



Bibliometric analysis of articles on digital educational environments

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ABSTRACT

This study's main objective is to present bibliometric data on articles related to digital educational environments (DEEs) published in the journals indexed in Scopus database between 2003 and February 2023. The data collected from 61 articles published within the study's scope were subjected to bibliometric analysis based on six categories: number of articles and citations, most cited articles, most used keywords, most influential countries, most-important institutions, and the most important journals. This study was designed as a descriptive study and offers bibliometric network maps of the most popular papers, keywords and countries, institutions, and journals. VOS viewer was used to create network diagrams and bibliometric analyses. The bibliometric analysis showed that the most frequently used keywords were digital learning environment(s), digital educational environment. The most prolific authors related to DEE are Antón-Sancho, Vergara, Barana, and Marchisio. The results showed that DEE studies were started in 2003 and the most articles were published in 2021. This study presents a global perspective on DEEs and proposes vision for future research.

Keywords: digital educational environment, digital learning environment, digital transformation in educational environment, bibliometric analysis

INTRODUCTION

The use of digital technology in education has been on the rise in recent years with more and more resources becoming available online. This shift toward a digital learning environment has had many effects on how students learn, and teachers teach (Kryukova et al., 2022; Zhdanov et al., 2022). However, much research remains to be conducted about the impact of technology on education, with studies focusing primarily on specific areas or issues rather than understanding its entire scope (Oschepkov et al., 2022;

Platonova et al., 2022; Szymkowiak et al., 2021). The objective of this article is to provide an overview of academic literature related to digital education by compiling data from various sources and analyzing it using bibliometric techniques. By doing so, gaps in knowledge may become clearer, which would then allow for further investigation into this complex topic.

The most cited studies in the literature are those that focus on the effectiveness of digital education and how various tools and resources such as online courses, virtual reality and adaptive learning systems can improve student achievement (Aldhafeeri & Alotaibi, 2022; Burch et al., 2016). These investigations looked at factors like whether using these technologies resulted in improved learning outcomes; furthermore, they examined how well different types of students responded to this new form of instruction.

Another trend seen in the literature is the use of a mixture of quantitative and qualitative research methods, which allows for an expansive understanding of a subject matter by combining numerical data with insights gleaned from students' experiences and teachers' perspectives. This approach provides both comprehensive information regarding student outcomes as well as rich insight into how these individuals understand education (Chusni et al., 2021; Hsu et al., 2019).

Research on digital education has shown that there was an increasing interest in using artificial intelligence (AI) and machine learning (ML) to personalize learning and improve student engagement and motivation. These studies examined the potential of these technologies to make sure each individual learner receives the most relevant information thus helping them stay interested in their classes (Cope et al., 2021; Huang et al., 2023; Yildirim & Celepcikay, 2021).

Another important aspect of digital educational environments (DEEs) being studied is the role of the teacher in online learning environments. Several studies have highlighted the importance of teacher support and guidance in ensuring that students are successful in DEEs (Garrison & Cleveland-Innes, 2005). These covers providing clear expectations and guidelines for online participation providing timely and detailed feedback on student work and fostering a sense of community among students.

Additionally, research has also shown that effective teacher training is crucial for the successful implementation of DEEs (Graham, 2006). This includes training on the use of technology, online teaching strategies and course design. Teachers may struggle to effectively use the tools and resources available in DEEs, leading to a less effective learning experience for students without proper training.

Numerous studies have been carried out to look into how digital learning environments affect student outcomes (Masalimova et al., 2022; Qarkaxhja et al., 2021; Sorakin et al., 2022). According to Papamitsiou et al.'s (2016) meta-analysis, when compared to traditional face-to-face classes, online education was equally effective in terms of student learning outcomes in 2016 with no discernible differences in performance. Another meta-analytical review, by Paprzycki and Rau (2017), looked at how online learning affected student motivation and engagement. They found that, although the results were inconsistent across studies, online learning was linked to higher motivation and engagement.

Additionally, a survey by National Center for Education Statistics (NCES, 2018) indicated that over the previous ten years, K-12 classes have used technology more often for instructional reasons, with over 90% of instructors stating that they do so. The study also discovered that teachers incorporating technology into their lesson plans reported better levels of motivation and student engagement.

In the light of the literature related to DEEs, most of the research on DEEs has been concentrated on the effectiveness of DEEs. Studies revealed that DEEs can lead to improved learning outcomes for students especially when combined with traditional face to face instruction (Barak, 2014). According to Kirschner et al. (2004), DEEs can lead to increased student engagement and motivation.

According to Papastergiou (2009), pupils using digital learning environment performed significantly better academically than those who did not. The author contributed the improvement to the digital environment's dynamic and engaging quality, which served to raise student motivation and engagement.

There are many studies providing a foundation for understanding the impact of DEEs on student learning outcomes and how technology can be used effectively in education (Anderson & Dron, 2011; Chen et al., 2010; Gray & DiLoreto, 2016; Heitink et al., 2016; Santandreu Calonge et al., 2019).

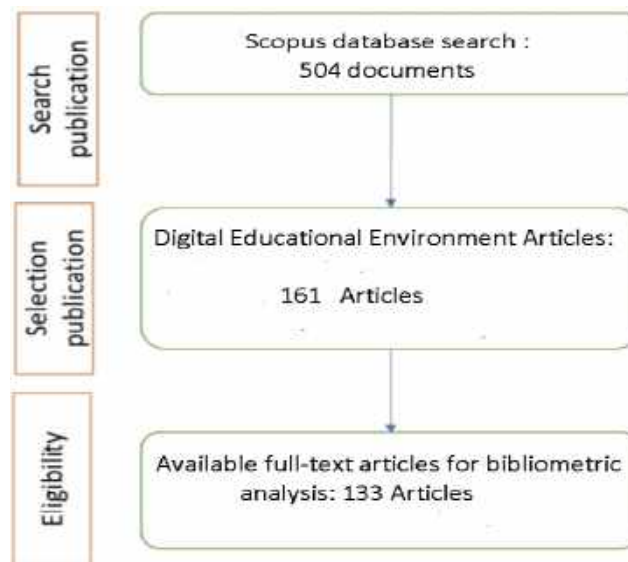


Figure 1. Publication selection process (Source: Authors)

Bibliometric Analysis

The systematic investigation of the literature to measure and evaluate trends of publishing, cooperation and citation is known as bibliometric analysis. This evaluation approach makes use of the large quantity of information accessible in published research articles, patents, conference proceedings and other sources to comprehend the evolution, structure and effect of a specific scientific or technical subject. Bibliometric analysis is widely used in a variety of domains, including science, technology, medicine and the social sciences to study trends in research and development, identify leading authors and institutions, evaluate the impact of research initiatives and track the progress of various disciplines.

According to Bornmann and Mutz (2015), bibliometric analysis is a method of literature analysis using quantitative measures such as the number of publications, citations, and authors to assess the impact and influence of a particular area of research. In this analysis, it was used Scopus database to identify relevant articles and the software VOS viewer to create a map of the research landscape. The search was performed using the keywords DEE and digital learning environment in the title, abstract and keyword fields of Scopus database.

In this study, the bibliometric analysis reviewed the articles related to DEE in Scopus database by investigating the number of articles by years, the most used keywords, the most prolific authors, countries publishing most articles, institutions contributed DEEs articles and funding agencies according to Scopus database.

METHOD

Process for Article Selection

The relevant keywords were used to search Scopus database with respect to the subject titled “digital educational environment”. These keywords were “digital educational environment” or “digital learning in educational environment” or “digital learning environment”. On the first scan, 504 publications were found. 161 of the publications were articles. In the following phase, the journals related to educational categories were chosen. As a result, this study included a bibliometric review of 61 articles indexed in Scopus database. **Figure 1** describes the article selection procedure in full according to preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Moher et al., 2009).

This study's aim was to discover patterns in research on DEE that had been published in journals included in Scopus database. By identifying the yearly counts, commonly used keywords, most cited authors, nations, institutions, funding agencies, and top-journals utilized in the relevant study, the bibliometric technique

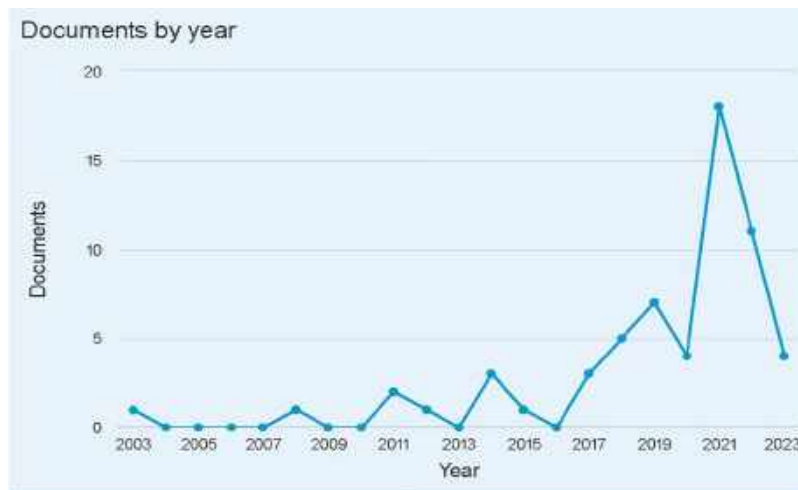


Figure 2. Annual accounts of the articles related to digital educational environment (Source: Authors)

analyzes the learning environment in scientific education. For the bibliometric study, learning environment and scientific education keywords were employed, and 133 publications from Scopus database were chosen. The results of the bibliometric research revealed that the terms digital learning environment(s) were most frequently utilized. In terms of the digital learning environment, B. J. Fraser was the most productive author. Vosniadou et al. were the most often mentioned author(s). The findings showed that digital learning environments research were first studied in 1989 with the greatest number of articles appearing in 2021. The digital learning environment is examined from a worldwide viewpoint in this paper suggesting a direction for further investigation.

Research Questions

This bibliometric analysis covers articles related to DEE between 2003 and 2023 years and focuses on the following research questions.

- RQ1:** What is the distribution of articles related to DEEs by years?
- RQ2:** What are the most used keywords in articles about DEE?
- RQ3:** Who are the most cited (citation and co-citation) authors in articles related to DEE?
- RQ4:** Which countries, universities, and funding institutions are the main researchers contributing to research on DEEs?

FINDINGS

Bibliometric Analysis Findings

The distribution of articles related to DEE by years is shown in **Figure 2**. The first article was published in 2003 and articles on DEE showed a fluctuating distribution until 2021 with 2022 being the year in which the most articles on this topic were published.

On the other hand, **Figure 3** shows the number of citations received by the relevant articles according to years. Overall, citations have increased over the years and naturally peaked in 2022.

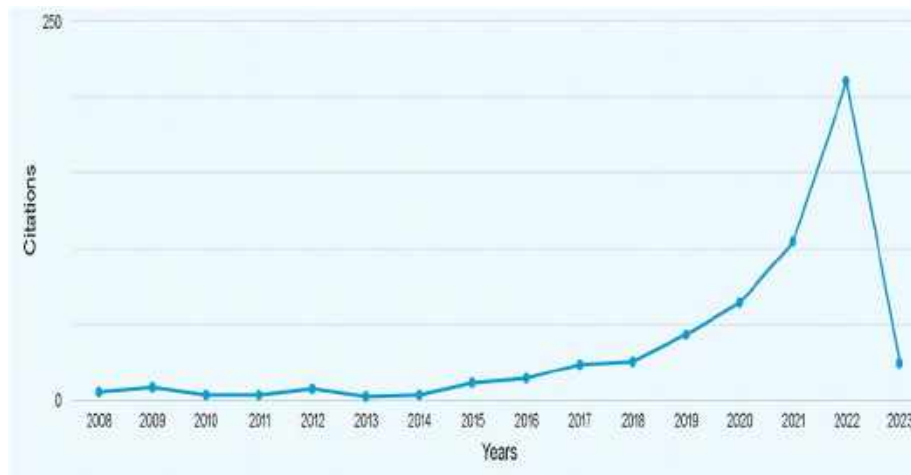


Figure 3. Number of citations related to digital learning environment articles (Source: Authors)

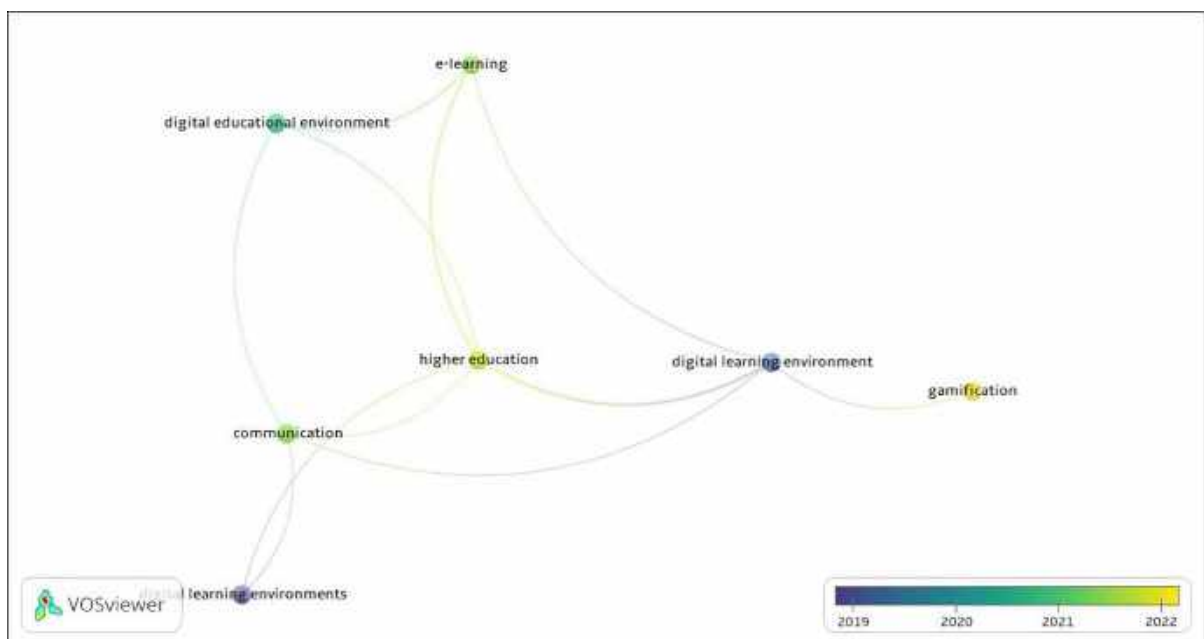


Figure 4. Distribution of the most used keywords in the articles related to DEE (Source: Authors)

The Most Used Keywords in Articles

'Co-occurrence' was selected as type of analysis and 'author keywords' was selected as unit of analysis in VOS viewer. The keywords' minimum repetition number was selected as three. The number of keywords has turned out to be seven automatically. The most used keywords were digital learning environment(s) ($f=31$), DEE ($f=8$), higher education ($f=7$), and e-learning ($f=5$). Distribution of the most used keywords in articles by years is presented in Figure 4.

The Most Prolific Authors

The most prolific authors related to DEE are Á. Antón-Sancho (four publications), D. Vergara (four publications), A. Barana (three publications), M. Marchisio (three publications), etc. Figure 5 shows the most prolific authors in relation to DEE articles.

Countries Publishing the Most Articles

Countries that publish the most articles were Russia (12 articles), Spain (seven articles), the United States (six articles), Germany (five articles), Austria, Finland, Italy, Netherlands, New Zealand, and Singapore (three articles per each country). Figure 6 shows the countries that publish the most articles.

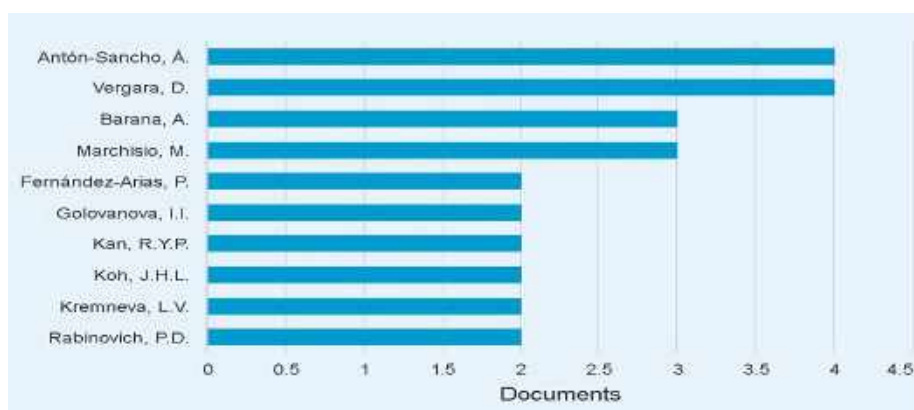


Figure 5. The most prolific authors related to DEEs (Source: Authors)

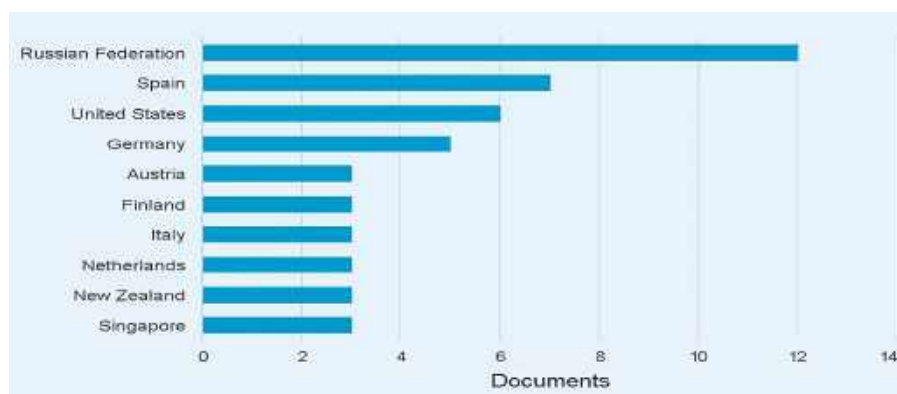


Figure 6. The countries publishing most articles (Source: Authors)

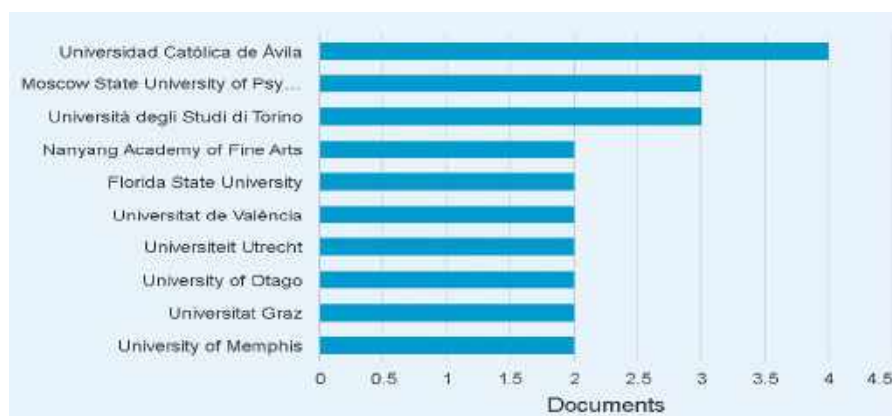


Figure 7. Institutions contributed DEEs articles indexed in Scopus database (Source: Authors)

Institutions

89 institutions have contributed to 105 publications related DEEs according to Scopus database. Scopus database revealed that the most contributive universities were Universidad Católica de Ávila (four articles), Moscow State University of Psychology and Education (three documents), Università degli Studi di Torino (three documents), Florida State University (two articles), etc. (Figure 7).

Funding Agencies

32 funding agencies expressed interest in investing in research into the DEEs according to Scopus Database. Four funding organizations that funded most of the research projects related to this research topic were Bundesministerium für Bildung und Forschung, Ministry of Education and Science of the Russian

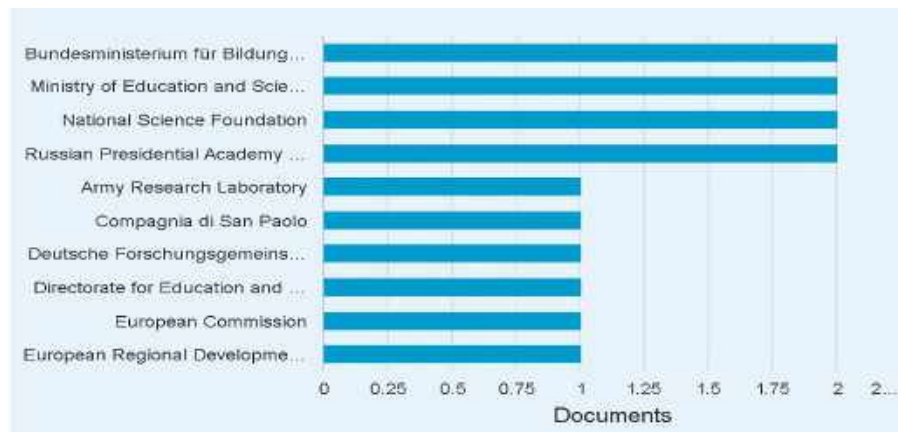


Figure 8. Funding agencies showing interest in investing in research on DEEs articles (Source: Authors)

Federation, National Science Foundation, and Russian Presidential Academy of National Economy and Public Administration as shown in [Figure 8](#).

DISCUSSION AND CONCLUSION

The digital transformation has brought about many changes in the way to learn including the use of technology to enhance the educational experience. In this article, it will be conducted a bibliometric analysis of the literature on DEEs to understand the current state of research in this field.

Previous bibliometric studies (Behl et al., 2022; Kocak & Soylu, 2022; Rojas-Sánchez et al., 2023; Schöbel et al., 2021; Yilmaz et al., 2022; Zhang et al., 2022) have examined DEE related to some specific concepts, but this research concentrated on broader and general perspective of DEEs. For example, some studies have focused in on the utilization of precise digital instruments such as learning management systems or digital games while others have focused on specific educational contexts such as higher education or K-12 education. In distinction, the study provides a summation of literature on DEEs published between 2003 and 2023.

The bibliometric analysis revealed that the majority of studies on DEEs have been conducted in Russian Federation followed by Spain and the United States. The most active institutions in the field were found to be universities and research centers with a large number of studies being conducted by researchers affiliated with these institutions.

As the world becomes increasingly connected, it is no surprise that scholars are exploring new ways to improve digital education in disadvantaged regions across the globe. Several studies have been conducted on this subject in Africa, Asia, and Latin America—all of which point to its potential benefits for improving access and leveling the playing field for students. A bibliometric analysis of the scholarly literature revealed that there is a lack of research concerning the long-term effects of digital education on students' learning outcomes. Additionally, growing evidence suggests that disparities in access to and use of digital educations may have undesirable consequences for students.

Future research in this field could look into the effectiveness of specific DEEs or platforms, how teachers and students use digital technology in the classroom, comparing the effectiveness of DEEs to traditional educational environments, studying the long-term effects of DEEs on students' learning outcomes and investigating potential biases and inconsistencies related to DEEs.

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Declaration of interest: Authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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