Major Trends in Technology Integration for Classroom Instruction Research: A Bibliometric Analysis from 2016 to 2025

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ABSTRACT

The integration of digital technologies into classroom instruction has become increasingly important in modern education as institutions seek to enhance teaching effectiveness and improve student learning experiences. Rapid technological advancement and the digitalisation of society have encouraged educators to adopt various digital tools and platforms to support interactive, flexible, and student-centred learning environments. Despite the growing body of literature, the field remains fragmented, with limited comprehensive bibliometric mapping of global research trends. Consequently, a clearer understanding of the development and intellectual structure of this field remains limited. This study aims to examine the scholarly landscape of research on technology integration for classroom instruction through a bibliometric analysis. Specifically, the study seeks to identify publication trends, leading contributors, collaboration patterns, influential sources, and major research themes in this field. The data for this study were retrieved from the Scopus database using a structured search strategy covering publications related to technology integration in classroom instruction. Following the screening and exclusion process, a total of 1,408 documents were retained for analysis. Bibliometric techniques were applied to analyse document characteristics, citation metrics, authorship patterns, country and institutional collaborations, source titles, and keyword relationships. Microsoft Excel was used for descriptive analysis, while VOS viewer was employed to visualise collaboration networks and keyword co-occurrence patterns. The results indicate that research on technology integration for classroom instruction has grown significantly over the past decade, particularly after 2020. The analysis identifies several influential journals, authors, and countries contributing to the development of this research area. Keyword analysis reveals major research themes including technology integration, technology-enhanced learning, e-learning, ICT integration, and TPACK. The findings also highlight strong international collaboration and an interdisciplinary research landscape involving education, computer science, and engineering. Overall, this study provides a comprehensive overview of the global research trends on technology integration for classroom instruction and offers valuable insights for researchers and educators seeking to understand the evolution of this field and identify potential directions for future research.

Keywords: bibliometric analysis; classroom instruction; educational technology; technology integration; technology-enhanced learning

INTRODUCTION

Classroom instruction remains a fundamental component of formal education, shaping how knowledge is delivered and how students interact with learning materials. Traditionally, classroom teaching relied largely on teacher-centred approaches, in which educators transmitted knowledge primarily through lectures and direct instruction (Amirova, 2025; Ghafar, 2023). However, rapid technological advancement and the increasing digitalisation of society have significantly transformed educational practices and learning environments. Educational institutions are increasingly integrating digital technologies into instructional processes to enhance

teaching efficiency, support curriculum objectives, and equip students with skills required in a technology-driven world (Bond et al., 2021; Zhao & Watterston, 2021; Haleem et al., 2022). In this context, technology integration in classroom instruction refers to the purposeful and strategic use of digital tools and technological resources to improve teaching effectiveness and enrich student learning experiences. Rather than merely introducing technological devices into educational settings, effective integration requires aligning digital technologies with pedagogical goals and instructional strategies. This alignment enables teachers to create meaningful learning experiences that promote knowledge construction and critical thinking (Çebi, 2022; Loureiro et al., 2024). Furthermore, the development of teachers' digital competence has become an essential factor in ensuring successful technology integration, as educators must possess the necessary technological, pedagogical, and content knowledge to effectively implement digital tools in their instructional practices (Howard et al., 2021; Tondeur et al., 2017). In this regard, the Technological Pedagogical Content Knowledge (TPACK) framework provides a widely recognised theoretical foundation for understanding how teachers integrate technology into instructional practices. The framework emphasises the interaction between technological knowledge, pedagogical knowledge, and content knowledge, highlighting the need for teachers to develop a balanced and integrated understanding of these domains to effectively support learning. The prominence of TPACK in the literature reflects its role as a guiding framework for examining technology integration in classroom contexts and shaping teacher professional development.

When implemented appropriately, technology-enhanced instruction can foster interactive learning environments, facilitate collaboration, and support personalised learning experiences that encourage deeper student engagement. Digital learning environments supported by multimedia tools, online platforms, and interactive applications have been shown to improve students' participation, motivation, and academic performance (Schindler et al., 2017; Haleem et al., 2022). In addition, the rapid emergence of advanced technologies such as artificial intelligence, learning analytics, and adaptive learning systems has further expanded opportunities for innovative teaching and learning approaches. These technologies enable educators to design more flexible and responsive instructional environments that can accommodate diverse learning needs and support active knowledge construction (Crompton & Burke, 2023; Shi et al., 2025). As digital technologies continue to reshape educational practices, research on technology integration in classroom instruction has expanded rapidly across various disciplines and educational contexts (Ngongpah & Oni, 2025). However, despite the growing body of literature, the research landscape remains fragmented, with many studies focusing on specific technologies, pedagogical approaches, or educational settings. Consequently, there is still limited understanding of the overall development, research trends, and intellectual structure of this field. A comprehensive overview of the evolution of research on technology integration for classroom instruction is therefore necessary to identify key research themes, influential publications, and emerging directions in the field.

To address this gap, the present study employs a bibliometric approach to systematically examine the scholarly literature on technology integration for classroom instruction. Bibliometric analysis has been widely used to map the development of research fields, identify influential contributors, and reveal patterns of scientific collaboration and thematic evolution (Ratnasari et al., 2024; Zakaria et al., 2021). By analysing publication trends, authorship patterns, citation structures, source contributions, and keyword relationships, this study aims to provide a comprehensive overview of the development of research in this area and to identify the major trends and influential studies shaping the current research landscape.

METHODOLOGY

In this study, publications related to technology integration for classroom instruction were retrieved from the Scopus database. Scopus is a comprehensive bibliographic database that indexes a large collection of peer-reviewed literature across major subject areas, including social sciences, education, physical sciences, and health sciences. Owing to its extensive coverage and robust citation tracking features, Scopus was selected as the primary data source for this bibliometric analysis. The Scopus database search was conducted on 15 February 2026, and the retrieved records were exported for bibliometric analysis. The search focused on publications published between 2016 and 2025 to capture the evolution and recent developments of research in this field. A structured search strategy was applied using relevant keywords associated with technology integration and classroom instruction. Table 1 presents the search string used in this analysis.

Table 1: Search string used in the selected database.

Database	String
Scopus	TITLE-ABS-KEY ((("technology integration" OR "educational technology integration" OR "instructional technology integration" OR "ICT integration" OR "technology-enhanced learning" OR "technology-enhanced instruction" OR "classroom technology use") AND ("classroom instruction" OR "classroom teaching" OR "teaching practices" OR "instructional practices" OR "teaching and learning"))) AND PUBYEAR > 2015 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE , "English"))

The review process followed the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and systematic data selection. A total of 2,036 documents were initially retrieved, and after applying the exclusion criteria, 1,408 documents were included in the bibliometric analysis.

Table 2: Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Timeline	2016 - 2025	2015 and earlier
Document type	Article, review article, chapter in a book, book, conference proceeding	None
Language	English	Non-English
Subject area	All	None

The bibliographic information of the selected Scopus-indexed articles, including authors, titles, publication years, author affiliations, keywords, and citation data, constituted the dataset for analysis. Microsoft Excel was used to perform frequency and descriptive analyses, while Harzing's Publish or Perish was employed to generate citation metrics. Data visualisation and network analyses, such as co-authorship and keyword co-occurrence, were conducted using VOS viewer version 1.6.20. Common bibliometric indicators examined in this study included publication trends, authorship patterns, collaboration networks, leading authors and institutions, contributing countries, core journals, and highly cited articles. The bibliometric workflow of the study is illustrated in Figure 1.

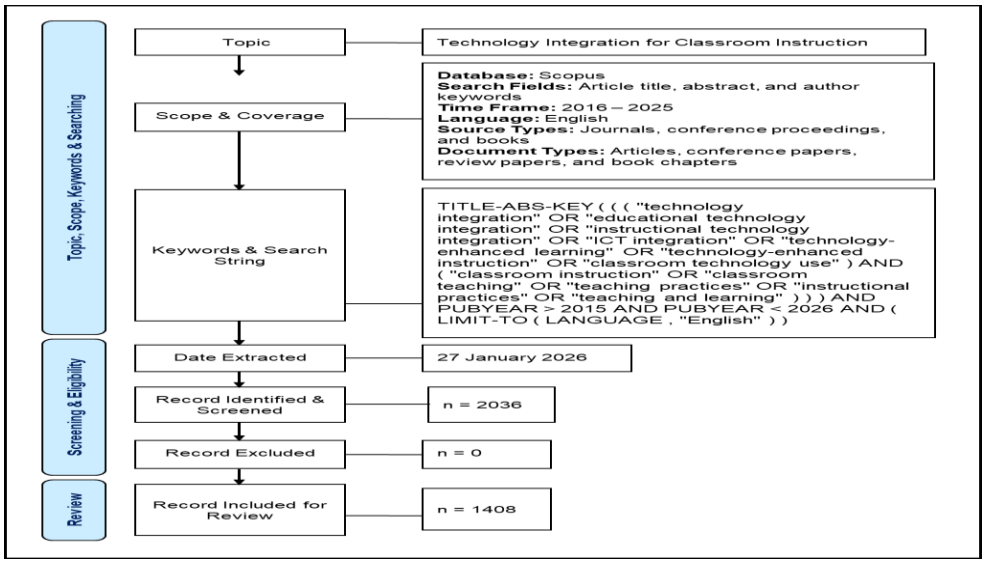

Figure 1. Flow diagram of the search strategy

Although Scopus was selected due to its comprehensive coverage and robust indexing of high-quality publications, the reliance on a single database may limit the inclusion of relevant studies indexed in other databases such as Web of Science. Future studies may consider integrating multiple databases to enhance the comprehensiveness and robustness of bibliometric findings.

RESULTS AND FINDINGS

This section presents and discusses the bibliometric results of the study, including an analysis of document profiles, temporal publication trends, geographical distribution of research output, authorship and institutional affiliations, source title productivity, citation performance, and keyword patterns within the field of technology integration for classroom instruction.

Documents Profiles

Table 3 presents the distribution of publications by document type in the field of technology integration for classroom instruction. Journal articles constitute the majority of the dataset, with 902 publications, accounting for 64.06 percent of the total output. This dominance indicates that the field is primarily disseminated through peer-reviewed journal articles, reflecting a strong emphasis on empirical research and theoretical contributions. Conference papers represent the second-largest category, with 272 publications (19.32 percent), suggesting that scholarly discussions on technology integration are also actively shared in academic conferences, often highlighting emerging ideas and preliminary findings. Book chapters account for 9.59 percent (135 publications), indicating contributions to edited volumes that provide in-depth discussions and conceptual insights. Review articles comprise 3.69 percent of the publications, demonstrating a growing effort to synthesise existing knowledge within the field. Other document types, including books, editorials, data papers, short surveys, and retracted documents, collectively represent a small proportion of the dataset. Overall, the distribution highlights the maturity of the research domain, with journal articles serving as the primary medium for knowledge dissemination, complemented by conference proceedings and scholarly books.

Table 3: Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	902	64.06
Conference Paper	272	19.32
Book Chapter	135	9.59
Review	52	3.69
Book	35	2.49
Editorial	7	0.50
Data Paper	3	0.21
Short Survey	1	0.07
Retracted	1	0.07

Table 4 presents the distribution of publications by source type in the field of technology integration for classroom instruction. Journals represent the dominant source of publications, with 966 documents accounting for 68.61 percent of the total output. This indicates that research in this field is primarily disseminated through peer-reviewed journal outlets, reflecting the field's emphasis on validated empirical findings and theoretical contributions. Conference proceedings constitute 14.20 percent of the publications (200 documents),

suggesting that academic conferences serve as an important platform for sharing emerging research and preliminary results. Books and book series together account for 17.19 percent of the total publications, with 137 books (9.73 percent) and 105 book series contributions (7.46 percent), highlighting the role of scholarly books in providing comprehensive and in-depth discussions on technology integration in educational contexts. Overall, the distribution of source types demonstrates a well-established research field in which journals serve as the primary medium of scholarly communication, supported by conferences and academic books that contribute to knowledge development and dissemination.

Table 4: Source Type

Source Type	**Total Publications (TP)**	**Percentage (%)**
Journal	966	68.61
Conference Proceeding	200	14.20
Book	137	9.73
Book Series	105	7.46
Total	**1408**	**100.00**

Table 5 presents the distribution of publications across subject areas related to research on technology integration for classroom instruction. The results indicate that Social Sciences account for the largest share of publications, with 1,083 documents representing 76.92% of the total output. This dominance is expected because studies on classroom instruction, pedagogy, and learning processes are primarily situated within the social sciences domain. The strong presence of this subject area highlights the central role of educational research in examining how digital technologies support teaching and learning practices. The second largest subject area is Computer Science, with 572 publications (40.63%), reflecting the technological dimension of the research field. Contributions from this area typically focus on the development and application of digital learning systems, educational software, artificial intelligence tools, and learning platforms that support classroom instruction. This demonstrates the interdisciplinary nature of technology integration research, where educational and technological perspectives intersect.

Other notable subject areas include Engineering (12.86%), Mathematics (9.45%), Psychology (8.31%), and Arts and Humanities (7.95%). These areas suggest that technology integration is examined from multiple perspectives, including technical development, analytical approaches, cognitive and behavioural aspects of learning, and broader educational and cultural contexts. Additionally, fields such as Business, Management and Accounting (4.40%) and Decision Sciences (3.91%) contribute to the literature by exploring issues related to educational management, digital transformation, and decision-making in technology adoption. Several other disciplines, including Medicine, Health Professions, Environmental Science, and Multidisciplinary studies, contribute smaller proportions to the research output. Although their contributions are relatively limited, they indicate that technology-enhanced instructional practices are increasingly being explored in specialised educational and professional training contexts. Overall, the subject area distribution highlights that research on technology integration for classroom instruction is highly interdisciplinary, combining insights from education, technology, psychology, and various applied sciences.

Table 5: Subject Area

Subject Area	**Total Publications (TP)**	**Percentage (%)**
Social Sciences	1083	76.92
Computer Science	572	40.63
Engineering	181	12.86

Mathematics	133	9.45
Psychology	117	8.31
Arts and Humanities	112	7.95
Business, Management and Accounting	62	4.40
Decision Sciences	55	3.91
Medicine	47	3.34
Health Professions	36	2.56
Environmental Science	31	2.20
Multidisciplinary	29	2.06
Energy	26	1.85
Physics and Astronomy	21	1.49
Nursing	18	1.28
Economics, Econometrics and Finance	17	1.21
Materials Science	11	0.78
Biochemistry, Genetics and Molecular Biology	8	0.57
Chemical Engineering	8	0.57
Neuroscience	6	0.43
Chemistry	5	0.36
Agricultural and Biological Sciences	4	0.28
Earth and Planetary Sciences	4	0.28
Pharmacology, Toxicology and Pharmaceutics	3	0.21
Dentistry	2	0.14

Publication Trends

Table 6 presents the annual distribution of publications related to technology integration for classroom instruction between 2016 and 2025. The results indicate a generally increasing trend in research output over the years, reflecting the growing academic interest in the integration of digital technologies within educational environments. In the earlier years of the study period, the number of publications remained relatively moderate, with 78 publications recorded in 2016 and 84 in 2017. A slight fluctuation was observed in 2018, with 81 publications, followed by a notable increase to 120 publications in 2019.

The upward trend continued from 2020 to 2022, with 113, 123, and 130 publications, respectively. This gradual growth suggests increasing attention from researchers toward exploring the role of technology in enhancing classroom instruction and learning outcomes. A more substantial rise in research productivity was observed in 2023, with 166 publications, indicating an expanding research focus on technology-enhanced learning practices. The most significant growth occurred in the most recent years, with 246 publications in 2024 and 267 publications in 2025, representing the highest output within the study period. This sharp increase

can be more explicitly linked to global educational disruptions caused by the COVID-19 pandemic, which accelerated the transition to online and hybrid learning environments worldwide. The urgent need for remote teaching solutions prompted educators and institutions to adopt digital technologies at an unprecedented scale, thereby stimulating increased scholarly interest in technology integration for classroom instruction. This shift has contributed significantly to the surge in publications observed after 2020.

In terms of citation impact, the C/CP (average citations per cited publication) shows a gradual increase over time, reaching its highest value of 4.58 in 2025, indicating stronger citation influence among the most recent publications. Additionally, the h-index and g-index values demonstrate consistent scholarly impact across the years, with particularly strong values observed in 2019 and 2020, where the h-index reached 28 and the g-index exceeded 48. Overall, the yearly publication pattern highlights a steadily growing research landscape, suggesting that technology integration for classroom instruction has become an increasingly significant area of scholarly inquiry.

Table 6: Year of Publication

Year	**TP**	**NCP**	**TC**	**C/P**	**C/CP**	***h***	***g***
2016	78	71	78	1.00	1.10	23	41
2017	84	70	84	1.00	1.20	19	36
2018	81	73	81	1.00	1.11	19	38
2019	120	105	120	1.00	1.14	28	49
2020	113	105	113	1.00	1.08	28	48
2021	123	108	123	1.00	1.14	27	56
2022	130	112	130	1.00	1.16	24	44
2023	166	138	166	1.00	1.20	24	48
2024	246	180	246	1.00	1.37	17	29
2025	267	98	449	1.68	4.58	12	16
Total	**1408**						

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

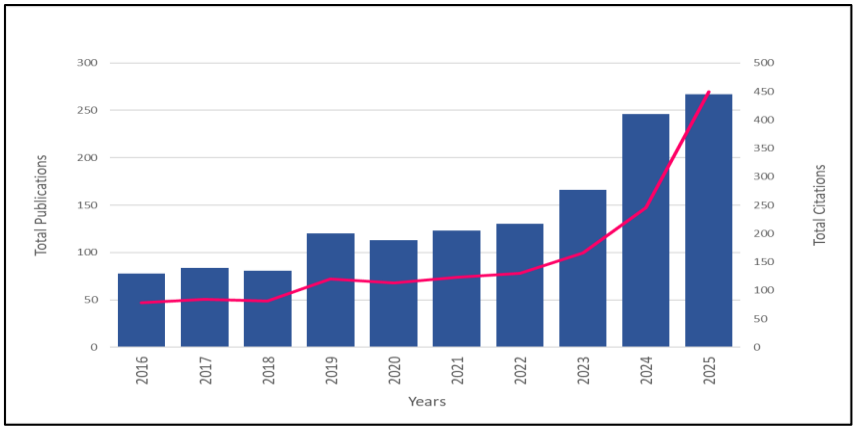

Figure 2. Total Publications and Citations by Year

Publications by Authors

Table 7 presents the most productive authors contributing to research on technology integration for classroom instruction. Among the listed scholars, Habibi, A. from Universitas Jambi, Indonesia recorded the highest number of publications, with 7 articles and a total of 276 citations, indicating strong research productivity and influence within the field. The author also achieved an h-index of 7 and a g-index of 7, demonstrating consistent scholarly impact.

The second most productive author is Petko, D. from the University of Zurich, Switzerland, with 6 publications and 230 citations, reflecting a significant contribution to research on technology integration. Similarly, several authors have contributed five publications each, including Baran, E. from Iowa State University, United States, Cattaneo, A. A. from the Swiss Federal Institute for Vocational Education and Training, Switzerland, and Lampropoulos, G. from the University of Macedonia, Greece. These authors have also accumulated substantial citation counts, indicating their influence in shaping scholarly discussions within this research area. Notably, Cattaneo, A. A. demonstrates the highest citation impact among these authors, with 256 citations and an average citation per publication (C/P) of 51.20, suggesting that the author's work has gained considerable attention in the academic community. Likewise, Lampropoulos, G. and Baran, E. have also achieved strong citation performance, with 242 and 240 total citations, respectively.

Other contributors such as Li, M. (China), Mukminin, A. (Indonesia), Muntean, G. M. (Ireland), Schmitz, M. L. (Switzerland), and Mozelius, P. (Sweden) have each produced five publications, reflecting active participation in advancing research on technology integration in classroom instruction across different geographical regions. Overall, the distribution of productive authors demonstrates the international nature of research in this field, with contributions emerging from institutions across Asia, Europe, and North America. These findings indicate that research on technology integration in classroom instruction is supported by a diverse group of scholars who collectively contribute to the development and dissemination of knowledge in this domain.

Table 7: Most Productive Authors

Author's Name	**Affiliation**	**Country**	**TP**	**NCP**	**TC**	**C/P**	**C/CP**	***h***	***g***
Habibi, A.	Universitas Jambi, Jambi, Indonesia	Indonesia	7	7	276	39.43	39.43	7	7
Petko, D.	Universität Zürich, Zurich	Switzerland	6	6	230	38.33	38.33	6	6
Baran, E.	Iowa State University, Ames	United States	5	5	240	48.00	48.00	4	5
Cattaneo, A.	Swiss Federal Institute for Vocational Education and Training, Lugano Massagno	Switzerland	5	5	256	51.20	51.20	5	5
Iyer, S.	Indian Institute of Technology Bombay, Centre for Educational Technology, Mumbai	India	5	4	23	4.60	5.75	2	4
Lampropoulos, G.	University of Macedonia, Thessaloniki	Greece	5	5	242	48.40	48.40	3	5

Li, M.	Xinyang Normal University, College of Teacher Education, Xinyang	China	5	5	45	9.00	9.00	4	5
Michel, C.	Université de Poitiers, Poitiers	France	5	5	13	2.60	2.60	3	3
Mozelius, P.	Mid Sweden University, Östersund, Department of Communication, Ostersund	Sweden	5	5	34	6.80	6.80	2	5
Mukminin, A.	Universitas Jambi, Jambi, Indonesia	Indonesia	5	5	74	14.80	14.80	4	5
Muntean, G.M.	Dublin City University, Dublin	Ireland	5	5	128	25.60	25.60	4	5
Pierrot, L.	Université de Poitiers, Poitiers	France	5	5	13	2.60	2.60	3	3
Schmitz, M.L.	Swiss Federal Institute for Vocational Education and Training, Zurich	Switzerland	5	5	201	40.20	40.20	5	5

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

Table 8 presents the distribution of publications according to the number of authors contributing to each document. The results indicate that collaborative authorship is common in research on technology integration for classroom instruction. The majority of publications were written by two authors, accounting for 423 documents (30.04%), followed by three-author publications with 356 documents (25.28%). This suggests that collaborative research partnerships are prevalent within this field, enabling researchers to combine expertise from different disciplines and institutions.

Single-author publications represent 254 documents (18.04%), indicating that while individual research contributions remain significant, collaboration is generally more common. Publications with four authors account for 191 documents (13.57%), while those with five authors represent 92 publications (6.53%). As the number of authors increases, the proportion of publications decreases gradually. Documents with six authors account for 51 publications (3.62%), while those with seven or more authors appear less frequently. Only a very small number of publications involve large research teams, such as those with eight authors (0.71%), nine authors (0.28%), and ten or more authors, each representing less than 0.1% of the total output. Additionally, one document (0.07%) was identified as a conference review without a listed author. Overall, the distribution indicates that most research in this field is produced through small collaborative teams, typically consisting of two to three authors, reflecting common scholarly collaboration patterns in educational research.

Table 8: Number of Author(s) per document

Author Count	**Total Publications (TP)**	**Percentage (%)**
1	254	18.04

2	423	30.04
3	356	25.28
4	191	13.57
5	92	6.53
6	51	3.62
7	20	1.42
8	10	0.71
9	4	0.28
10	1	0.07
11	1	0.07
12	1	0.07
13	3	0.21
0*	1	0.07
Total	**1408**	**100.00**

*Conference review document. No author is listed.

Publications by Institutions

Table 9 presents the most productive institutions contributing to research on technology integration for classroom instruction, considering institutions with a minimum of ten publications. Among the listed institutions, Universiti Malaya (Malaysia) recorded the highest research output with 21 publications, of which 17 were cited, accumulating 314 total citations. This indicates that Universiti Malaya plays a significant role in advancing research in this field. Institutions from South Africa also demonstrate strong research contributions. Both the University of Johannesburg and the University of South Africa produced 15 publications each, highlighting their active involvement in technology integration research. Notably, the University of Johannesburg recorded the highest citation impact among the institutions listed, with 403 total citations and an average of 26.87 citations per publication, suggesting that its publications have received substantial recognition in the academic community. Similarly, the University of South Africa accumulated 238 citations, reflecting its influence within the research landscape.

Several other institutions recorded 11 publications, including Cape Peninsula University of Technology (South Africa), Universiti Kebangsaan Malaysia (Malaysia), Nanyang Technological University (Singapore), The University of Hong Kong (Hong Kong), National Institute of Education (Singapore), and The University of Queensland (Australia). Among these institutions, The University of Hong Kong shows a particularly strong citation performance with 366 total citations and a high average citation per publication of 33.27, indicating a significant scholarly impact despite having a similar number of publications.

Other contributing institutions include Indian Institute of Technology Bombay (India), Universiti Putra Malaysia (Malaysia), and Universitas Negeri Malang (Indonesia), each producing 10 publications. Although these institutions recorded slightly lower citation counts, their contributions highlight the expanding global participation in research on technology integration for classroom instruction. Overall, the findings demonstrate

that research in this field is distributed across institutions from Asia, Africa, and Australia, reflecting the international and collaborative nature of scholarship on technology integration in education. The presence of multiple institutions from developing and developed countries further suggests that interest in technology-enhanced classroom instruction is growing across diverse educational contexts worldwide.

Table 9: Most productive institutions with minimum of ten publications

Affiliation	**Country**	**TP**	**NCP**	**TC**	**C/P**	**C/CP**	***h***	***g***
Universiti Malaya	Malaysia	21	17	314	14.95	18.47	8	7
University of Johannesburg	South Africa	15	12	403	26.87	33.58	6	15
University of South Africa	South Africa	15	9	238	15.87	26.44	5	15
Cape Peninsula University of Technology	South Africa	11	10	175	15.91	17.50	6	11
Universiti Kebangsaan Malaysia	Malaysia	11	7	36	3.27	5.14	3	5
Nanyang Technological University	Singapore	11	8	63	5.73	7.88	6	7
The University of Hong Kong	Hong Kong	11	8	366	33.27	45.75	5	11
National Institute of Education	Singapore	11	8	63	5.73	7.88	6	7
The University of Queensland	Australia	11	8	60	5.45	7.50	5	7
Indian Institute of Technology Bombay	India	10	6	31	3.10	5.17	3	5
Universiti Putra Malaysia	Malaysia	10	5	30	3.00	6.00	3	5
Universitas Negeri Malang	Indonesia	10	9	59	5.90	6.56	4	7

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

Global Distribution of Publications

Table 10 presents the top 20 countries contributing to research on technology integration for classroom instruction. The results show that the United States leads in research productivity, with 209 publications, 157 cited publications, and a total of 4,411 citations, indicating its strong influence and leadership in this research area. The country also records the highest h-index (36) and g-index (61) among the listed countries, reflecting the significant scholarly impact of its publications. Several other countries also demonstrate substantial contributions to the field. South Africa ranks second with 116 publications, followed closely by China (106 publications) and Malaysia (96 publications). These findings indicate that research on technology integration is widely distributed across different regions, with notable participation from both developed and developing countries. The United Kingdom and Australia also show strong contributions, with 86 and 73 publications, respectively. In terms of citation impact, Australia and the United Kingdom demonstrate high citation averages, with 23.16 and 22.13 citations per publication, indicating strong academic influence.

Interestingly, some countries show high citation impact despite having fewer publications. For example, Spain records 39 publications but accumulates 1,540 citations, with an average of 39.49 citations per publication,

suggesting that its research outputs are highly influential. Similarly, Taiwan, Saudi Arabia, and Canada demonstrate strong citation performance, indicating the quality and relevance of research produced in these countries. Several Asian countries, including India, Indonesia, Hong Kong, Taiwan, and Viet Nam, also contribute significantly to the literature, reflecting the increasing research interest in technology-enhanced learning within the region. European countries such as Germany, Spain, Portugal, Greece, and Italy further contribute to the global research landscape, highlighting the international and interdisciplinary nature of this field. Overall, the distribution of publications across multiple countries demonstrates that research on technology integration for classroom instruction is a globally expanding research domain, with strong participation from institutions across North America, Europe, Asia, Africa, and Oceania.

Table 10: Top 20 Countries contributed to the publications

Country	**TP**	**NCP**	**TC**	**C/P**	**C/CP**	***h***	***g***
United States	209	157	4411	21.11	28.10	36	61
South Africa	116	81	957	8.25	11.81	14	18
China	106	74	1417	13.37	19.15	18	36
Malaysia	96	65	631	6.57	9.71	13	12
United Kingdom	86	73	1903	22.13	26.07	23	42
India	77	41	413	5.36	10.07	11	19
Australia	73	63	1691	23.16	26.84	18	40
Indonesia	70	62	582	8.31	9.39	13	21
Spain	39	33	1540	39.49	46.67	17	39
Germany	38	28	471	12.39	16.82	10	21
Philippines	37	25	231	6.24	9.24	7	14
Turkey	36	28	341	9.47	12.18	11	18
Hong Kong	31	21	538	17.35	25.62	9	23
Canada	30	22	713	23.77	32.41	10	26
Saudi Arabia	29	25	771	26.59	30.84	11	27
Portugal	28	21	242	8.64	11.52	9	15
Taiwan	26	21	819	31.50	39.00	9	26
Greece	25	22	642	25.68	29.18	11	25
Italy	25	18	636	25.44	35.33	7	25
Ghana	21	18	179	8.52	9.94	9	12
Viet Nam	21	12	74	3.52	6.17	5	8

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

Figure 3 illustrates the global distribution of scientific publications on technology integration for classroom instruction indexed in the Scopus database. The map highlights the geographical spread of research contributions across different regions, indicating that scholarly work in this field is widely distributed worldwide. The intensity of colour in the figure reflects the level of research productivity, with darker shades representing countries with higher publication outputs.

The United States appears as the most prominent contributor, producing the highest number of publications in this research area. This reflects the country's strong academic infrastructure and its long-standing leadership in educational technology research. Other countries with notable contributions include South Africa, China, Malaysia, the United Kingdom, India, Australia, and Indonesia, all of which demonstrate substantial research output in the field. These findings align with the data presented in Table 10, which identifies these countries as among the top contributors to the literature. The figure also shows active participation from countries across Europe, Asia, Africa, and Oceania, indicating the global interest in technology-enhanced classroom instruction. European countries such as Spain, Germany, Portugal, Greece, and Italy contribute consistently to the research landscape, while Asian countries including China, Malaysia, Indonesia, Hong Kong, Taiwan, and Viet Nam show increasing research activity. Similarly, contributions from African countries, particularly South Africa, highlight the growing importance of technology integration research in developing educational contexts.

Overall, the global distribution map demonstrates that research on technology integration for classroom instruction is not limited to a single region but has become an international research domain. The widespread geographical participation suggests that educators and researchers worldwide are increasingly exploring how digital technologies can enhance teaching practices and improve learning outcomes in classroom settings.

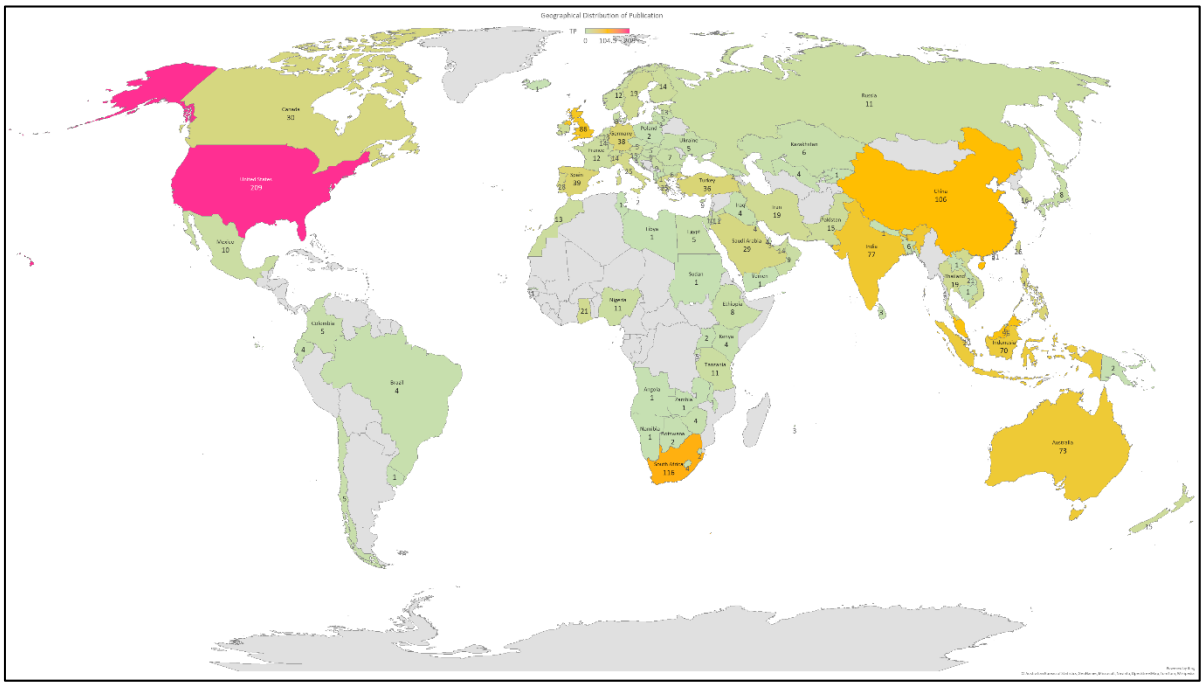

Figure 3. Worldwide scientific production indexed by Scopus on Technology Integration for Classroom Instruction

Publications by Source Titles

Table 11 presents the most active source titles publishing research on technology integration for classroom instruction. The results show that Education and Information Technologies, published by Springer Nature, is the most productive journal with 42 publications, accumulating 1,852 citations. The journal also demonstrates strong impact indicators, with a Cite Score of 11.8, SJR of 1.654, and SNIP of 2.689, highlighting its

importance as a leading platform for research dissemination in educational technology. The second most influential source is Computers and Education, published by Elsevier, which records 24 publications but achieves the highest citation count of 1,951 among the listed sources. The journal also shows the strongest impact metrics, including a CiteScore of 23.7, SJR of 3.343, and SNIP of 4.176, indicating its prominent role as a highly reputable outlet for educational technology research. Other notable sources include Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics, which also published 24 documents, although with a lower citation impact compared to journal articles. Similarly, Education Sciences, published by MDPI, contributed 23 publications and received 204 citations, reflecting its growing relevance within the field.

Additional contributions come from International Journal of Learning, Teaching and Educational Research (17 publications), ACM International Conference Proceeding Series (16 publications), and British Journal of Educational Technology (16 publications). Notably, the British Journal of Educational Technology, published by John Wiley & Sons, shows strong citation performance with 869 citations and high journal impact indicators, including a CiteScore of 17.6 and SJR of 2.69, indicating its significant scholarly influence. Other active sources include Lecture Notes in Networks and Systems, Proceedings of the European Conference on E-Learning, and Cogent Education, each contributing between 14 and 16 publications. Overall, the distribution of source titles indicates that research on technology integration for classroom instruction is disseminated through a combination of high-impact journals, conference proceedings, and scholarly book series, reflecting the interdisciplinary and evolving nature of this research field.

Table 11: Most active source titles

Source Title	**TP**	**TC**	**Publisher**	**Cite Score**	**SJR 2020**	**SNIP 2020**
Education and Information Technologies	42	1852	Springer Nature	11.8	1.654	2.689
Computers and Education	24	1951	Elsevier	23.7	3.343	4.176
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	24	104	Springer Science and Business Media Deutschland GmbH	2.4	0.352	0.555
Education Sciences	23	204	Multidisciplinary Digital Publishing Institute (MDPI)	5.5	0.73	1.4
International Journal of Learning Teaching and Educational Research	17	121	Society for Research and Knowledge Management	2.3	0.316	0.638
ACM International Conference Proceeding Series	16	63	N/A	N/A	N/A	N/A
British Journal of Educational Technology	16	869	John Wiley & Sons	17.6	2.69	3.311
Lecture Notes in Networks and Systems	16	30	Springer Nature	1	0.166	0.233
Proceedings of the European Conference on E Learning Ecel	15	23	Academic Conferences and Publishing International Limited	1	0.177	0.284

Cogent Education	14	165	Taylor & Francis	2.9	0.602	1.234

Notes: TP=total number of publications; TC=total citations; CiteScore = average citations received per document published in the source title; SJR = SCImago Journal Rank measures weighted citations received by the source title; SNIP = source normalised impact per paper measures actual citations received relative to citations expected for the source title's subject field.

Figure 4 presents the source title co-citation network generated using VOS viewer. The network visualisation illustrates the relationships among frequently cited journals in the field of technology integration for classroom instruction. In this map, each node represents a source title, while the size of the node reflects the frequency of citations received by the journal. The connecting lines indicate co-citation relationships, showing how frequently two journals are cited together in the same publications. Different colours represent clusters of journals that are closely related in terms of research focus and citation patterns. Among the journals displayed in the network, Computers & Education appears as the most prominent source, indicated by the largest node at the centre of the map. This suggests that the journal plays a pivotal role in shaping research on technology integration and educational technology. Its central position indicates that it is widely cited across multiple research clusters and is strongly connected with other key journals in the field.

Other influential journals include Education and Information Technologies and the Journal of Research on Technology in Education, both of which are positioned close to the centre of the network. Their strong connections with other sources indicate their importance in disseminating research related to educational technologies and classroom instruction. Additionally, the Journal of Technology and Teacher Education also appears as a significant source, highlighting the importance of teacher-focused research in the integration of digital technologies in classroom settings. Several clusters can be observed within the network, each representing different thematic areas within the field. For instance, one cluster focuses on educational technology and digital learning environments, while another cluster highlights research related to teacher education and pedagogical practices. Other clusters include journals associated with computer-assisted learning, language learning technologies, and specialised educational contexts. These clusters illustrate the interdisciplinary nature of research on technology integration for classroom instruction, where studies intersect across fields such as education, technology, and instructional design.

Overall, the co-citation network reveals that research on technology integration for classroom instruction is anchored by several influential journals that serve as key knowledge sources in the field. The interconnected structure of the network further demonstrates the collaborative and multidisciplinary characteristics of educational technology research.

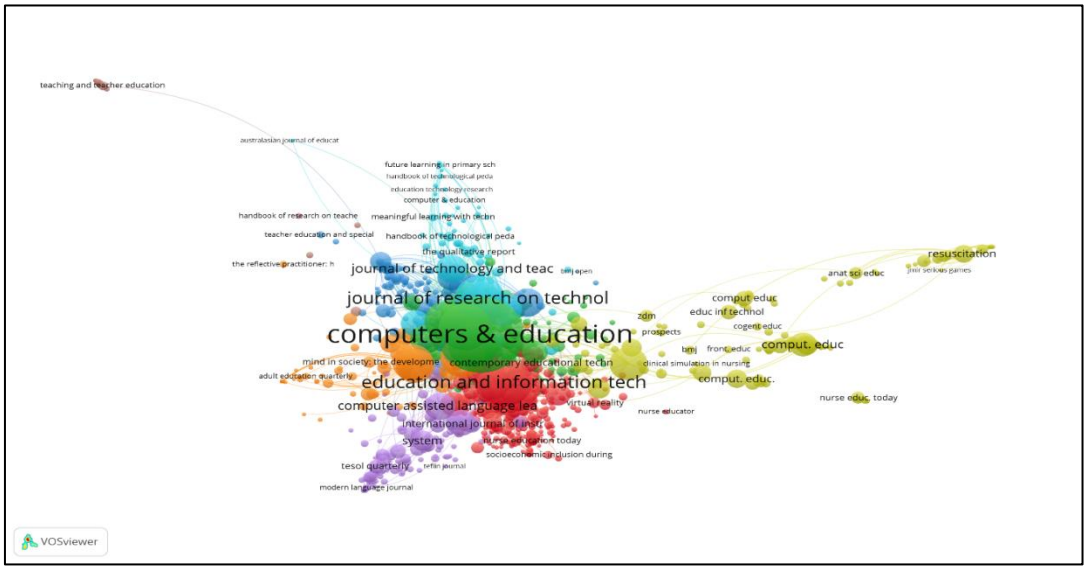

Figure 4. Co-citation analysis of source titles network visualization map.

Citation Metrics

Table 12 presents the overall citation metrics for publications related to technology integration for classroom instruction. The dataset consists of 1,408 papers, which collectively received 20,364 citations over a 10-year period. This indicates a substantial level of scholarly attention and growing academic interest in the field. On average, the publications receive 2,036.4 citations per year, reflecting a steady citation rate and consistent scholarly engagement with the research topic. The dataset also records an average of 14.46 citations per paper, suggesting that the publications included in the analysis have a moderate to strong citation impact within the academic community. Additionally, the average citations per author (8,629.7) and papers per author (663.96) further indicate the active participation of researchers contributing to the development of knowledge in this field. The authors per paper value of 2.85 suggests that most publications are produced through small collaborative teams, which aligns with the earlier findings on authorship patterns. Collaboration among researchers is often essential in interdisciplinary fields such as educational technology, where expertise from pedagogy, computer science, and instructional design may be required.

Furthermore, the dataset records an h-index of 62 and a g-index of 108, indicating that a substantial number of publications in this field have achieved strong citation impact. The h-index reflects that at least 62 publications have received 62 or more citations, demonstrating the presence of several highly influential studies. Meanwhile, the g-index highlights the cumulative citation impact of the most highly cited publications in the dataset. Overall, the citation metrics indicate that research on technology integration for classroom instruction has achieved considerable academic visibility and impact, with a growing body of literature that continues to influence subsequent studies in educational technology and instructional innovation.

Table 12: Citation metrics

Metrics	**Data**
Papers	1408
Citations	20364
Years	10
Cites_Year	2036.4
Cites_Paper	14.46
Cites_Author	8629.7
Papers_Author	663.96
Authors_Paper	2.85
h_index	62
g_index	108

Highly Cited Documents

Table 13 presents the top 20 most highly cited articles related to technology integration for classroom instruction. These highly cited publications represent influential contributions that have significantly shaped research and scholarly discussions in the field of educational technology. Among the listed articles, the study by Celik, Dindar, Muukkonen, and Järvelä (2022) titled “The Promises and Challenges of Artificial Intelligence for Teachers: A Systematic Review of Research” recorded the highest number of citations, with 572 citations and an average of 143 citations per year. This indicates the growing importance of artificial

intelligence in educational contexts and its potential impact on teaching practices and learning environments. Another highly influential study is Trinidad, Villagrasa, and colleagues (2023), which focuses on the implications of digital technologies on education and factors influencing schools' digital capacity and transformation. This article accumulated 510 citations with an impressive 170 citations per year, highlighting the increasing relevance of digital transformation in education systems worldwide.

Research conducted during the COVID-19 pandemic also appears prominently among the most cited publications. For example, Daniel (2020) examined the transition to E-learning during the COVID-19 pandemic, receiving 392 citations, while König, Jäger-Biela, and Glutsch (2020) analysed teachers' adaptation to online teaching, accumulating 329 citations. These studies reflect the significant scholarly attention given to emergency remote teaching and the rapid shift toward digital learning during the global pandemic. Several other influential articles address topics such as technology-enhanced learning environments, digital competence, augmented and virtual reality in education, and ICT integration in teaching practices. For instance, Fawns (2019) and Zawacki-Richter et al. (2019) contribute to discussions on digital transformation and technology integration in higher education, while Bond and Bedenlier (2019) explore the impact of digital technologies on student engagement and learning outcomes. Overall, the highly cited articles demonstrate that research on technology integration for classroom instruction spans multiple themes, including artificial intelligence, online learning, digital competence, immersive technologies, and educational transformation. The citation patterns also suggest that recent global developments, particularly the COVID-19 pandemic and the rise of advanced educational technologies, have significantly influenced research priorities in this field. These influential publications continue to shape the direction of future studies and contribute to the advancement of knowledge in technology-enhanced education.

Table 13: Top 20 highly cited articles

No.	Authors	Title	Cites	Cites per Year
1	I. Celik, M. Dindar, H. Muukkonen, S. Jarvela (2022)	The Promises and Challenges of Artificial Intelligence for Teachers: A Systematic Review of Research	572	143
2	S. Timotheou, O. Miliou, Y. Dimitriadis, S.V. Villagra-Sobrino, N. Yiannoutsou, R. Cachia, A.M. Martanez-Monas, A. Ioannou (2023)	Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review	510	170
3	D. Turnbull, R. Chugh, J. Luck (2021)	Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge?	392	78.4
4	K. McKnight, K. O'Malley, R. Ruzic, M. Horsley, J.J. Franey, K. Bassett (2016)	Teaching in a digital age: How educators use technology to improve student learning	329	32.9
5	R. Greif, A. Lockey, J. Breckwoldt, F. Carmona, P. Conaghan, A. Kuzovlev, L. Pflanzl-Knizacek, F. Sari, S. Shammet, A. Scapigliati, N. Turner, J. Yeung, K.G. Monsieurs (2021)	European Resuscitation Council Guidelines 2021: Education for resuscitation	274	54.8
6	T.J. Dunn, M. Kennedy (2019)	Technology Enhanced Learning in higher education; motivations, engagement and academic	270	38.57

		achievement		
7	M.A. Adarkwah (2021)	I'm not against online teaching, but what about us?: ICT in Ghana post Covid-19	266	53.2
8	D.J. Lemay, P. Bazelais, T. Doleck (2021)	Transition to online learning during the COVID-19 pandemic	243	48.6
9	J. Jang, Y. Ko, W.S. Shin, I. Han (2021)	Augmented Reality and Virtual Reality for Learning: An Examination Using an Extended Technology Acceptance Model	238	47.6
10	J. Tondeur, K. Aesaert, S. Prestridge, E. Consuegra (2018)	A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies	237	29.63
11	C.-W. Shen, J.-T. Ho (2020)	Technology-enhanced learning in higher education: A bibliometric analysis with latent semantic approach	229	38.17
12	T. Fawns (2019)	Postdigital Education in Design and Practice	223	31.86
13	M. Spiteri, S.-N. Chang Rundgren (2020)	Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology	222	37
14	D. Uerz, M. Volman, M. Kral (2018)	Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature	210	26.25
15	T. Long, J. Cummins, M. Waugh (2017)	Use of the flipped classroom instructional model in higher education: instructors' perspectives	185	20.56
16	R. Kaplan-Rakowski, K. Grotewold, P. Hartwick, K. Papin (2023)	Generative AI and Teachers' Perspectives on Its Implementation in Education	180	60
17	H. Akram, A.H. Abdelrady, A. Al-Adwan, M. Ramzan (2022)	Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review	178	44.5
18	J. Tondeur, R. Scherer, E. Baran, F. Siddiq, T. Valtonen, E. Sointu (2019)	Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education	178	25.43
19	S. Mhlongo, K. Mbatha, B. Ramatsetse, R. Dlamini (2023)	Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning	175	58.33

		environments: An iterative review		
20	W.V. Wu, J.S.C. Chen Hsieh, J.C. Yang (2017)	Creating an online learning community in a flipped classroom to enhance EFL learners' oral proficiency	175	19.44

Top Keywords

Table 14 presents the most frequently used author keywords in publications related to technology integration for classroom instruction. Keyword analysis is important in bibliometric studies as it reveals the major research themes and evolving focus areas within a particular field. The keyword "Technology Integration" appears most frequently, with 346 publications (24.57%), indicating that it represents the central focus of research in this domain. This is followed closely by "Teaching", which appears in 327 publications (23.22%), reflecting the strong connection between technology integration and instructional practices in educational settings. The prominence of these keywords highlights that a significant portion of the literature focuses on how digital technologies are incorporated into teaching processes to support learning outcomes. Several keywords are also related to learning environments and digital learning approaches. For example, "Technology Enhanced Learning" (179 publications, 12.71%), "Teaching and Learning" (178 publications, 12.64%), and "E-learning" (168 publications, 11.93%) appear frequently across the dataset. These terms suggest that researchers have extensively explored technology-supported learning environments, online learning systems, and digital instructional strategies.

In addition, keywords such as "Educational Technology" (118 publications, 8.38%), "Learning Systems" (94 publications, 6.68%), and "Educational Computing" (66 publications, 4.69%) indicate the growing role of digital platforms, systems, and computational tools in modern educational practices. Similarly, "ICT Integration" (77 publications, 5.47%) and "Computer Aided Instruction" (74 publications, 5.26%) reflect earlier and continuing research streams focusing on the use of information and communication technologies in classroom instruction. The presence of theoretical and pedagogical frameworks is also evident. The keyword "TPACK" (Technological Pedagogical Content Knowledge) appears in 76 publications (5.40%), demonstrating the importance of teacher knowledge and pedagogical competence in effectively integrating technology into teaching. Other related terms such as "Teachers" (78 publications, 5.54%) and "Curricula" (69 publications, 4.90%) further emphasize the role of educators and curriculum design in technology-supported instruction.

Furthermore, keywords like "Engineering Education" (200 publications, 14.20%) and "Higher Education" (113 publications, 8.03%) suggest that a substantial portion of the research has been conducted within higher education institutions and specialized academic disciplines. Overall, the keyword analysis reveals that research on technology integration for classroom instruction is highly interdisciplinary and focuses on themes such as digital learning environments, instructional design, teacher competencies, and technology-supported pedagogical frameworks. The distribution of keywords also indicates a strong emphasis on improving teaching effectiveness and student learning experiences through the strategic integration of educational technologies.

Table 14: Top author's keywords

Author Keywords	**Total Publications (TP)**	**Percentage (%)**
Technology Integration	346	24.57%
Teaching	327	23.22%
Engineering Education	200	14.20%
Students	193	13.71%

Technology Enhanced Learning	179	12.71%
Teaching and Learning	178	12.64%
E-learning	168	11.93%
Technology-enhanced Learning	124	8.81%
Educational Technology	118	8.38%
Education	116	8.24%
Higher Education	113	8.03%
Learning Systems	94	6.68%
Integration	83	5.89%
Teachers	78	5.54%
ICT Integration	77	5.47%
TPACK	76	5.40%
Computer Aided Instruction	74	5.26%
Curricula	69	4.90%
Educational Computing	66	4.69%
Learning	65	4.62%

Co-authorship by author

Figure 5 illustrates the co-authorship network of authors in the field of technology integration for classroom instruction using VOSviewer. Co-authorship analysis is commonly employed in bibliometric studies to identify patterns of collaboration among researchers and to reveal the structure of scholarly networks within a research domain. The visualisation shows several distinct collaboration clusters, each represented by different colours. Authors within the same cluster are closely connected, indicating frequent collaboration or co-authorship in published studies. The size of each node represents the author's productivity or influence within the dataset, while the lines between nodes indicate collaborative relationships between authors. One of the prominent clusters includes authors such as Zhang Y., Zhao L., Sun Y., and Tao W., suggesting an active research group contributing significantly to studies related to technology integration and educational technologies. Another cluster centres around Li M., which appears to serve as a connecting node linking several collaborating researchers such as Yang S., Zhao S., and Cheng Y. This indicates that certain authors play an important bridging role within collaborative networks, facilitating knowledge exchange across research groups.

Additional clusters show smaller collaborative teams, including groups led by authors such as Li Z. and Zhu L., indicating localized or specialized collaborations within specific research topics or institutions. The presence of multiple clusters suggests that research on technology integration for classroom instruction is conducted by several independent research communities rather than a single highly interconnected global network. Overall, the co-authorship network highlights the collaborative nature of research in educational technology, where scholars often work in teams across institutions and countries. Such collaboration networks contribute to the

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dissemination of knowledge, interdisciplinary research development, and the advancement of innovative teaching practices through technology integration.

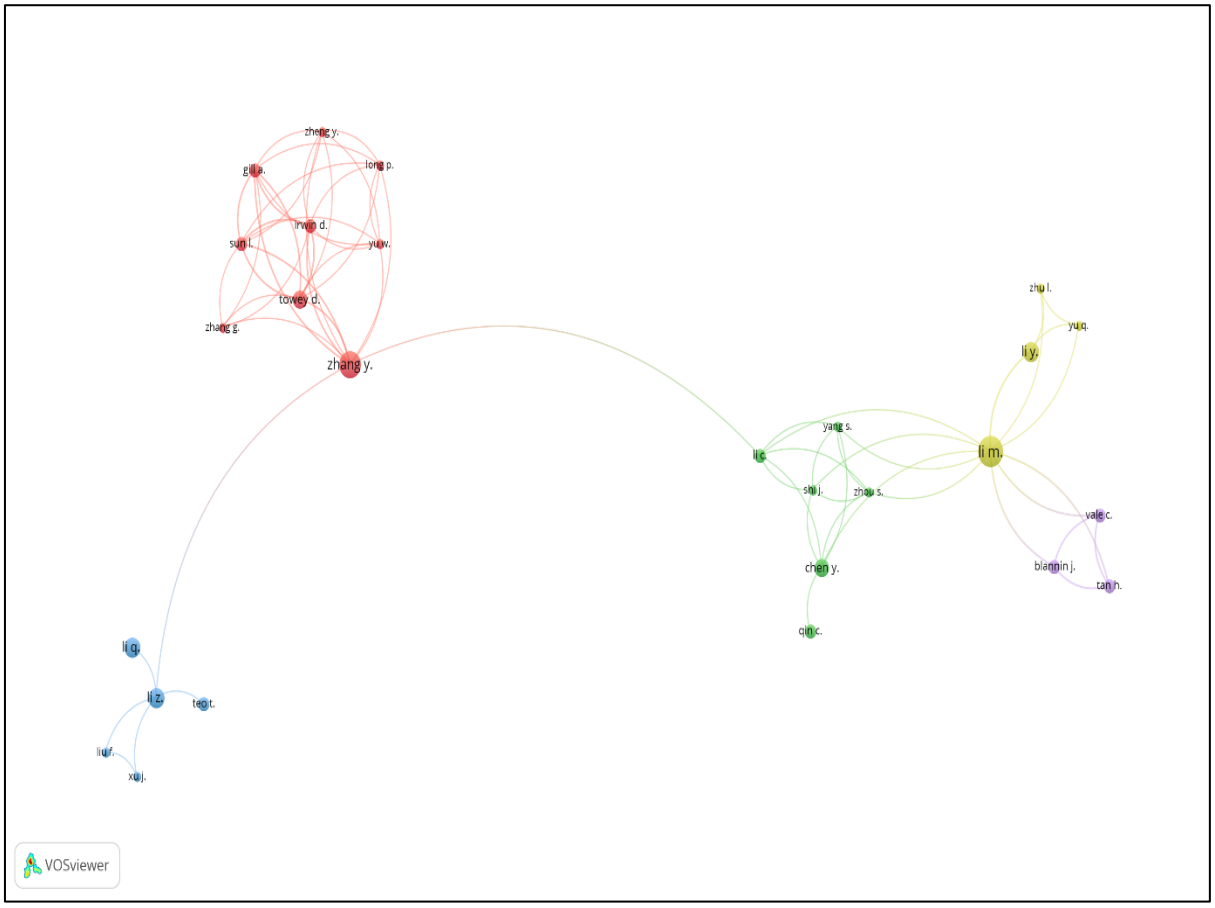

Figure 5. Network visualisation map of the co-authorship by authors

Co-authorship by organisations

Figure 6 illustrates the institutional collaboration network among organizations contributing to research on technology integration for classroom instruction. The network was generated using VOSviewer to visualize collaborative relationships between institutions based on co-authored publications. The network demonstrates a high level of interconnectedness among institutions, as indicated by the dense web of links connecting multiple nodes. Each node represents an institution, while the connecting lines represent collaborative research relationships between them. The dense structure of the network suggests that institutions involved in this field frequently collaborate in producing scholarly publications. Several institutions appear to play central roles within the network due to their multiple collaborative connections. These include University Hospitals Birmingham, Warwick Medical School, the Croatian Resuscitation Council, and the Faculty of Education Sciences, which are positioned near the center of the network. Their central placement indicates that they serve as important hubs facilitating research collaboration across different organizations.

The network also highlights collaborations across various disciplinary domains, including education, healthcare, and technology-related departments. Institutions such as departments of anesthesiology, emergency medicine, pediatric intensive care, and simulation-based education centers are interconnected, suggesting that research on technology integration often intersects with simulation-based training and digital learning environments. Overall, the institutional collaboration network indicates that research on technology integration for classroom instruction is supported by strong institutional partnerships and interdisciplinary collaboration. Such collaborations enhance knowledge exchange, strengthen research capacity, and contribute to the development of innovative technology-enhanced teaching practices across educational and professional training contexts.

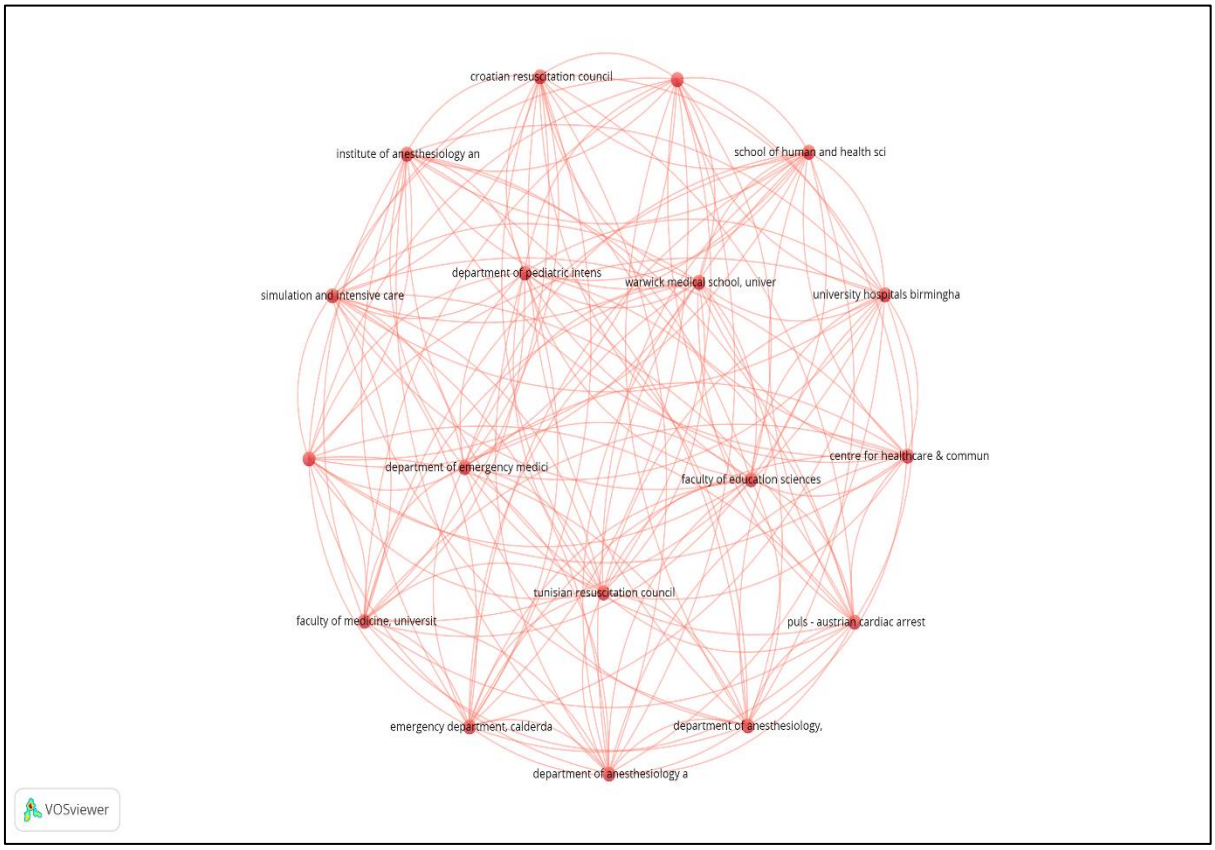

Figure 6. Network visualisation map of the co-authorship by organisations

Co-authorship by countries

Figure 7 illustrates the international collaboration network among countries contributing to research on technology integration for classroom instruction. The visualisation was generated using VOSviewer to map collaborative relationships between countries based on co-authored publications. The network demonstrates that research in this field involves extensive international collaboration, with several countries acting as major hubs connecting multiple research partners. The United States appears as one of the most central nodes in the network, reflecting its strong research output and its collaborative links with numerous countries, including the United Kingdom, China, India, and several European nations. The prominent position of the United States suggests its significant influence in shaping global research on educational technology and classroom innovation. Other countries also play important roles in the collaboration network. For instance, the United Kingdom and China appear as key contributors with multiple collaborative links to other countries. These nations serve as important bridges connecting research groups across different geographical regions. Similarly, Australia, Spain, and Canada are actively involved in international research collaborations, contributing to knowledge exchange and interdisciplinary research development.

The network also highlights the growing participation of Asian and developing countries, including Malaysia, Indonesia, India, and Pakistan, which maintain collaborative ties with leading research countries. In particular, Malaysia and Indonesia appear centrally connected within the network, indicating increasing scholarly contributions from Southeast Asia in the field of technology-enhanced education. Additionally, South Africa forms a distinct cluster connected with several other countries, reflecting strong research activity and international collaboration within the African region. The presence of countries such as Ghana and Rwanda further indicates the expanding global interest in integrating technology into classroom instruction. Overall, the collaboration map suggests that research on technology integration for classroom instruction is globally distributed and increasingly collaborative. Strong international partnerships enable researchers to share expertise, develop innovative teaching strategies, and address emerging educational challenges through technology-enhanced learning environments.

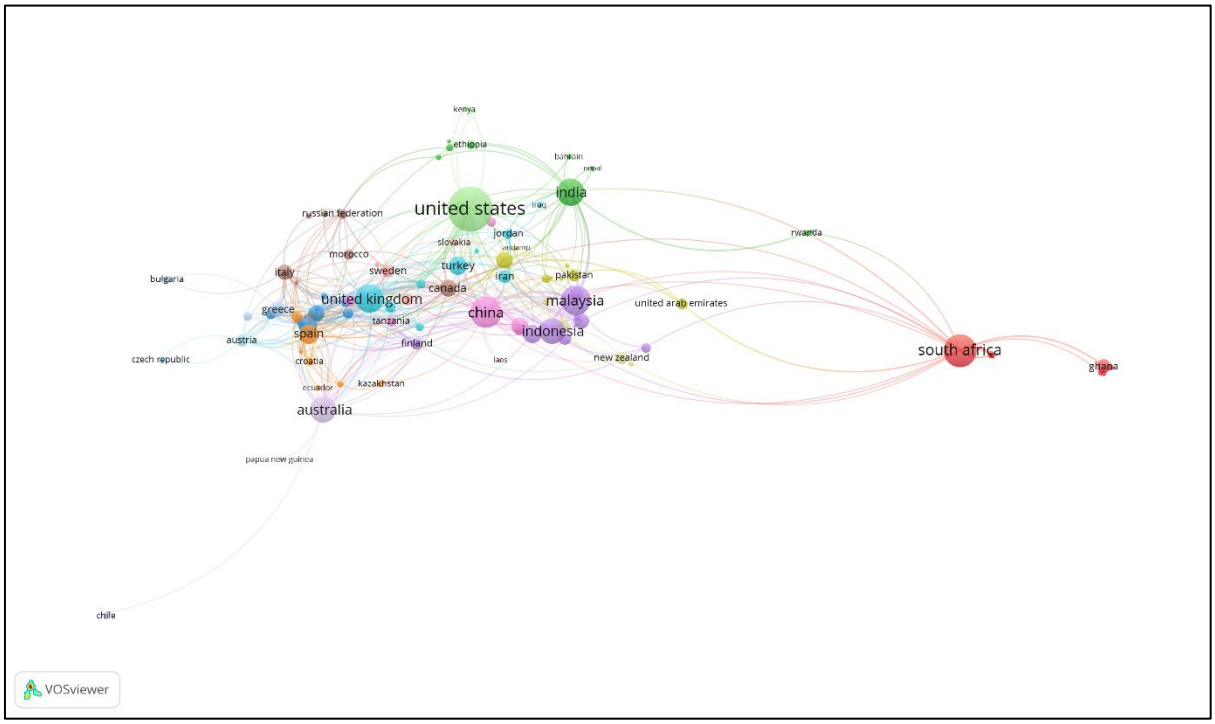

Figure 7. Network visualisation map of the co-authorship by countries

Co-occurrence analysis of author's keywords

Figure 8 presents the keyword co-occurrence network generated using VOSviewer, illustrating the relationships among the most frequently occurring author keywords in research on technology integration for classroom instruction. Keyword co-occurrence analysis helps identify major research themes and conceptual structures within a particular field by examining how frequently keywords appear together in publications. The visualization reveals several distinct thematic clusters, each represented by different colours. At the centre of the network is the keyword "technology integration," which acts as a major hub connecting multiple related research themes. This central position indicates that technology integration serves as the core concept linking various strands of research in the field.

One prominent cluster revolves around technology-enhanced learning, which includes keywords such as technology-enhanced learning, mobile learning, e-learning, learning analytics, augmented reality, and instructional design. This cluster reflects the growing interest in digital learning environments and emerging technologies that support interactive and flexible learning experiences. Another cluster focuses on teacher-related factors and pedagogical frameworks, with keywords such as TPACK, teacher education, pre-service teachers, teacher professional development, and self-efficacy. The presence of these keywords highlights the importance of teacher knowledge, skills, and pedagogical competencies in effectively integrating technology into classroom instruction.

A further cluster is associated with online learning and digital transformation, including terms such as online learning, hybrid learning, digital transformation, and active learning. The inclusion of the keyword COVID-19 within this cluster suggests that the global pandemic significantly accelerated the adoption of digital technologies in educational settings and influenced research on remote and hybrid teaching practices. Additionally, keywords such as engineering education, mathematics education, and language learning indicate that technology integration research spans multiple disciplinary contexts. These terms demonstrate that digital tools are increasingly used to support subject-specific teaching and learning across different educational fields.

Overall, the keyword co-occurrence network highlights that research on technology integration for classroom instruction is structured around several interconnected themes, including digital learning environments, teacher competencies, pedagogical frameworks, and technology-supported instructional strategies. The presence of

these clusters indicates a multidisciplinary research landscape that continues to evolve as new technologies and teaching approaches emerge.

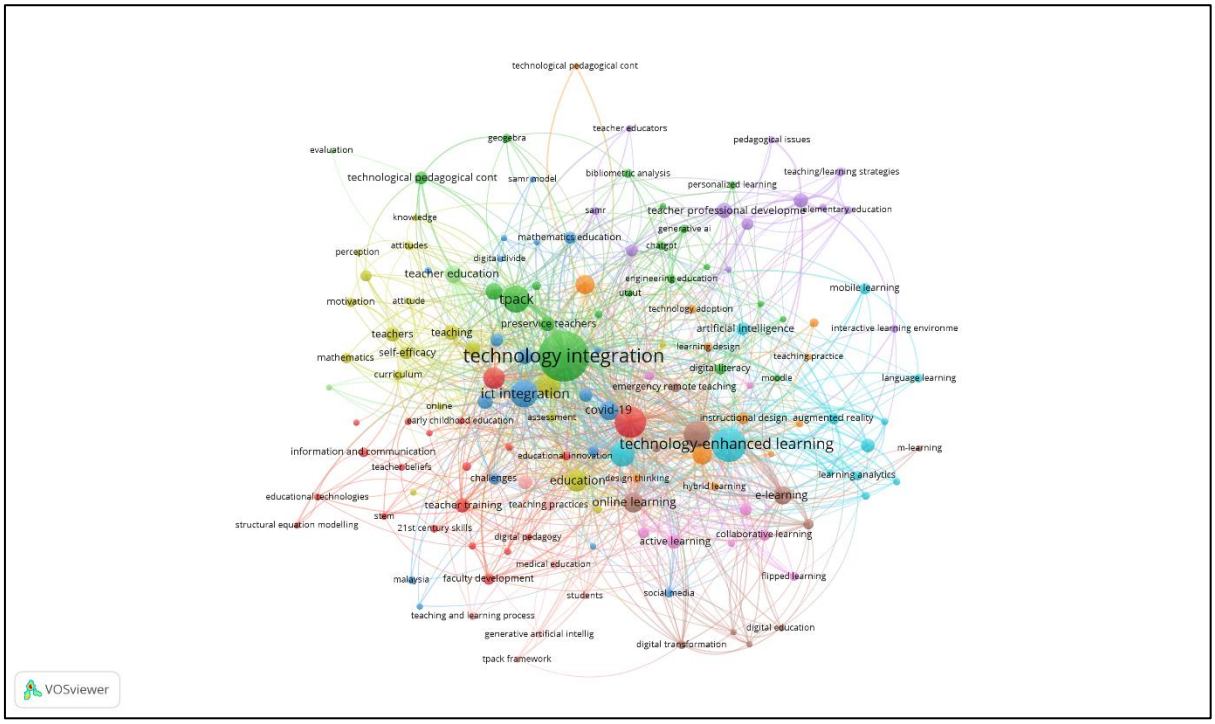

Figure 8. Network visualisation of the author's keywords

DISCUSSION

The present bibliometric study provides a comprehensive overview of global research trends on technology integration for classroom instruction based on publications indexed in the Scopus database. By analysing publication characteristics, citation patterns, authorship structures, institutional productivity, and keyword networks, this study reveals the evolving research landscape and the key themes shaping this field. The results indicate a steady growth in publications over the past decade, with a particularly sharp increase after 2020. This surge can be attributed largely to the rapid digital transformation in education and the widespread adoption of online and hybrid learning during the COVID-19 pandemic. The findings suggest that the pandemic significantly accelerated the integration of digital technologies into teaching practices and stimulated scholarly interest in technology-supported learning environments.

The analysis of document and source types shows that journal articles dominate the publication landscape, reflecting the maturity and academic significance of research on technology integration. The prominence of journals such as Computers & Education and Education and Information Technologies further indicates that the field is strongly embedded within the domain of educational technology and digital learning research. In addition, the subject area distribution highlights the interdisciplinary nature of this research area. Although the majority of publications fall within the social sciences, substantial contributions also originate from computer science, engineering, psychology, and management disciplines. This interdisciplinary composition suggests that technology integration in classroom instruction extends beyond pedagogy and involves technological innovation, learning system development, and behavioural factors influencing teaching and learning.

The findings from the country and institutional analyses reveal that research activity is concentrated in several leading countries, particularly the United States, China, the United Kingdom, and Australia. These countries also demonstrate strong international collaboration networks, indicating that research on technology integration is increasingly global in scope. Emerging contributions from countries such as Malaysia, Indonesia, and South Africa further reflect the expanding global engagement in digital transformation within education. The keyword and co-occurrence analyses identify several dominant research themes within the field, including technology integration, technology-enhanced learning, e-learning, ICT integration, and TPACK. The presence

of keywords such as online learning, digital transformation, and COVID-19 further highlights recent shifts toward remote and hybrid learning environments. These thematic patterns suggest that current research is increasingly focused on understanding how digital technologies can enhance teaching effectiveness, support student engagement, and improve learning outcomes.

More importantly, the dominance of themes such as TPACK and technology-enhanced learning indicates that research in this field is not solely driven by technological advancement but also by the need to conceptualise effective pedagogical integration. The prominence of TPACK reflects the growing recognition that effective technology integration requires the alignment of technological, pedagogical, and content knowledge, rather than treating technology as an isolated instructional tool. This trend suggests that future research is likely to move beyond the adoption of digital tools toward refining theoretical frameworks and examining how educators can effectively operationalise these models in diverse and complex educational contexts.

Contribution of the Study

This study contributes to the existing literature in several important ways. First, it provides a comprehensive bibliometric mapping of research on technology integration for classroom instruction using a large dataset retrieved from the Scopus database. By systematically analysing publication trends, citation structures, and collaboration networks, this study offers a structured overview of the development of this research domain. Second, the study identifies the most influential authors, institutions, countries, and journals contributing to the field. These findings provide valuable insights for researchers seeking to understand the major contributors and collaboration networks shaping scholarly work in technology-enhanced education. Third, the keyword and thematic analyses reveal the major research themes and emerging topics within the field. The identification of clusters related to digital learning environments, teacher competencies, pedagogical frameworks, and online learning provides a clearer understanding of how research on technology integration has evolved over time. Finally, the study offers a knowledge base for future researchers, enabling scholars to identify research gaps, potential collaboration opportunities, and emerging areas of investigation related to technology integration in classroom instruction.

Future Research Directions

Although research on technology integration for classroom instruction has expanded significantly, several opportunities remain for future studies. First, future research could explore the effectiveness of emerging technologies, such as artificial intelligence, learning analytics, virtual reality, and generative AI in enhancing classroom instruction. As digital technologies continue to evolve, understanding how these tools can be effectively integrated into teaching practices will become increasingly important. Second, there is a need for more research focusing on teachers' competencies and professional development in technology integration. Frameworks such as TPACK highlight the importance of technological, pedagogical, and content knowledge; however, further empirical studies are required to understand how educators develop and apply these competencies in diverse educational contexts. Third, future studies should examine technology integration in diverse educational settings, including primary education, vocational training, and developing countries. Much of the existing research focuses on higher education institutions, suggesting that other educational levels remain underexplored. Fourth, future research could investigate the long-term impact of digital transformation on teaching and learning, particularly in post-pandemic educational environments. Understanding how hybrid and blended learning models influence student engagement, academic performance, and instructional design will be an important area of inquiry. Finally, further bibliometric and systematic review studies could expand the scope by incorporating multiple databases such as Web of Science or Dimensions to provide a more comprehensive understanding of global research trends in technology integration.

CONCLUSION

This study presents a comprehensive bibliometric analysis of research on technology integration for classroom instruction using publications indexed in the Scopus database. By analysing 1,408 documents, the study provides a systematic overview of the development, structure, and emerging trends within this research domain. The findings reveal a significant increase in scholarly output over recent years, reflecting the growing

importance of digital technologies in contemporary educational practices. The surge in publications after 2020 highlights the accelerated adoption of technology-driven teaching approaches, particularly following global disruptions such as the COVID-19 pandemic. The bibliometric results indicate that research on technology integration is highly interdisciplinary, with major contributions from the social sciences, computer science, and engineering. Journal articles represent the dominant form of publication, demonstrating the academic maturity of the field. The analysis also identifies leading countries, institutions, and authors contributing to this research area, with strong international collaborations observed among major research hubs. Furthermore, keyword and co-occurrence analyses reveal that prominent themes in the literature include technology-enhanced learning, ICT integration, e-learning, TPACK, and online learning environments, indicating a strong focus on improving teaching practices and learning outcomes through digital technologies. Overall, this study offers a structured overview of the global research landscape on technology integration for classroom instruction. The findings provide valuable insights for educators, researchers, and policymakers seeking to understand the evolution of technology-supported teaching and learning. By identifying key contributors, influential publications, and emerging research themes, this bibliometric study serves as a useful reference for guiding future research and supporting the continued advancement of technology-enhanced education.

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