

Deep learning in education: a bibliometric analysis

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ABSTRACT

This study investigates the application and development of deep learning in educational settings. Based on the statistics of scientific papers, analysis done using bibliometrics demonstrates the rise of deep learning in educational settings. Deep learning is having a transformative effect on all aspects of education and learning, as well as research. These findings could pave the way for more investigation into deep learning, particularly in education. According to the bibliometric results, the Netherlands, China, the United States of America, India, and Norway are the five countries that have contributed the most to deep learning in education. Norway came in fifth place. In addition, some of the possible directions that research could go in the future concerning deep learning in education include online, machine, blended, remote, informal, and deep reinforcement learning.

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1. Introduction

The modern classroom has become increasingly digitized due to recent advancements in artificial intelligence (AI) [1], [2]. This technology is beginning to take over repetitive classroom tasks, such as continuous student assessment or grading, optimizing course work, and revolutionizing how teachers teach and students learn [3]. Modern classrooms can improve their resource allocation, the context of personalized learning, adaptive assessments, and predictive analysis by using technology namely Machine Learning (ML).

ML is an AI subfield, a discipline of computing that uses statistical approaches to endow computer systems with the capacity to learn. ML has advanced rapidly in recent years, allowing machines to learn from examples and experiences, establishing a foothold in the educational sector [4]. On the other hand, Deep learning (DL) is a subfield of ML that focuses on the creation of artificial neural networks (ANN). These networks are comprised of algorithms that are modeled after the structure and function of the human brain [5]. For various objectives, deep learning may be used in education, including obtaining individualized information about each student's educational experience [6]. Instructors and administrators can then utilize this information to assist them in making automated choices based on data. A significant advantage of machine learning models is their ability to find patterns in big data sets that are difficult to notice manually, allowing for the regulation of abnormal behaviors, early diagnosis of school failure, and grouping of students or teachers [7], [8].

Educational and technical innovation occurs through high-quality digitalization and enhancement of teaching and learning to enhance students' and instructors' personal, professional, and social growth, hence the development of families and society [9]. It has been demonstrated that online activity strongly correlates with a student's grade on a topic [10]. Student engagement in learning activities may be a significant predictor of teaching quality since it demonstrates students' interest in the deep processing of learning information and reflects the time students spend on assignments assigned by

teachers. Thus, technologies are required to track and increase student activity [11], [12] and cooperation in the digital learning environment and create a competence profile of the student that can help them improve their quality of life in the most critical areas.

While instructors are critical to the educational process, leading and promoting student learning, the future of education will see increased collaboration between teachers and technology to benefit students [13]. Technology is increasingly assisting instructors in locating and focusing on learning and assessment through increased cooperation and creativity [14]. Today, deep learning algorithms identify trends in enormous data sets of instructor and student behavior [15], therefore assisting in optimizing instructional practices.

The purpose of this research is to explore the use of DL in educational settings as well as its growth. Bibliometrics analysis, which is derived from the statistics of published scientific publications, is used to illustrate the expansion of DL in educational settings. The findings might lead scholars to pursue more study in the area of profound educational learning.

2. Method

An analytical and bibliometric examination of the current publishing trends in the field of deep learning education is carried out in this work. It is anticipated that this method will quickly achieve widespread adoption in the field of information science and will be explicitly utilized in all research seeking to quantify the processes of textual communication. This study highlights the immense potential for quantitative, bibliometric assessments of the academic literature to give a comprehensive picture of scholarly activity and performance as well as the policy implications of their findings. In the field of scientific research, it is essential to get a more comprehensive understanding of the research that has already been conducted on a pertinent topic, as well as a bibliometric analysis profile on the research trajectory and the dynamics of global research activities.

This study conducts an in-depth analysis of the previously published research by making use of the Scopus database maintained by Elsevier. The purpose of this research is to undertake a bibliometric analysis of papers published in international journals in order to give a useful reference for further investigation. The information used to compile this article came from the database (<http://www.scopus.com>), which was accessed on December 27, 2021. In addition to this, the database has information on 186 different publications that were published between the years 1993 and 2022. In order to obtain a more relevant result, the following search terms were utilized: (TITLE (deep AND learning)) AND ((education)) AND (teaching) AND (LIMIT-TO (SUBJAREA, "COMP")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")) The combination of these terms yielded the best results. The data were then analyzed using an application called Biblioshiny, which is based on the programming language R [16] and can be downloaded for free here: <https://bibliometrix.org/>.

3. Results and Discussion

3.1. Three-field Plot Analyses

The three-field plot analysis, which was used to illustrate correlations between the three units (the author, the author's nation, and the keywords), is depicted in Fig. 1. Using the number 20 as a guide, we chose 20 different writers, 20 different nations, and 20 different keywords. The nation of the author, the writers themselves, and the top research keywords are all presented with gray relationships to illustrate the connection between one area and the one that comes after it. The extent of each rectangle in each list represents the number of items that are associated with that particular component. The AU_CO plane in the centre of the three-plane graphic serves as the focus of emphasis. In 2021, the top five nations will consist of Norway, the United States, China, and India. The Netherlands will fill out the top five. Furthermore, Fig.1 depicts a green rectangle (DE) for each of the five most published topics, deep learning in education, including deep learning, artificial intelligence, online learning, machine learning, and MOOCs. More research themes arise in larger rectangles, so this study described a common research topic.

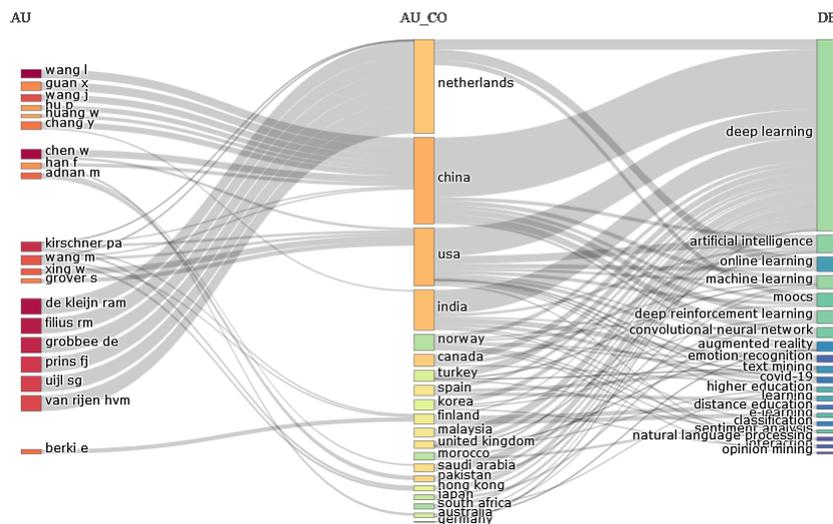


Fig. 1. Three-field plot correlations in the deep learning and education terms

3.2. The Author's Contribution

We examined the top five writers to determine the extent of their influence, the entire articles they contributed to, and the partnerships they formed. According to Fig. 2, Faust, O. ranks top with 398 citations. These citations are for papers with the title Deep learning for healthcare applications based on physiological signals: A review [3], which led to a major review of deep learning for healthcare applications. The research conducted by Vos N on the impact of designing vs playing an educational game on student motivation and the application of deep learning strategies [17] has received 219 citations, making it the second most referenced piece of work. The next researcher on this list is Francois-Lavet V., who has 211 citations for his work on introducing deep reinforcement learning [18]. With 139 citations, Grover S.'s work on designing for deeper learning in a blended computer science course for middle school students came in at number four on the list of articles with the most citations [19]. Lastly, surface and deep learning processes in distant education: Synchronous versus asynchronous systems by Offir B was the fifth most referenced article overall, receiving a total of 111 citations. This article was ranked fifth because it was authored [20]. Based on this finding, we anticipate that the author will earn a significant number of citations in the academic year 2020–2021, and that this number will keep growing over time.

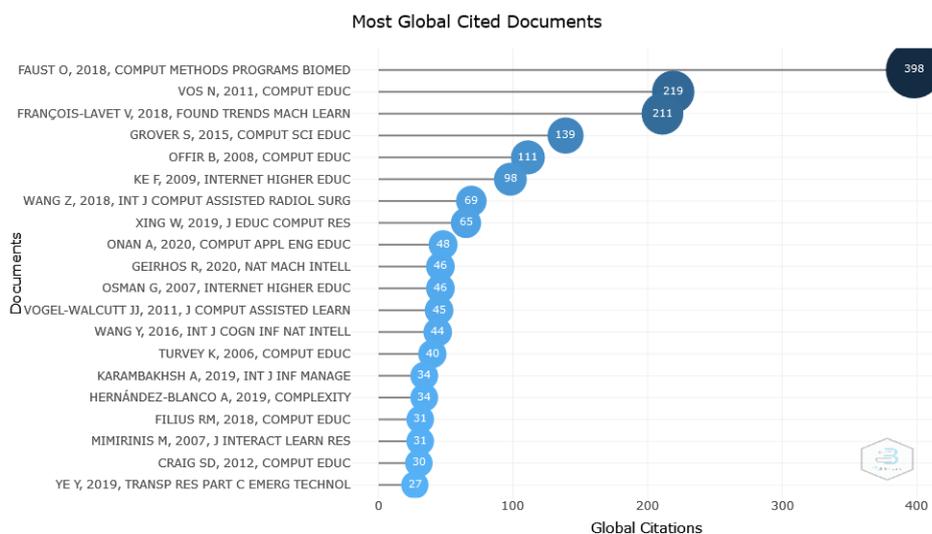


Fig. 2. The author's most globally-cited works

Another aspect that should be taken into consideration and credited is the author's contribution to the text. That will indicate international cooperation between researchers on a certain topic from different countries. In addition, other researchers, particularly rookie

researchers, can get in touch with the author in a country where there is a lot of collaborative work being done on the same topic. Single Country Publications (SCP) and Multiple Country Publications (MCP) in Scopus are displayed side-by-side in Fig. 3. According to the information gathered from the source, the countries with the most SCPs are China, the United States, the United Kingdom, and India. Meanwhile, according to MCP statistics, China has the most six articles, Pakistan has three articles, and the United States, the United Kingdom, Saudi Arabia, and Sweden have two articles.

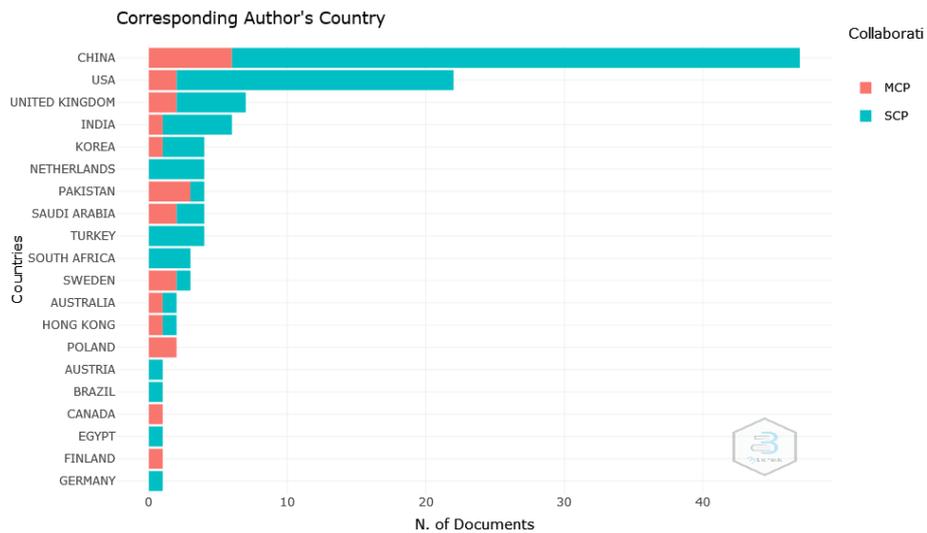


Fig. 3. Single-country and multi-country publications in terms of profound knowledge and education

3.3. The Most Frequent Keywords and Future Research

When it comes to conducting research on trends, keywords are of the utmost importance. Not only is it a trend in keyword research, but it also makes it simple for readers and researchers to locate topics that are relevant to their professions. The degree of precision with which these terms are selected will have an impact, both on the ease with which searches can be made and on the issues that are currently being discussed. Each keyword, which can be a single word or a combination of two words in various forms, will direct the investigation and the search through the relevant literature. The most frequently used phrases in relation to deep learning in education are illustrated in Fig. 4.

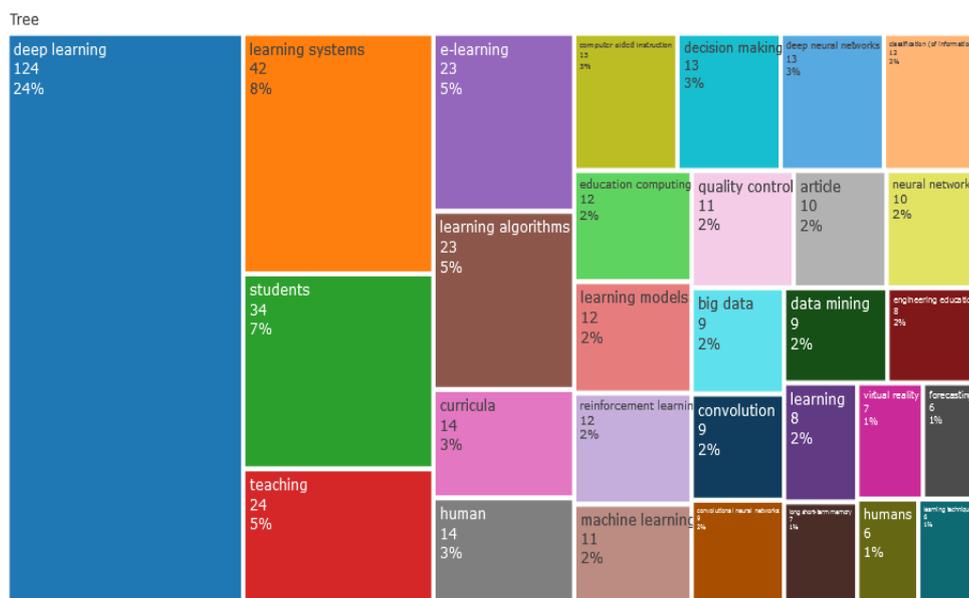


Fig. 4. Tree mapping of most used keywords

According to Fig. 4, deep learning (n = 124), learning systems (n = 42), students (n = 34), teaching (n = 24), and e-learning (n = 23) were the most common terms. In other words, deep learning, learning systems, and students were the most prevalent subjects for Scopus publications in deep learning in education. As a result, deep learning has become increasingly significant among learning systems and students in linked education. Furthermore, this discovery may be utilized to generate an intriguing subject of deep learning that can be used in education, such as learning systems, teaching, and e-learning. As shown in Fig. 5, the Thematic Map analysis backs up this result.

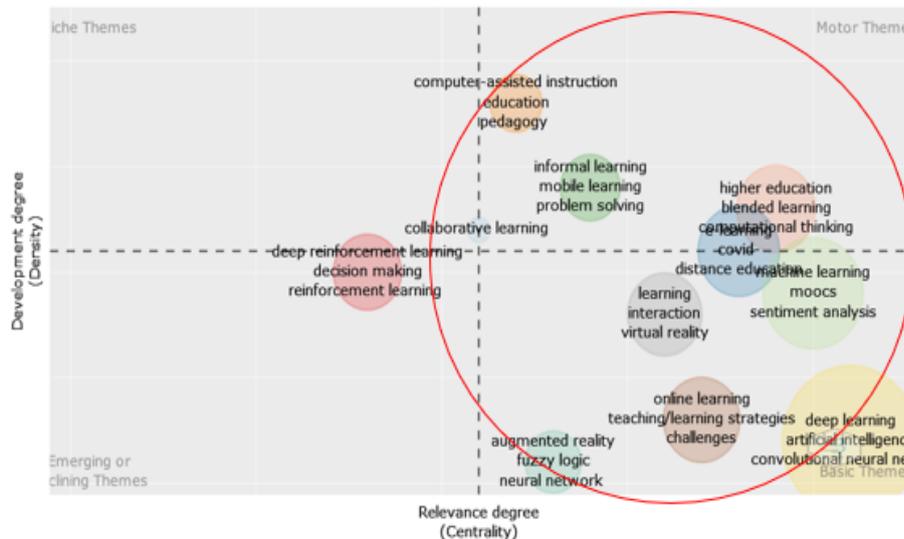


Fig. 5. Thematic map analysis

Fig. 5 presents the potential trends for future research on deep learning in education. Another exciting notion to use after deep learning is the multi-disciplinary theme. Online learning, machine learning, blended learning, remote education, informal learning, and deep reinforcement learning are some of the conceivable clusters depicted in Fig. 5. Several themes using yellow, green, blue, purple, red, orange, and gray hues are suggested for further research based on the educational goal scope.

4. Conclusion

An investigation into using bibliometrics revealed a positive trend toward deep learning in education. In education domains, deep learning (DL) has been successfully implemented. DL is revolutionizing education, teaching, learning, and research. Educators are utilizing DL to identify difficult pupils and intervene early. Students use deep learning to extract meaning and knowledge from course materials and experiences. Students may be able to acquire the knowledge and skills necessary for success more quickly and easily with the assistance of localization, transcription, text-to-speech, and personalization of the learning content. As a result, DL has the potential to affect positively the access to education that will be available in the future.

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