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DIGITAL TECHNOLOGY LEARNING FROM (2020-2025): A BIBLIOMETRIC ANALYSIS

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Abstract:

This bibliometric analysis examines the global development of digital technology in learning from 2020 to 2025, emphasizing its impact on educational progress and the enhancement of teacher competency. Data comprising 39,827 documents including journal articles, conference proceedings, book chapters, and books were collected from the Scopus database. The information was analyzed using VOSviewer software version 1.6.15 to map networks of co-authorship, keyword relationships, and international research collaborations. The findings indicate a continuous increase in research output from 2020 to 2024, peaking with over 9,800 publications. Journal articles (46.7%) and conference papers (39.5%) were identified as the main mediums for research dissemination, supported by contributions from books and chapters offering deeper theoretical insights. Cluster analysis revealed five major research domains: technological advancement, sustainability, digital pedagogy, human-centered approaches, and engineering-related applications, highlighting the multidisciplinary nature of this field. Moreover, the visualization network showed that China, the United Kingdom, and the United States were the leading contributors to global collaboration, while countries such as Malaysia and Saudi Arabia demonstrated growing regional engagement. Overall, the study underscores the increasing importance of digital technology in transforming teaching and learning practices worldwide. It provides valuable insights into how technological integration strengthens professional development, fosters international collaboration, and supports the creation of equitable and future-ready education systems.

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Keywords:

Digital Technology in Education, Bibliometric Analysis, Teacher Competency, Research Collaboration; Educational Transformation

Introduction

The rapid digital advancement in education over the past decade has profoundly transformed the landscape of teaching and learning. The increasing use of digital tools, platforms, and resources has not only driven transformative classroom practices but has also redefined the competencies teachers need to thrive in 21st-century educational environments. The COVID-19 pandemic served as a catalyst for this shift, compelling educators worldwide to adapt to remote and hybrid teaching methods, thereby heightening the demand for strong digital skills among teachers (Demissie et al., 2022; Juliandarini et al., 2024; Nurhidayat et al., 2024). As digital technology becomes increasingly embedded in pedagogical processes, teachers' ability to implement, adapt, and creatively utilize these tools is now recognized as a cornerstone of educational quality and student success.

Teachers' digital competence is a multidimensional construct that extends beyond basic technical skills. Modern frameworks such as TPACK (Technological Pedagogical Content Knowledge), DigCompEdu (European Digital Competence Framework for Educators), and DEPSWALIC emphasize the integration of technical, pedagogical, ethical, and socio-emotional aspects (Cui et al., 2024; Falloon, 2020; Joshi et al., 2021). These frameworks reflect a holistic understanding of digital competence, acknowledging that effective technology integration requires not only operational proficiency but also critical responsiveness, ethical decision-making, and the development of competent digital citizenship. The multidimensionality of teachers' digital competence is increasingly recognized as a vital foundation for fostering inclusive, adaptive, and innovative learning cultures.

This report evaluates recent research on digital technology as a driver of teacher capability, focusing on empirical evidence, theoretical frameworks, and practical applications. It examines the most influential digital technologies, the mechanisms influencing teachers' skills and professional growth, and the mediating roles of demographic, attitudinal, and contextual factors (Demissie et al., 2022; Letnes, 2025). In addition, the report identifies persistent gaps and emerging trends in the literature, offering insights for future research and policy development.

In conclusion, the rapidly evolving digital transformation in education demands a reassessment of the concept of teacher competence as holistic and dynamic. By linking theoretical foundations with practical perspectives, this report aims to provide guidance for educators, policymakers, and researchers in integrating digital technology for sustainable and equitable teacher development.

Literature Review

Recent scholarly research has identified a wide range of digital technologies that play a crucial role in enhancing teachers' skills. Collaborative platforms such as cloud-based learning management systems, virtual reality (VR) environments, game-based learning tools (gamification), and big data analytics are among the most prominent technologies (Cui et al., 2024; Demissie et al., 2022; Rajput & Sharma, 2025). These technologies not only support

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content delivery but also encourage collaboration, creativity, and reflective practice. Theoretical frameworks such as TPACK, DigCompEdu, and DEPSWALIC provide structured approaches for integrating these technologies into teachers' professional development. Specifically, DigCompEdu shifts the focus from mere IT proficiency to pedagogical innovation, while DEPSWALIC emphasizes ethical and policy dimensions, ensuring that digital competence remains balanced with autonomy and professional judgment (Cui et al., 2024; Joshi et al., 2021).

Digital technology enhances teachers' competencies and professional growth through several interrelated mechanisms. Digital practices are reinforced by tools such as video analysis, digital journals, and VR-based self-assessment platforms that enable teachers to evaluate and improve their instructional strategies (Atal et al., 2024; Gràcia et al., 2025). Collaborative learning models supported by online communities and cloud platforms promote knowledge exchange among peers and collective problem-solving (Lazareva & Tømte, 2024; Letnes, 2025). Professional development, increasingly driven by big data analytics and data-informed learning, allows for targeted interventions tailored to the needs and contexts of individual teachers (Rajput & Sharma, 2025). More importantly, the integration of socio-emotional competencies such as self-regulation, empathy, and resilience is now widely recognized as essential, with technologies like gamification and VR providing immersive environments for their cultivation (Mendzheritskaya et al., 2024; Sáez-Delgado et al., 2025).

The development and implementation of teachers' digital competencies are influenced by the complex interaction between demographic, attitudinal, and contextual factors. Empirical research shows that variables such as age, gender, teaching experience, and field of specialization significantly affect levels of digital competence (Amzat et al., 2022; Gracia-Zomeño et al., 2025; O'Brien, 2025). For instance, younger teachers and those in STEM fields tend to demonstrate higher digital proficiency, while positive attitudes toward technology and supportive institutional environments further strengthen competence development. Contextual factors such as access to resources, leadership support, and school culture play vital roles in shaping teachers' opportunities and challenges in integrating digital technologies (Carpenter et al., 2024).

Continuous development of teachers' digital competence is closely linked to administrative support, expert mentoring, and a culture of lifelong professional learning. Distributed leadership, instructional coaching, and structured mentoring programs have been shown to positively influence teachers' self-efficacy and the effective use of digital tools (Baiges et al., 2024; Gracia-Zomeño et al., 2025; Amzat et al., 2022). Organizational support systems, including access to expert feedback and collaborative professional learning communities, are crucial for enhancing digital competence in daily practice and fostering innovation in teaching (O'Brien, 2025). The COVID-19 pandemic further underscored the urgent need for such support as teachers were forced to adapt to sudden shifts in instructional methods.

Despite significant progress, gaps remain in the implementation of digital competencies in both pre-service training and continuous professional development. Overreliance on self-assessment, limited use of advanced digital tools in training, and unequal access continue to hinder the development of comprehensive digital competence (Gökdaş et al., 2024; McGarr, 2024; Nurhidayat et al., 2024). Current trends point toward precision-based training frameworks, holistic and interdisciplinary competency models, and increased use of immersive

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technologies such as VR and gamification in teacher education (Wang, 2025). Post-pandemic developments also emphasize the need for institutional policies that foster sustainable digital competence, equity, and teacher autonomy. Future research should focus on the long-term impact of digital interventions, objective assessment methods, and strategies to digitize education across diverse contexts.

Research Question

Q1 What are the research trends in digital technology learning studies according to the year of publication?

Q2 which are the most relevant and studies, authors, affiliation?

Q3 What are co-occurrence, authors, and countries' collaboration?

Methodology

This bibliometric study employs a quantitative analytical approach to examine the global progress of research in the field of digital technology learning from 2020 to 2025. Data were systematically collected from the Scopus database, which provides extensive coverage of multidisciplinary and peer-reviewed academic publications (Juliandarini, Sudira, & Fara, 2024). The search was conducted using the Boolean expression TITLE-ABS-KEY ("Digital Technology Learning"), limited to works published between 2019 and 2025 in the English language. To ensure balanced disciplinary representation, the search was restricted to subject areas such as computer science, education, engineering, social sciences, mathematics, energy, environmental studies, and decision sciences. Only journal articles, conference papers, book chapters, and books were included, resulting in a total of 39,827 relevant documents for detailed analysis.

This study follows bibliometric procedures that emphasize objectivity, reproducibility, and visual interpretation of academic data (Falloon, 2020; Demissie, Labiso, & Thuo, 2022). The analytical processing was conducted using VOSviewer software version 1.6.15, a recognized tool for generating bibliometric analyses through VOS clustering and mapping techniques. This approach enables visualization of co-authorship structures, keyword co-occurrence, and international collaborations, providing a comprehensive overview of the thematic and intellectual organization within this research domain (Van Eck & Waltman, 2010). The methodological process involved three main phases. First, descriptive statistics were used to summarize publication trends and document distribution. Second, relational mapping examined the connections among authors, institutions, and countries through citation patterns and collaborative writing networks. Third, visual network analysis identified thematic clusters and emerging research trends (Rajput & Sharma, 2025; Wang, 2025). A data normalization technique was also applied to ensure reliability and consistency across document types and sources.

Overall, this comprehensive bibliometric framework provides a data-driven understanding of the evolution of digital learning technologies at the global level, emphasizing collaborative growth, thematic diversity, and the interdisciplinary nature of digital education research.

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Data Search Strategy

This study employed a systematic filtering sequence strategy to determine search terms in order to retrieve relevant and appropriate articles. The research process began with a query in the Scopus database using the following expression TITLE-ABS-KEY ("Digital Technology Learning") AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "MATH") OR LIMIT-TO (SUBJAREA, "ENER") OR LIMIT-TO (SUBJAREA, "ARTS") OR LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "DECI")) AND (LIMIT-TO (SRCTYPE, "j") OR LIMIT-TO (SRCTYPE, "p") OR LIMIT-TO (SRCTYPE, "k") OR LIMIT-TO (SRCTYPE, "b")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "ch") OR LIMIT-TO (DOCTYPE, "bk")). Using this search strategy, a total of 39,827 articles were successfully retrieved. This approach ensured that only peer-reviewed and relevant documents from diverse fields such as computer science, engineering, social sciences, mathematics, energy, arts, environmental studies, and decision sciences were included. The process also guaranteed balanced data coverage across various academic disciplines and publication types—including journal articles, conference papers, book chapters, and books—for the purpose of conducting a comprehensive bibliometric analysis.

Data Analysis

The dataset analysis used in this study includes publication information such as year, title, author, journal, citation count, and keywords obtained from the Scopus database, covering publications from 2020 to November 2025. The data were analyzed using VOSviewer software version 1.6.15, a recognized tool for visualizing bibliometric networks through clustering and mapping techniques. According to Van Eck and Waltman (2010), VOSviewer serves as an alternative to the Multidimensional Scaling (MDS) approach, sharing the same objective of positioning items within a low-dimensional space so that the distance between two items accurately reflects their degree of relatedness or similarity (Appio et al., 2014). Unlike MDS, which typically relies on similarity measures such as the Jaccard index or cosine coefficient, the VOS method employs a more refined approach to normalize co-occurrence frequencies using the association strength (ASij) measure (Van Eck & Waltman, 2007). This index is calculated as the ratio between the observed number of co-occurrences of two items and the expected number of co-occurrences under the assumption that both items are statistically independent (Van Eck & Waltman, 2010):

$$ASij = Cij$$

$$Wiwj$$

VOSviewer then constructs a visual map by minimizing the weighted sum of squared distances between items, resulting in a clear representation of the relationships within the data. The LinLog/modularity normalization technique, as described by Appio et al. (2016), was also applied to enhance clustering accuracy. Through this visualization method, the study successfully identified structural and thematic variations within the dataset by conducting analyses such as keyword co-occurrence, authorship, and international collaboration. The keyword co-occurrence analysis helps trace the evolution of research topics over time and identify emerging themes within specific disciplines (Li & Chu, 2017). Meanwhile, authorship analysis, a comprehensive bibliometric method (Hassan & Duarte, 2024), employs network

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theory to map the structural relationships among documents, thereby providing insights into the intellectual organization and core research areas within the domain of digital technology learning.

Findings

Q1: What Are The Research Trends In Online Learning Studies According To The Year Of Publication (2020-2025)?

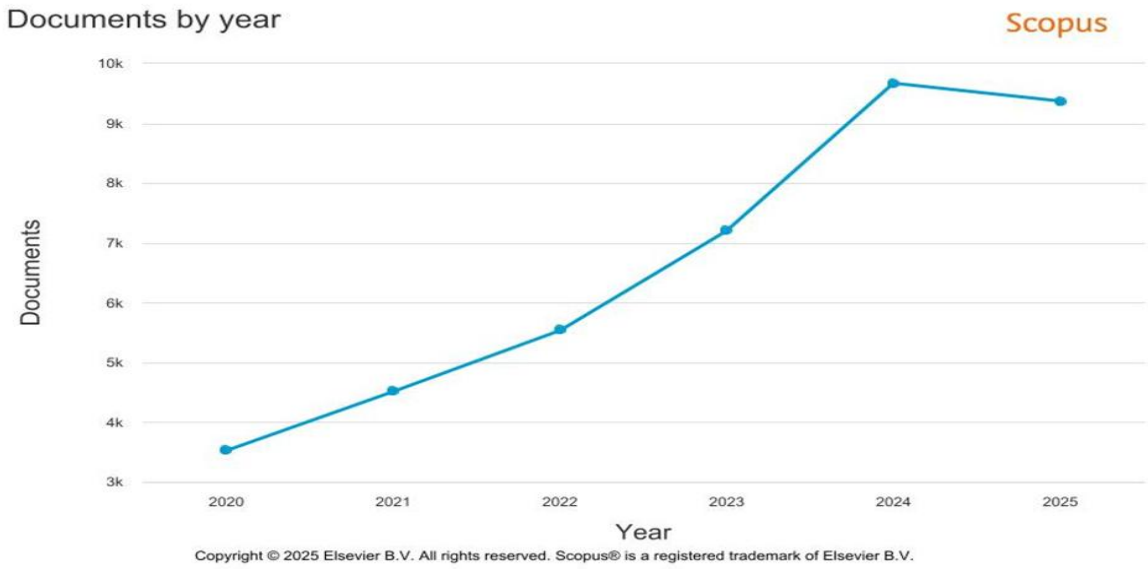

Figure 1: Trend Of Research in Digital Technology Learning by Years

Year	Documents
2025	9366
2024	9672
2023	7202
2022	5544
2021	4518
2020	3525

In 2020, a total of 3,525 documents were indexed, marking the lowest point in the research trend. The number of documents then increased to 4,518 in 2021, 5,544 in 2022, and 7,202 in 2023. The highest number of publications was recorded in 2024 with 9,366 documents, indicating rapid growth in global research activity. However, in 2025, there was a slight overall decline to approximately 9,366 documents, possibly due to the ongoing indexing process or natural adjustment following the substantial surge in previous years. Overall, the chart reflects a strong and positive upward trend in research output, particularly between 2022 and 2024. This increase can be attributed to advances in digital research platforms, broader international collaborations, and the recovery of academic productivity after the pandemic period. Despite the slight decline in 2025, the overall data demonstrate a continuing upward trajectory and highlight Scopus's influence in revealing global research and publication trends.

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Q2: Which Are The Most Relevant And Studies , Authors, Affiliation?

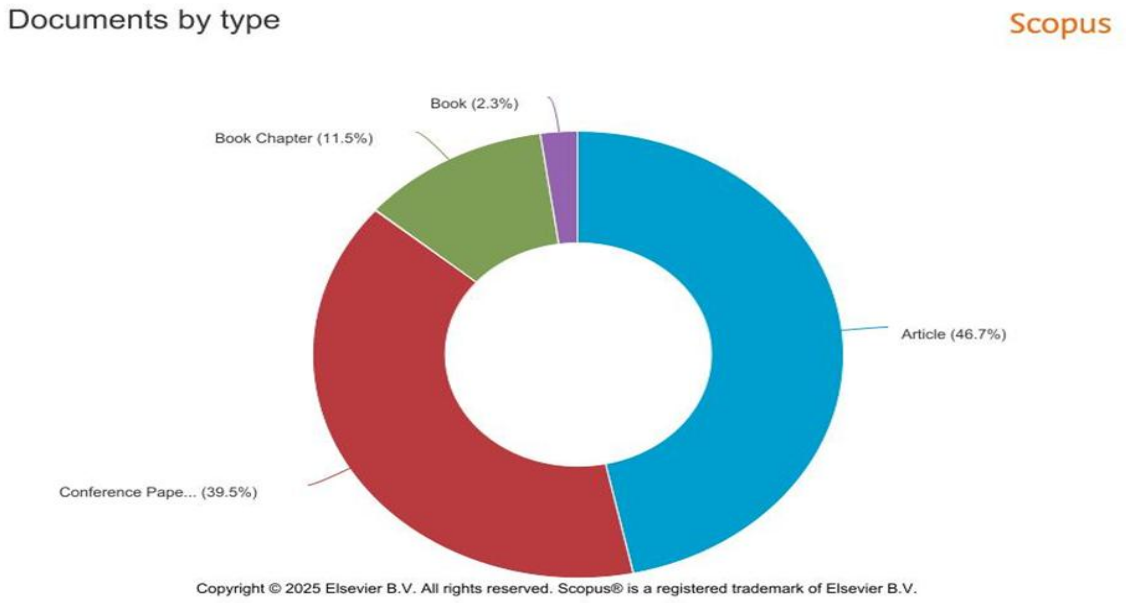

Figure 2: Top Document By Type

Based on the data, articles account for 46.7%, indicating that journal publications remain the most preferred and influential medium for communicating research outcomes. This dominance emphasizes the importance of peer-reviewed journals as reliable sources of scientific knowledge. Conference papers make up 39.5%, showing their significant role in presenting early research findings and innovations, particularly in fast-evolving fields such as engineering, technology, and computer science. In addition, book chapters comprise 11.5%, highlighting the value of scholarly contributions in edited volumes that offer in-depth discussions on specific topics. Meanwhile, books contribute 2.3%, suggesting that full-length monographs, while less frequent, remain essential for comprehensive academic exploration. Overall, the chart depicts a research landscape led by journal articles and conference papers, which together form more than 85% of the total publications. Nonetheless, book chapters and books continue to serve as important avenues for detailed theoretical insights and specialized research contributions. This pattern reflects the dynamic nature of academic publishing, where different types of documents collectively enhance the dissemination and advancement of global scholarly knowledge.

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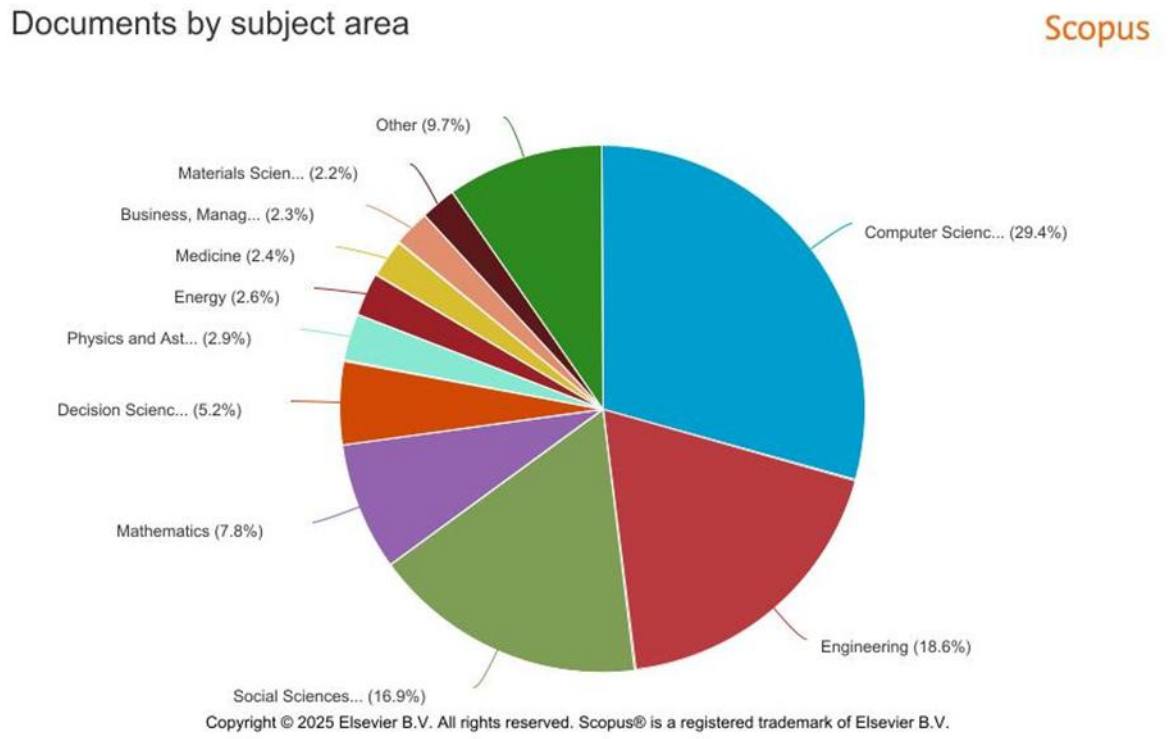

Figure 3: Most Relevan Studies In Digital Technology Learning By Document

This pie chart illustrates the distribution of research publications on digital technology learning across various academic disciplines indexed in the Scopus database. Computer Science leads with 29.4%, highlighting its influential role in driving the advancement of digital learning systems, artificial intelligence (AI), and educational technology. Engineering contributes 18.6%, reflecting its importance in the design and implementation of technological infrastructures that support modern education. Social Sciences, accounting for 16.9%, indicate a growing focus on pedagogical, social, and behavioral dimensions in the use of technology within learning environments. Meanwhile, Mathematics (7.8%), Decision Sciences (5.2%), and Physics and Astronomy (2.9%) serve supportive roles in areas such as data analytics, problem-solving frameworks, and computational modeling. The lowest proportions come from Energy (2.6%), Medicine (2.4%), Business and Management (2.3%), and Materials Science (2.2%), demonstrating that research in digital learning has also expanded beyond traditional education-related disciplines. The “Others” category, representing 9.7%, includes emerging fields such as sustainability, digital policy, and data ethics. Overall, the data suggest that while technology- and engineering-related fields remain dominant in digital learning research, there is a strengthening trend of interdisciplinary collaboration involving the social sciences and natural sciences. This diversity reflects a more holistic and comprehensive approach to empowering education in today’s digital era.

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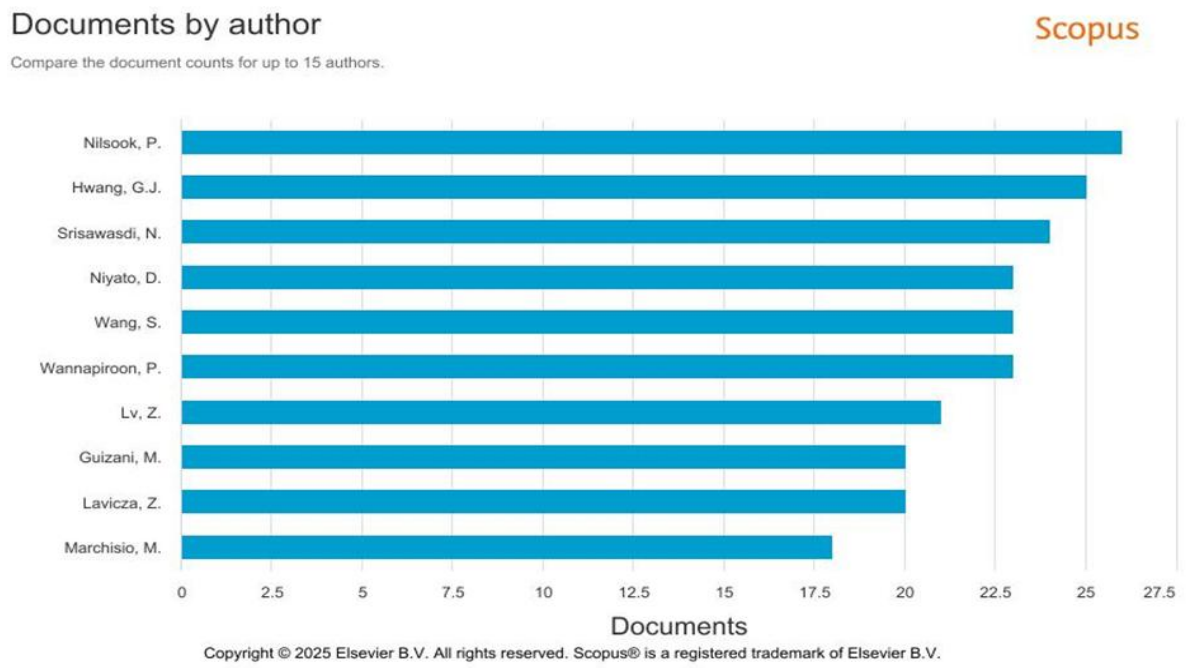

Figure 4: Top Author

This bar chart presents the leading authors who have contributed most significantly to research in the field of digital technology learning, based on data from the Scopus database. Nilsook, P. ranks first as the most active author with 26 publications, followed by Hwang, G. J. with 25 publications and Srisawasdi, N. with 24 publications, highlighting their strong influence in educational technology and digital pedagogy. Meanwhile, Niyato, D., Wang, S., and Wannapiroon, P. each have 23 publications, reflecting their active engagement in topics such as e-learning innovation, digital transformation, and smart education systems. Lv, Z. contributes 21 publications, while Guizani, M. and Lavicza, Z. each have 20 publications, indicating their consistent involvement in technology-based education research. Lastly, Marchisio, M. is also listed with approximately 18–19 publications, demonstrating ongoing participation in this academic domain. Overall, this data illustrates that a small group of highly prolific researchers plays a crucial role in shaping the global research landscape on digital learning technologies. Their contributions emphasize the importance of interdisciplinary collaboration, innovation, and technological integration in advancing the quality of teaching and learning worldwide.

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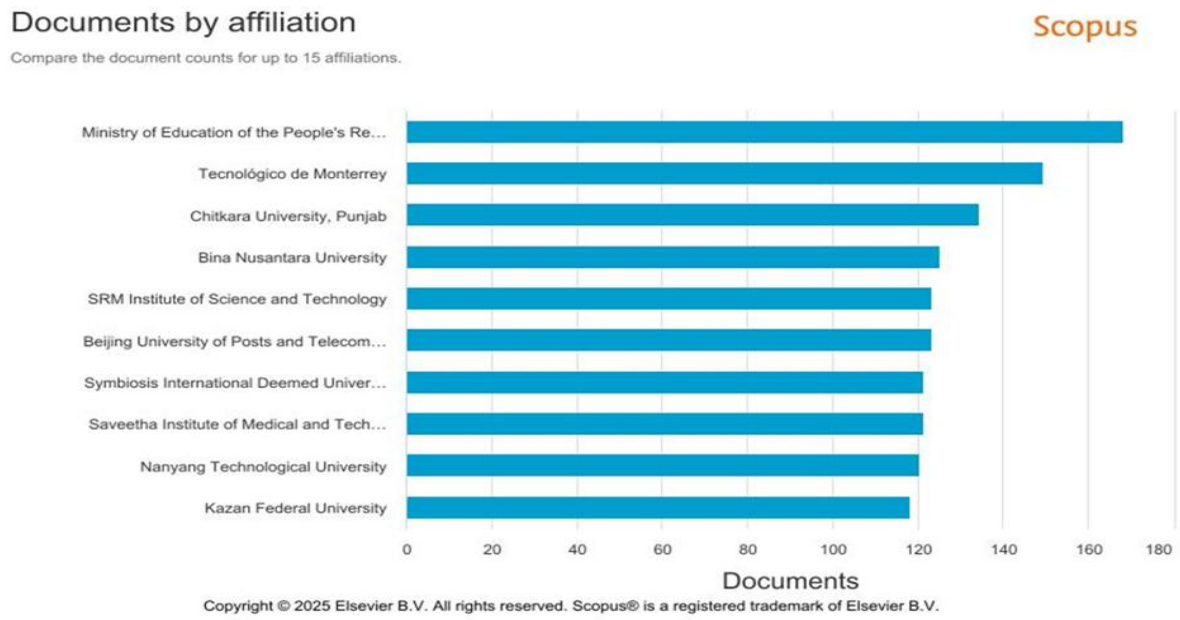

Figure 5: Top Document By Affiliation

The results of the study show that the Ministry of Education of the People's Republic of China ranks first with 168 publications, indicating the country's broad dominance in research output. It is followed by Tecnológico de Monterrey from Mexico with 149 publications, and Chitkara University, Punjab in India with 134 publications, reflecting the active role of both institutions in academic research. Bina Nusantara University in Indonesia recorded 125 publications, while both the SRM Institute of Science and Technology and Beijing University of Posts and Telecommunications contributed 123 publications each, demonstrating balanced productivity in the fields of science and technology. Symbiosis International Deemed University in India follows closely with 121 publications, signifying India's expanding engagement in the global research arena. Overall, these findings indicate that Asian institutions, particularly those from China and India, are emerging as major contributors to global scholarly output. This increase may be driven by significant investments in education and technology, strong international collaborations, and continuous innovation, which together strengthen Asia's position as an active player in global research and the development of digital education.

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Q3: What Are Co-Occurrence, Authors, And Countries' Collaboration?

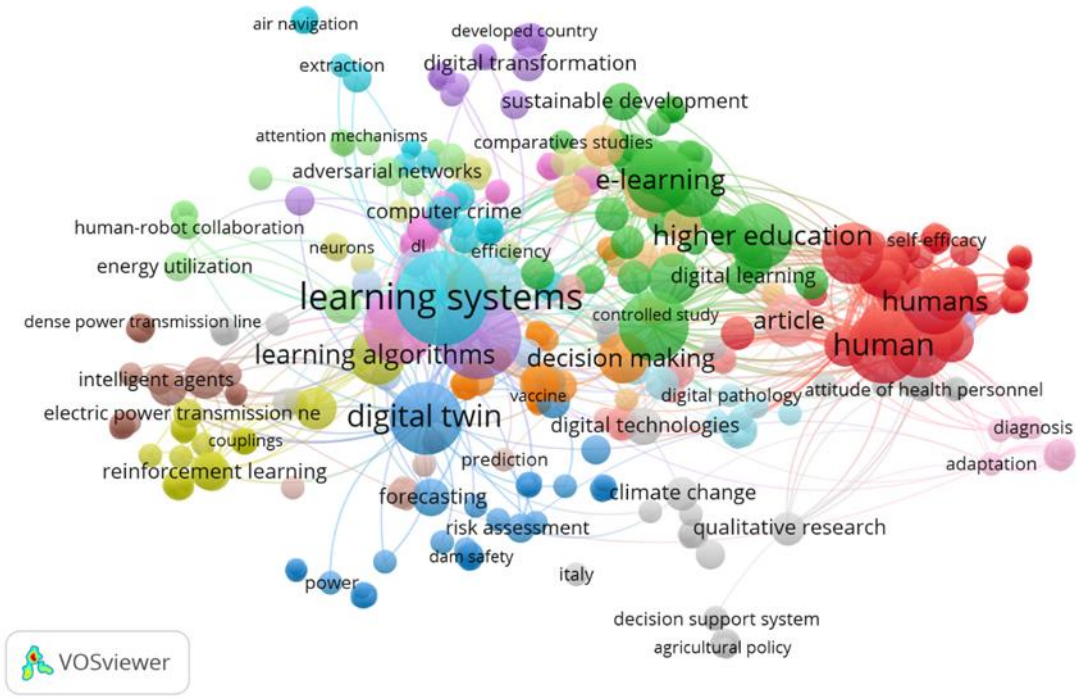

Figure 6: Notice That The Search Topics By Co-Occurrence

The visualization was generated using VOSviewer software. The findings reveal a network of keyword co-occurrences that reflects the main research themes and the interconnections among fields within the domain of digital learning and technology-driven education. The size of each node represents the frequency of a keyword's appearance, while the color indicates the grouping of related research themes (clusters). The most dominant and centrally positioned terms in the network—such as "learning systems," "learning algorithms," "digital twin," and "higher education"—signify the core focus areas of academic research. Surrounding these main themes are closely related keywords such as "digital transformation," "e-learning," "decision making," and "sustainable development," illustrating the integration of digital technology across multiple disciplines. Meanwhile, the appearance of keywords like "human," "self-efficacy," and "qualitative research" indicates that researchers are also paying attention to the human and behavioral dimensions in the adoption and use of digital tools. The network density and interconnectedness among these keywords demonstrate the interdisciplinary nature of current research, linking fields such as artificial intelligence (AI), education, health, and

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sustainability. Overall, this visualization portrays a dynamic and interconnected scientific landscape centered on digital learning systems, intelligent algorithms, and human-centered innovation as the main themes driving contemporary academic inquiry.

The VOSviewer network map uses color-coded clusters to represent groups of interrelated research themes based on keyword associations, thereby highlighting connections among various multidisciplinary domains within digital learning and educational technology. The Blue Cluster emphasizes research related to technological and computational innovation, including keywords such as digital twin, forecasting, risk assessment, and reinforcement learning. This cluster reflects the application of artificial intelligence (AI), data modeling, and smart predictive systems in education. The Purple Cluster focuses on digital transformation and sustainability, featuring keywords like developed country and sustainable development, which indicate studies exploring how digital technologies act as catalysts for progress and global change.

The Green Cluster relates to education and learning systems, encompassing keywords such as learning systems, higher education, e-learning, and digital learning. This cluster underscores the emphasis on digital pedagogy, online education, and technological integration in academic institutions. The Red Cluster highlights the human and psychological dimensions, with keywords such as human, humans, self-efficacy, and attitude of health personnel, indicating research examining human interaction, motivation, and behavioral responses toward digital technology use.

The Brown and Yellow Clusters represent research in engineering and energy systems, including topics such as intelligent agents, energy utilization, and electric power transmission lines, reflecting the connection between digital technological innovation and the development of energy and smart systems. Overall, these color-coded clusters illustrate a highly multidisciplinary research landscape that interweaves technology, education, sustainability, and human factors as core components in the study of global digital transformation.

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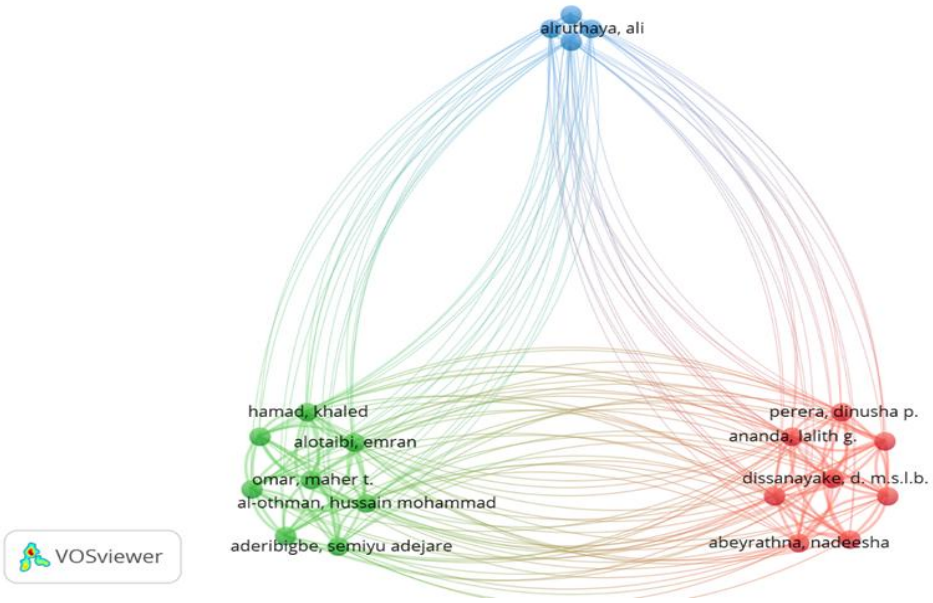

Figure 7: Network Visualization Authors

The map generated using VOSviewer illustrates the co-authorship network, reflecting patterns of collaboration among researchers in the field of digital technology learning. Each node (circle) represents an author, while the connecting lines indicate the strength of their research collaboration. The colored clusters represent groups of authors who frequently publish together, signifying the presence of active and interconnected research communities. In this map, the blue cluster, led by Alruthaya, Ali, stands out as the most prominent and highly connected group, indicating that this author plays a key role as a central figure linking multiple research teams. The green cluster, which includes researchers such as Hamad, Khaled and Alotaibi, Emran, represents another active collaborative group contributing significantly to studies related to digital education and smart learning technologies. Meanwhile, the red cluster, consisting of authors such as Perera, Dinusha P., Ananda, Lalith G., and Dissanayake, D. M. S. L. B., forms a distinct research network that nonetheless maintains close connections with other clusters. The visible interconnections among these clusters indicate the existence of strong cross-disciplinary and inter-institutional collaboration, with Alruthaya, Ali serving as an important bridge author who links various international research groups. Overall, this map highlights a dynamic and interactive global research community, showing that studies on digital technology learning are conducted through broad, interdisciplinary collaborative networks that strengthen innovation and knowledge exchange at the international level.

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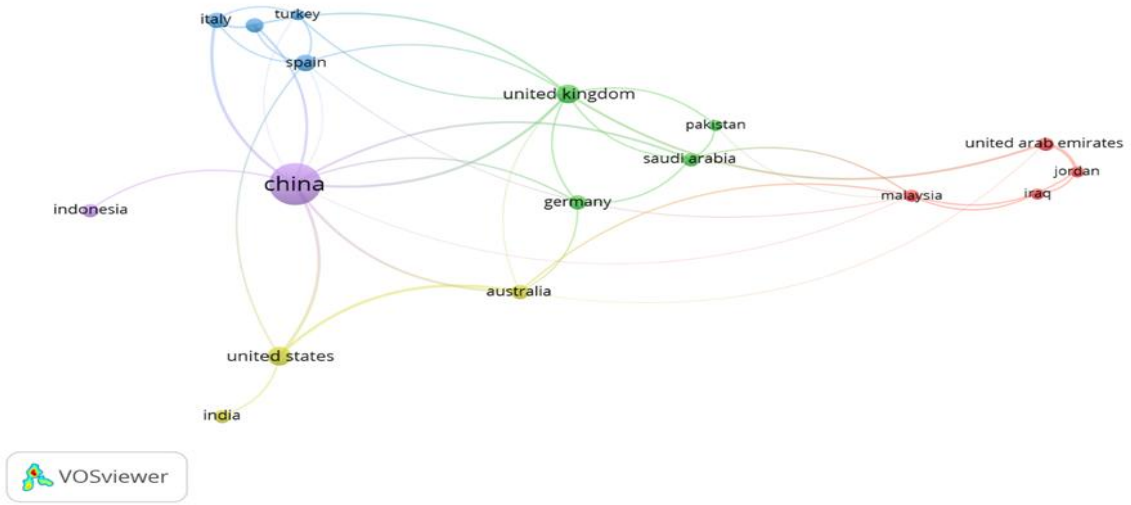

Figure 8: The Countries Whose Authors Collaborate Digital Technology Learning

This VOSviewer map illustrates the research collaboration network (coupling) among countries, where each dot represents a country, and the connecting lines indicate the strength of scientific collaboration in joint academic publications. The size of each dot reflects the total number of research outputs, while the thickness of the lines represents the intensity of collaboration between countries. From this visualization, China emerges as the most prominent and central country, maintaining strong collaborative ties with the United Kingdom, the United States, Australia, Germany, and Italy, signifying its role as a leading hub in the global research network. The United Kingdom is also identified as a key connector, actively collaborating with Saudi Arabia, Germany, and Pakistan, thereby highlighting its important role in facilitating cross-border research. Meanwhile, a smaller but significant cluster includes Malaysia, the United Arab Emirates (UAE), Iraq, and Jordan, reflecting regional cooperation between Asia and the Middle East. Additionally, India and the United States exhibit a close research partnership, while Indonesia shows collaborative links with China, indicating the growing potential for cooperation within the Southeast Asian region. Overall, this coupling network underscores China's central position in international academic collaboration and highlights the interconnected nature of global research. The exchange of knowledge and joint publications among countries strengthen scientific progress and innovation in digital education, demonstrating that contemporary research is increasingly founded on international collaboration and cross-border expertise sharing.

Discussion

The results of the bibliometric analysis for the period 2020 to 2025 show a consistent upward trend in research related to digital technology in education, reflecting the growing global focus on technology-based teaching and learning. The number of publications peaked in 2024, with over 9,800 documents, indicating strong interest in digital transformation, online pedagogy, and teacher competency enhancement. This increase aligns with post-pandemic educational shifts that emphasize remote learning, digital integration, and innovation in instructional design. The analysis reveals that journal articles (46.7%) and conference papers (39.5%)

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dominate academic dissemination channels, underscoring the importance of these two mediums as primary sources of research communication. Meanwhile, book chapters and books continue to hold value by providing deeper theoretical insights and focused perspectives on specific topics. The keyword co-occurrence mapping identifies five major research domains technological advancement, sustainability, digital pedagogy, human interaction, and engineering applications highlighting the interdisciplinary nature of this field. Additionally, the coupling and co-authorship analyses reveal strong international collaborations, with China, the United Kingdom, and the United States emerging as leading contributors, followed by growing partnerships among Asian and Middle Eastern countries. These patterns indicate an expanding global engagement in educational research, reinforcing the role of digital technology as a key catalyst for advancing the future of education.

Conclusion

Overall, the bibliometric analysis indicates that digital technology learning has evolved into an increasingly interdisciplinary and globally networked field of research. The continuous rise in publication output from 2020 to 2024 underscores the sustained commitment to advancing digital transformation in education. The growing international collaborations, particularly between China and Western countries, demonstrate the importance of cross-border partnerships in strengthening innovation and knowledge exchange. Although there was a slight decline in 2025, this may be attributed to incomplete data, but it also highlights the need for ongoing monitoring and broader engagement from diverse research regions. In summary, the findings suggest that the integration of digital technology is redefining educational practices worldwide, reinforcing global collaboration, and supporting the creation of a more equitable, inclusive, and future-oriented learning ecosystem.

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Reference

Amzat, I. H., Yanti, P. G., & Suswandari, S. (2022). Estimating the Effect of Principal Instructional and Distributed Leadership on Professional Development of Teachers in Jakarta, Indonesia. *SAGE Open*, *12*(3). https://doi.org/10.1177/21582440221109585

Atal, D., Admiraal, W., & Saab, N. (2024). Effects of 360 ° video virtual reality-supported reflection on student teachers' classroom management self-efficacy and their stress levels. *Teaching and Teacher Education*, *144*. https://doi.org/10.1016/j.tate.2024.104573

Appio, F.P., Cesaroni, F. and Di Minin, A. (2014), "Visualizing the structure and bridges of the intellectual property management and strategy literature: a document co-citation analysis", Scientometrics, Vol. 101 No. 1, pp. 623-661.

Appio, F. P., Martini, A., Massa, S., & Testa, S. (2016). Unveiling the intellectual origins of social media-based innovation: insights from a bibliometric approach. Scientometrics, 108(1), 355-388.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 28 (December 2025) PP. 645-661
DOI: 10.35631/IJMOE.728046
Baiges, A. R., Lázaro-Cantabrana, J. L., & García, J. H. (2024). Improving teachers'digital competence, moving towards institutional digital maturity: a systematic review. *Edutec*, *88*, 179–199. https://doi.org/10.21556/edutec.2024.88.3143

Carpenter, J. P., Rosenberg, J. M., Kessler, A., Romero-Hall, E., & Fischer, C. (2024). The importance of context in teacher educators' professional digital competence. *Teachers and Teaching: Theory and Practice*, *30*(4), 400–416. https://doi.org/10.1080/13540602.2024.2320155

Cui, M., Li, Y., He, X., & Zhou, R. (2024). Data-driven Analysis and Evaluation of Pedagogical Innovation. *2024 4th International Conference on Educational Technology, ICET 2024*, 527–531. https://doi.org/10.1109/ICET62460.2024.10867986

Demissie, E. B., Labiso, T. O., & Thuo, M. W. (2022). Teachers' digital competencies and technology integration in education: Insights from secondary schools in Wolaita Zone, Ethiopia. *Social Sciences and Humanities Open*, *6*(1). https://doi.org/10.1016/j.ssaho.2022.100355

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Gökdaş, İ., Karacaoğlu, Ö. C., & Özkaya, A. (2024). COVID-19 and teachers' digital competencies: a comprehensive bibliometric and topic modeling analysis. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-04335-0

Gracia-Zomeño, A., García-Toledano, E., García-Perales, R., & Palomares-Ruiz, A. (2025). Leadership and Entrepreneurship in Education and Their Impact on the Management of Sustainable Educational Environments. *Sustainability (Switzerland)*, *17*(7). https://doi.org/10.3390/su17072911

Gràcia, M., Villalobos, K., & Vega, F. (2025). A reflective teacher development programme to improve classroom management and children's oral language competence. *Teacher Development*, *29*(5), 1005–1023. https://doi.org/10.1080/13664530.2025.2461661

Joshi, D. R., Neupane, U., & Joshi, P. R. (2021). Synthesis review of digital frameworks and DEPSWALIC Digital competency framework for teachers from basic to University Level. *Mathematics Teaching-Research Journal*, *13*(2), 108–136. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85110254352&partnerID=40&md5=568355abef2f60e9f2d3ec64c430261c

Hassan, W., & Duarte, A. E. (2024). Bibliometric analysis: a few suggestions. *Current problems in cardiology*, *49*(8), 102640.

Juliandarini, J., Sudira, P., & Fara, T. (2024). Research on teacher's digital competency: A bibliometric analysis. In S. B.R. & S. null (Eds.), *AIP Conference Proceedings* (Vol. 3145, Issue 1). American Institute of Physics. https://doi.org/10.1063/5.0214915

Lazareva, A., & Tømte, C. E. (2024). Flexible learning spaces as an arena for developing professional digital competence through small group collaboration. *Teachers and Teaching: Theory and Practice*, *30*(4), 489–508. https://doi.org/10.1080/13540602.2024.2308893

Letnes, M.-A. (2025). The ICT coordinator as a mediating actor in the development of professional digital competence within a school-based activity system. *European Journal of Teacher Education*. https://doi.org/10.1080/02619768.2025.2565634

Li, M., & Chu, Y. (2017). Explore the research front of a specific research theme based on a novel technique of enhanced co-word analysis. *Journal of Information Science*, *43*(6), 725-741.

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 28 (December 2025) PP. 645-661
DOI: 10.35631/IJMOE.728046
McGarr, O. (2024). Exploring and reflecting on the influences that shape teacher professional digital competence frameworks. *Teachers and Teaching: Theory and Practice*, *30*(4), 509–525. https://doi.org/10.1080/13540602.2024.2313641

Mendzheritskaya, J., Hansen, M., & Breitenbach, S. (2024). The effects of virtual reality learning activities on student teachers' emotional and behavioral response tendences to challenging classroom situations. *International Conference on Higher Education Advances*, 67–74. https://doi.org/10.4995/HEAd24.2024.17291

Nurhidayat, E., Mujiyanto, J., Yuliasri, I., & Hartono, R. (2024). Technology integration and teachers' competency in the development of 21st-century learning in EFL classroom. *Journal of Education and Learning*, *18*(2), 342–349. https://doi.org/10.11591/edulearn.v18i2.21069

O Brien, E. (2025). Professional learning to support digital transformation and change in education: an integrated, systematic literature review. *Journal of E-Learning and Knowledge Society*, *21*(1), 148–158. https://doi.org/10.20368/1971-8829/1136121

Rajput, R., & Sharma, P. (2025). Teacher professional development in the digital age. In *Smart Education and Sustainable Learning Environments in Smart Cities* (pp. 533–555). IGI Global. https://doi.org/10.4018/979-8-3693-7723-9.ch030

Sáez-Delgado, F., Coronado-Sánchez, P., Mella-Norambuena, J., López-Angulo, Y., Brieba-Fuenzalida, J., Contreras-Saavedra, C., & Lozano-Peña, G. (2025). Use of Digital Technologies to Support Socioemotional Teacher Training: A Systematic Review. *Education Sciences*, *15*(10). https://doi.org/10.3390/educsci15101377

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523–538. https://doi.org/10.1007/s11192-009- 0146-3

Van Eck, N.J. and Waltman, L. (2007), "Bibliometric mapping of the computational intelligence field", International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, Vol. 15 No. 5, pp. 625-645

Wang, L. (2025). Big Data-Driven Precision in Teacher Digital Competency Training: Application Framework and Operation Guarantee. *Proceedings - 2nd International Conference on Informatics Education and Computer Technology Applications, IECA 2025*, 1–4. https://doi.org/10.1109/IECA66054.2025.00007