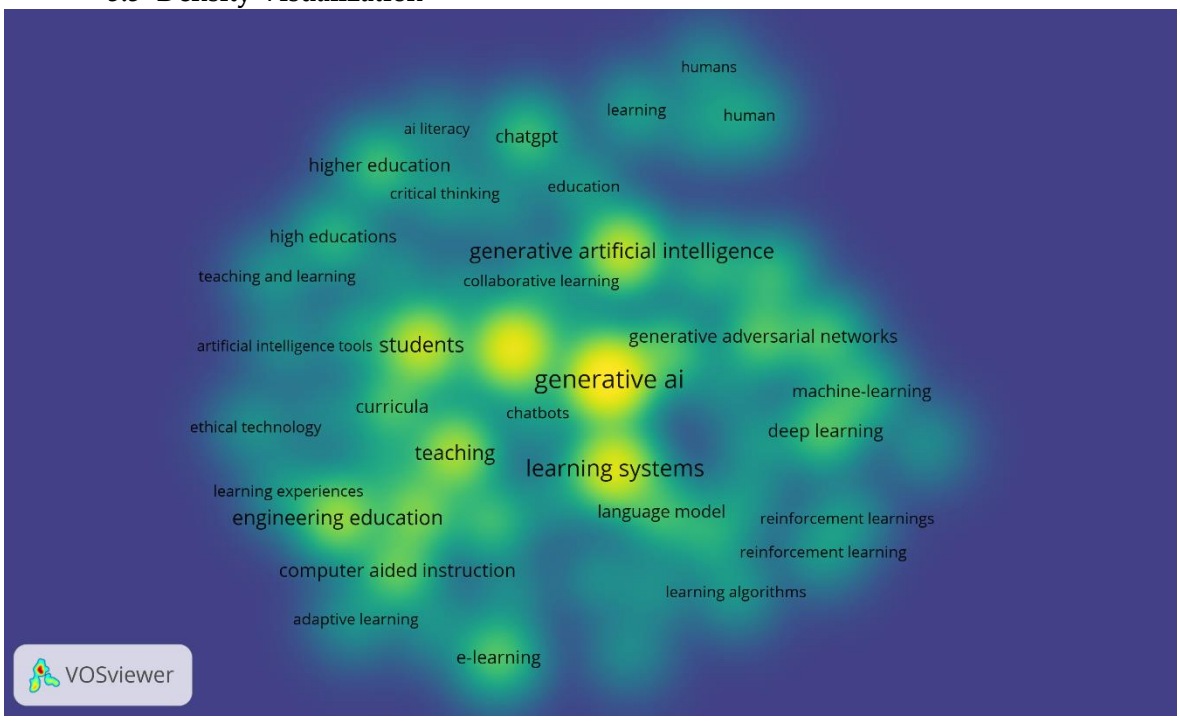

Figure 3. Density Visualization
Source: Data Analysis Result, 2026

The Figure 3 below presents the concentration and prominence of research areas concerning Generative AI for Learning. The color intensity shows how frequently and prominently the selected keywords occur, where regions with bright colors show the highest frequency of usage and prominence of the keyword. From the figure, it is clear that the keywords "generative AI," "students," "learning systems," and "generative artificial intelligence" are the most prominent ones and are located at highly concentrated regions. This shows that the recent scientific discourse has been highly centered on the investigation of the impact of the generative AI technologies on learning processes, educational systems, and students. It can be confirmed by the high concentration of the mentioned keywords because the generative AI has become one of the most important research topics after the wide spread of AI-based technologies like ChatGPT.

The visualization also provides an insight into the variety of interconnected research areas around the main theme. Key phrases like machine learning, deep learning, language models, and generative adversarial networks point at the technical basis of generative AI creation, whereas such terms as teaching, e-learning, adaptive learning, curricula, higher education, AI literacy, and critical thinking indicate the human dimension of AI application. It is clear that the use of such emergent concepts as AI literacy, ethical technology, and human-AI interaction points out that nowadays' research goes beyond technologies and moves towards responsibility and education.

3.4 Co-Authorship Analysis

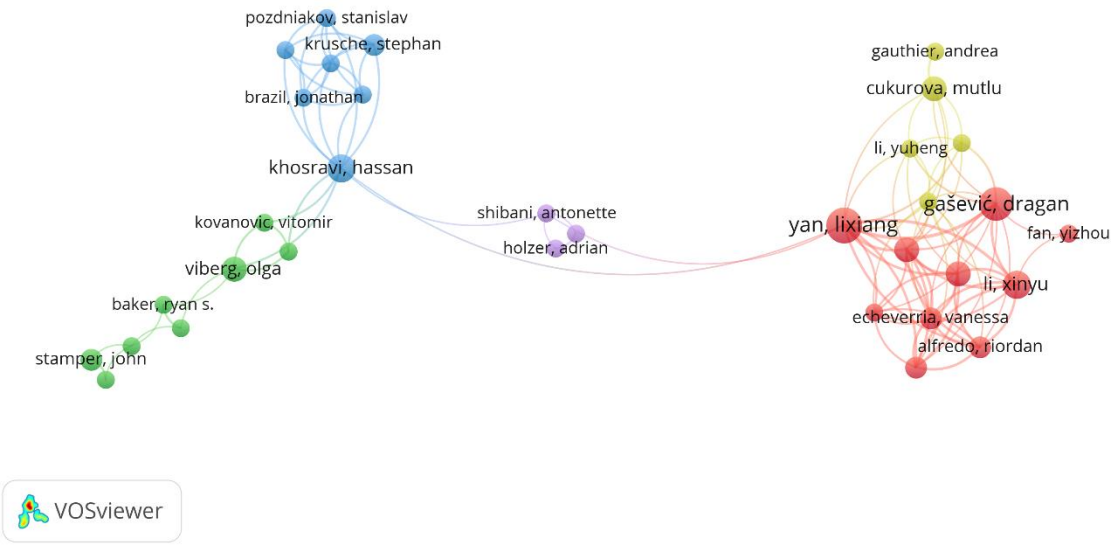

Figure 4. Author Visualization
Source: Data Analysis Result, 2026

Figure 4 provides a visual representation of the collaboration network of key researchers in the field of Generative AI for Learning. As can be seen, there are several author clusters in the network, which demonstrates that research activities are carried out within different scientific communities and collaborating teams. One of the most important collaboration networks is the red cluster comprising of authors like Yan, Lixiang, Gasevic, Dragan, Li, Xinyu, among others, which indicates that there are significant research contributions in the area of artificial intelligence in education, learning analytics, and usage of generative AI technologies in education. Another author cluster comprises of authors like Pozdniakov, Stanislav, Krusche, Stephan, Khosravi, Hassan, et al., who conduct research in the field of AI-based learning systems and educational technologies. The "green" cluster comprising authors like Viberg, Olga; Baker, Ryan S.; and Stamper, John is a sign of cooperation in the larger domain of learning analytics, adaptive learning, and education-related data-based approaches. The purple cluster consisting of authors such as Shibani, Antoinette and Holzer, Adrian demonstrates the development of new collaborations in the intersection of AI, human learning, and educational innovations. The small number of inter-cluster connections shows that despite fast development in generative AI for learning, there is still some fragmentation in the authorial collaboration.

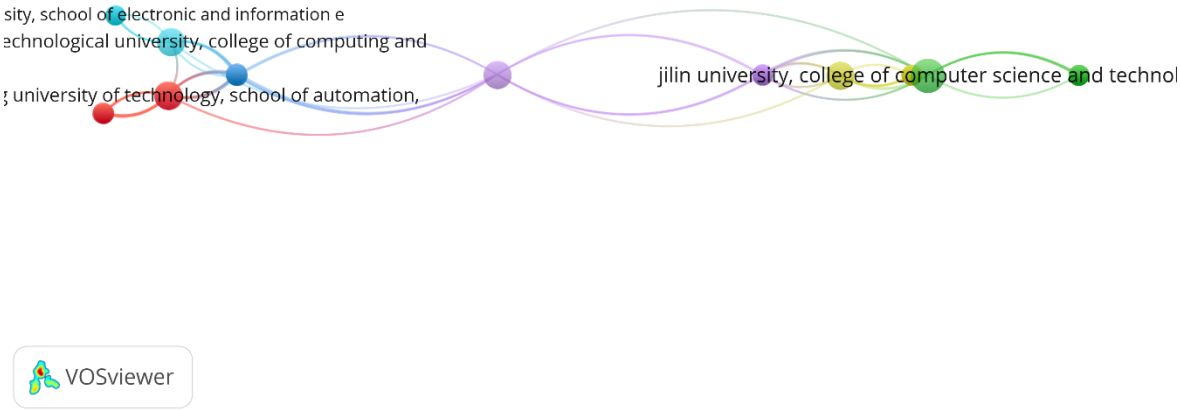

Figure 5. Institution Visualization
Source: Data Analysis Result, 2026

Figure 5 portrays the interdependencies among various institutions engaged in research within the field of Generative AI for Learning. It should be noted that the graph demonstrates a number of institutional hubs linked by cooperative ties, which means that there are certain patterns of academic collaboration between institutions. The existence of Jilin University, College of Computer Science and Technology, and other computer sciences-based institutions indicates a high level of participation of technology-based universities in the development of research within artificial intelligence, machine learning, and AI education areas. Based on the interdependencies, it can be argued that the research of generative AI in learning is primarily carried out through cooperation between computer sciences and educational technologies departments.

Visualization also shows that collaboration within institutions is still quite localized in certain academic networks with several clusters linked through some bridging institutions. This means that there is an ongoing process of interdisciplinary collaboration of artificial intelligence experts and those who specialize in education, although there is still a chance for expansion. It is explained by the fact that institutions which belong to the field of computer science dominate the visualization because generative AI is based on technology, although future progress may need collaboration with the fields of education and social sciences.

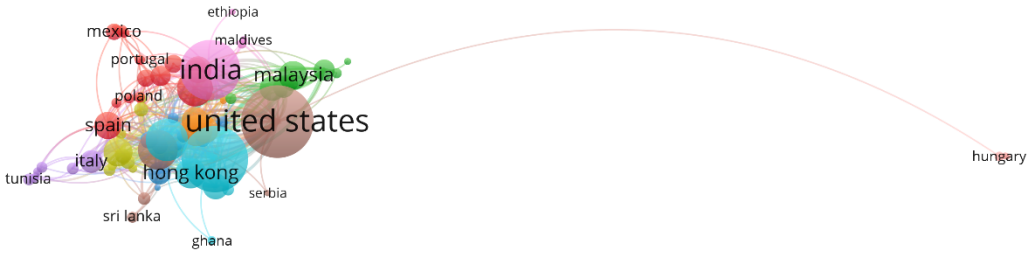

Figure 6. Country Visualization
Source: Data Analysis Result, 2026

Figure 6 shows the global distribution and international collaboration patterns of research on Generative AI for Learning. From the network above, it is clear that the United States is the most dominant and central country in contributing to research, as shown through the large size of the node and numerous connections it has with other nations. This implies that the United States has made numerous contributions in research and has been influential in developing knowledge internationally in the area of generative AI and learning. Some of the countries that have been well-connected include India, Malaysia, China/Hong Kong, Spain, Portugal, and Poland.

From the visualization, it is also possible to establish that research collaboration takes place through multiple networks both regionally and internationally. Countries such as India and Malaysia exhibit proximity and connections to research centers, implying that there is research collaboration on educational research using artificial intelligence, especially in new technology environments. Europe countries such as Spain, Italy, Portugal, and Poland exhibit network links, showing contributions to the field of educational technology, AI adoption, and digital transformation in learning. On the other hand, countries like Ghana, Ethiopia, Sri Lanka, and Hungary have small nodes showing emerging collaboration.

CONCLUSION

The results of this bibliometric analysis allow drawing a complete picture of the current global scientific environment concerning Generative AI for Learning by reviewing the patterns of publication activity, influential publications, keyword structure, collaboration of researchers, collaboration of institutions, and international collaboration. It can be concluded that the rapid development of the interdisciplinary field of generative AI is fueled by developments in such areas of science as artificial intelligence, deep learning, large language models, and conversational AI technologies. According to the most influential papers, contemporary research in generative AI is influenced by three main approaches: development of technologies of AI, educational use of such technologies in the learning process, and evaluation of various aspects of generative AI including ethical, cognitive, and institutional. Keyword structure implies the main concepts related to the topic under consideration, namely generative AI, ChatGPT, learning systems, students, teaching, and AI

literacy as there is a shift from technological investigation of the phenomenon towards human-oriented education.

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