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# A Bibliometric Studies: Digital Learning and Teacher Teaching Quality

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### ABSTRACT

This paper presents a comprehensive bibliometric analysis aimed at exploring the intersection between digital learning and teacher teaching quality. In recent years, the landscape of education has been significantly influenced by advancements in digital technology, leading to the widespread adoption of digital learning platforms. An overview of the importance of digital learning and high-quality teacher instruction in modern education is given in the introduction section. The problem statement outlines the main obstacles and gaps in the research on digital learning and the calibre of teaching methods. By elucidating these issues, the study aims to address pertinent questions concerning effective pedagogical strategies in the digital era and ways to enhance teachers' effectiveness. Methodologically, this study employs bibliometric analysis techniques and VOSviewer version 1.16.20 to examine a corpus of scholarly publications retrieved from reputable databases. The focus is on identifying relevant literature, analysing citation patterns, and mapping out thematic trends and research trajectories. Through systematic data extraction and analysis, this approach enables the synthesis of existing knowledge and the identification of prominent themes and research clusters. The results of the bibliometric analysis reveal significant insights into the scholarly landscape of digital learning and teacher teaching quality. Findings include the identification of seminal works, influential authors, key research themes, and emerging trends. In conclusion, this study offers valuable insights into the current state of research on digital learning and teacher teaching quality. By synthesizing existing knowledge and identifying research gaps, it provides a foundation for future research endeavours aimed at advancing our understanding of effective educational practices in the digital age.

#### Keywords:

Digital; learning; teacher; teaching; quality

## 1. Introduction

In the contemporary educational landscape, the integration of digital learning platforms has revolutionised teaching practices and profoundly influenced the quality of instruction delivered by educators. This article delves into the multifaceted relationship between digital learning and teacher teaching quality, highlighting the transformative potential of technology in enhancing pedagogical effectiveness, as taken from the previous studies [1-10]. Digital learning platforms offer educators a plethora of tools and resources to engage students in dynamic and interactive learning

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experiences, fostering deeper understanding and retention of content as cited by [11, 12]. Moreover, these platforms facilitate personalised learning pathways, allowing teachers to cater to the diverse needs and learning styles of individual students. As teachers harness the power of digital learning tools, they can create immersive learning environments that promote critical thinking, collaboration, and creativity among students, thereby elevating the overall quality of teaching and learning in the classroom.

However, the successful integration of digital learning into teaching practices hinges on educators' proficiency in leveraging these technologies effectively. Furthermore, [14] claimed that digital learning platforms offer immense potential for enhancing teaching quality, they also pose challenges related to technological proficiency, pedagogical integration, and equitable access. Therefore, teacher professional development programs play a crucial role in empowering educators with the knowledge and skills needed to maximise the benefits of digital learning. By providing ongoing trainings and supports, educational institutions can equip teachers with the confidence and expertise to navigate the complexities of digital learning integration and leverage technology to optimise the quality of teaching practices. Additionally, collaboration among educators, administrators, and technology specialists, according to [15-18], are essential for fostering a culture of innovation and continuous improvement in digital learning practices, ultimately leading to enhanced teacher teaching quality and improved student outcomes.

Technology integration in education poses an increasingly vital equity concern, yet understanding its application for the 7 million K-12 special education students remains limited (NCES, 2019). Despite its neglect in research, evidence suggests that technology often widens opportunity gaps for students with disabilities. The rapid shift to remote learning amid COVID-19 offers a chance to explore facilitators and barriers to technology-enabled learning for special education (SPED). Through in-depth interviews (N = 20) with special educators, this study aims to uncover key factors influencing SPED teachers' technology use, emphasising structural, teacher, and student-level aspects. Findings highlight structural challenges impacting the accessibility of SPED instruction, necessitating recommendations for improving digital learning for all students, particularly those with diverse needs.

Due to the pandemic and rapid technological progress, e-learning has gained popularity, offering students flexibility and accessibility. Understanding factors impacting student learning and achievement in this digital environment is crucial for educators and institutions aiming to enhance teaching effectiveness through e-learning platforms. Various variables affecting student use, learning, and performance influence the success of e-learning. This study aims to explore the impact of extrinsic and intrinsic factors on students' use, learning outcomes, and performance in higher education across two countries. Through a quantitative approach, the study assesses how these elements collectively influence e-learning utilization, learning level, and performance, aiding educators, policymakers, and e-learning developers in enhancing student experiences and learning outcomes, as specified by [19, 20].

The COVID-19 pandemic has profoundly impacted various facets of daily life, including education. Despite living in an era of advanced technology, not all educators or institutions possess the requisite readiness or resources to ensure seamless quality education continuity. Telesimulation, an offshoot of clinical simulation, represents a formal instructional method fostering active learning within controlled and safe environments. Unlike traditional methods, telesimulation enables synchronous and remote interaction. Within the realm of health sciences, [21] suggested that interprofessionalism fundamental to comprehensive clinical care can be cultivated through telesimulation, offering avenues for training and skill development in remote settings.

Although improving educational resources for refugees is emphasised in scholarly research on education in crises and for refugees, political restrictions placed by host governments frequently obstruct high-quality education. This article delves into how refugees themselves counteract educational restrictions through traditional community mobilisation and modern technology. Focusing on Rohingya youths and community-based education networks in Bangladesh's refugee camps, it examines strategies for securing basic education despite political barriers. Drawing from qualitative interviews and digital data collection, the article reveals insights into how these networks and educators address political challenges. This is in line with [22] as it underscores their potential as valuable resources for humanitarian education providers to engage with.

Amidst the COVID-19 pandemic, transitioning to online mobile teaching and learning posed unique challenges for South Africa as a nation grappling with historical injustices. The study, which was carried out at a teacher-training college in South Africa, suggests that this change could function as a spur for encouraging inclusive education, digital equity, and active participation. This interpretative case study aimed to investigate how postgraduate STEM students utilised mobile digital technologies during the pandemic. As stated by [23], the data from 20 selected students revealed that these technologies facilitated translanguaging, practical science exposure, interdisciplinary connections, offered insights into operationalizing STEM education, addressed access and social justice issues, and enhanced STEM teaching practices post-pandemic.

The article examines the historical context of the subject between 2001 and 2011. Aiming to identify ten primary research trends in second language performance from 2012 to 2022. It will scour scientific articles in the Social Science Citation Index (WOS) and the Educational Resources Information Centre (ERIC) databases to uncover emerging themes compared to the previous decade. Additionally, it will discuss these trends, alternative perspectives, and related issues. Offering a critical overview of the past two decades, it utilises a documentary review method to select ten articles and delve into their qualitative content, revealing significant developments and interdisciplinary approaches, as asserted by [24].

Digital education has emerged as a prevalent educational approach, yet challenges persist regarding teacher-student interactions in online settings. Besides that, it hinders its ability to match the instructional quality of traditional and face-to-face methods. Particularly, design practice courses face exacerbated issues in this regard. To address this, a novel teaching interaction support framework is proposed, employing the TAPs method to devise evaluation criteria based on students' design thought processes and feedback-related ruminations. This model, according to [25], integrates these cognitive criteria with the LSTM model, enhancing communication efficacy between instructors and learners. A case study of an online design practice course demonstrates the efficacy of this approach in elevating teaching standards.

Virtual learning environments (VLEs) have been implemented in educational institutions to facilitate systematic online teaching and learning. This study explores how social factors, self-efficacy, and technological support impact VLE utilisation in education. Employing a quantitative approach, data was gathered through questionnaires administered to 356 accounting teachers in secondary schools in Peninsular Malaysia. A reflective measurement model utilising partial least squares structural equation modelling assessed the influence of exogenous latent variables on endogenous latent variables. Findings indicate that social factors (colleagues, administrators, and school culture), self-efficacy, and technological support (facilities quality, internet access, and technical support) significantly influence VLE usage among teachers. [26] acknowledged that improving technological infrastructure and providing adequate teacher training are recommended to enhance educational processes and foster teachers' proficiency in digital technology use.

Blockchain technology is currently recognised as a leading-edge tool in educational information systems. It addresses issues like data security and trust in online education, which are characteristic of its decentralization. Blockchain technology has traceable and multi-party consensus features. Furthermore, blockchain safeguards educational resources, enhances transparency in teaching materials, and streamlines copyright transactions, thus fostering teacher innovation. This study examines blockchain's impact on education, particularly its influence on online resource sharing. The results indicate strong reliability and validity of the study's questionnaire. Blockchain's applications, such as cross-institutional learning records, certificate management, and collaborative ecosystems, significantly enhance online resource sharing. These findings offer valuable insights for integrating educational resources, refining digital resource applications, and improving online education services, as taken from [27].

This research paper aims to offer insights into certified learning apps for biological education by presenting a comprehensive list of apps utilised by Austrian biology teachers. Additionally, it describes the certification process for educational apps. Methodologically, an online questionnaire was distributed to biology teachers across Austria to identify apps and understand their selection process. Findings reveal 84 different learning apps in use, with two certified options. "Anton" emerges as the most popular app. Teachers typically discover apps through personal research or peer recommendations, with regional and school-specific variations. The study is in agreement with [28] as it underscores the need for teacher training to address issues like data protection and advertising.

Teacher training is vital for enhancing higher education quality and refining teaching methods, particularly for language educators fostering cross-cultural understanding. This study combines descriptive-analytical and qualitative approaches. Additionally, it assesses European Union directives regarding the requirements for methodological and digital training for university instructors. It investigates online training courses offered by German and Spanish universities listed in the 2016 Shanghai Ranking, considering course characteristics and target audience. Furthermore, a survey among university language instructors evaluates the provision of training, ICT integration, and their training needs. The findings indicate a lack of tailored courses for the methodological and digital competence of language educators. Therefore, emphasis is placed on the need for appropriate training plans, especially for language instructors, considering the diversity of languages and cultures.

The research explores the educational outcomes of implementing Content and Language Integrated Learning (CLIL) in master's programs, focusing on a pedagogical model tailored for IT teachers. A study involving 62 graduate students utilised various mobile applications, including FluentU, to develop the "CLIL for IT Teachers" course. This approach fostered a conducive learning environment, facilitating targeted learning, collaborative education, and creative expression. Students not only produced an educational product on informatics but also notably enhanced their English communication skills for professional contexts. This experience offers valuable insights for educators seeking effective pedagogical methods and digital tools to enhance their teaching quality as quoted by [29].

Amidst COVID-19 school closures, the abrupt shift to digital teaching posed challenges, particularly in maintaining student engagement. Limited research has examined the quality of digital distance teaching and its impact on student learning, including the role of technology familiarity acquired in face-to-face settings. Analysing data from 729 ninth graders, the author explored how student-perceived learning activities during distance learning correlated with effort investment in mathematics and German. Cognitive activation mediated this relationship. Surprisingly, familiarity with face-to-face technology didn't significantly impact digital distance

teaching quality during the pandemic. Thus, as emphasised by [30], infrastructural support like tablet provision may not be crucial for effective digital teaching in short-term transitions.

This study investigates teachers' technology integration into the curriculum to enhance teaching and learning by analysing the quality of teaching artefacts. Focusing on primary school teachers in Shanghai, researchers examine how digital tools are incorporated into teaching practices and evolve over nine semesters. Through semi-automatic processes and automatic annotations, researchers assess artefact quality changes, revealing that teachers improve technology flexibility, content variety, and instructional diversity over time. Unlike traditional research, this study emphasises the importance of enhancing teachers' technological understanding and adapting teaching practices to technological contexts. Analysing artefacts quality, according to [31, 32], provides valuable insights into teachers' technology adoption processes and aids in objective technology integration.

Tech Mandatory is a compulsory subject in NSW Stage 4, covering Agriculture and Food Technologies (AFT), Digital Technologies (DT), and Engineered Systems and Material Technologies. The GPS Cows Module, co-designed by the NSW Department of Education and CQ University Australia, addresses the concerns of teachers regarding teaching AFT and DT components. This module focuses on livestock production and utilising digital solutions to tackle real-world challenges. Professional learning workshops were conducted to introduce teachers to the module, with post-workshop surveys showing positive feedback regarding its suitability for AFT and DT outcomes. Despite some implementation barriers, [33] claimed that the GPS Cows Module offers high-quality content, emphasising authentic data and real-life applications.

In response to the ongoing digitalization, teachers are required to not just incorporate technology into their teaching but also to engage in learning through digital formats. Latvia's adoption of a competency-based curriculum emphasises self-regulated learning (SRL) as a key skill. This necessitates tailored teacher professional development (TPD) and the integration of digital solutions, especially heightened by the COVID-19 pandemic. Recognising the advantages of online learning and the value of SRL for lifelong learning, an online TPD course was organized to bolster teachers' understanding and efficacy in fostering students' SRL skills. It was attended by 126 teachers in grades 7–12. The research, as discussed by [34], assesses the course's impact on teachers' competence in SRL development, revealing significant enhancements in both theoretical understanding and practical skills through this TPD format.

In the contemporary digital age, there's a burgeoning approach to teaching foreign languages utilising digital technologies. The emphasis has shifted from simply developing professional skills to producing competent specialists capable of using digital tools. This article aims to delineate current trends in language instruction in this digital landscape and evaluate avenues for enhancing language training for future professionals in intercultural contexts. By delving into methodological frameworks and comparative analyses of educational practices, it explores how digital technologies integrate into language education. Emphasising the imperative shift towards digital tools, [35] acknowledged that the study underscores their role in enhancing language learning outcomes, offering a novel approach to integrating digital technologies, and establishing digital learning environments in language instruction.

A secondary school conducted a trial in Year 10 Advanced Mathematics in Melbourne, Australia, introducing screencast recordings for student-led peer learning. After interviewing the four participating mathematics teachers, thematic analysis revealed a lack of awareness among teachers regarding the necessity to adjust their teaching methods for effective technology integration. Furthermore, three teachers prioritised the quality of the screencasts over scaffolding for meaningful student-led learning. Despite one teacher successfully implementing scaffolding, there

was difficulty in promoting a consistent approach among colleagues. In line with [36], this study emphasises the crucial need for teacher professional development in pedagogical techniques tailored for student-centred, technology-driven learning to ensure successful integration of digital tools in modern secondary school classrooms.

Teachers' beliefs play a vital role in determining their professional competence and teaching effectiveness, particularly in technology-integrated instruction, where research on competence-related beliefs is lacking. This study aims to validate a measure assessing teachers' beliefs about empowering learners, including differentiation and active engagement dimensions according to the European Framework for Digital Competence of Educators (DigCompEdu). It also explores the association between these beliefs and teachers' use of digital technologies for classroom management, cognitive activation, and supportive climates. Analysis of data from 145 teachers supports a bi-factor model, which is parallel to [37], as it highlights the importance of understanding these beliefs for effective teacher education and student engagement.

In medical education, tablets are increasingly used for teaching. We compared a tablet-based, student-centred seminar with traditional teacher-centred instruction in radiology. The aim was to assess their impact on academic performance, learning gain, teaching quality, and the influence of teacher charisma and student digital affinity. Data from 366 students was gathered over three semesters to assess digital affinity, teaching quality, and seminar satisfaction. Tablet-based seminars were rated higher for quality and satisfaction, but traditional seminars performed better in terms of academic performance and learning gain. Teacher charisma correlated with learning gain in tablet-based sessions, and digital affinity influenced teaching quality. Effective seminar organisation, clear objectives, and varied activities were vital. Understanding these dynamics is crucial for successful tablet integration, as mentioned by [38].

The article reveals a significant research gap in understanding how digital learning technologies affect the quality of teacher instruction, particularly concerning pedagogical effectiveness and technology accessibility. While there is extensive research on the potential of digital learning to enhance educational experiences, there is a lack of in-depth studies on the structural and technical challenges teachers face in integrating these technologies, especially for students with special needs and in diverse educational environments. The contribution of this article is to address this gap by evaluating how teachers can more effectively leverage technology in their teaching and identifying critical factors influencing the success of technology integration, such as teachers' digital competence, institutional support, and access equity. This provides valuable insights for developing better professional development strategies and technological solutions in education.

## **2. Methodology**

Combining, organising, and analysing bibliographic data from scientific publications is known as bibliometrics, as cited from previous studies [39-41]. It is also consistent with [42], whereby the process includes intricate methods like document co-citation analysis in addition to general descriptive statistics like publishing journals, publication year, and major author categorization. Similarly, [43] added that, to create a thorough bibliography and produce reliable results, a successful literature review requires an iterative process that includes selecting relevant keywords, searching the literature, and doing in-depth analysis. Considering this, the study aimed to concentrate on high-calibre publications since they provide insightful information about the theoretical stances influencing the development of the field of study. The SCOPUS database was used by the study to collect data in order to guarantee data reliability, as claimed by [44, 45].

Furthermore, books and lecture notes were purposefully left out in order to guarantee the inclusion of high-calibre publications. Therefore, as explained by [46], only papers that were published in scholarly publications that underwent extensive peer review were taken into account. Notably, papers from 1989 to December 2023 were collected for further research thanks to Elsevier's Scopus, which is renowned for its broad coverage.

### 2.1 Data Search Strategy

The study employed a screening sequence to determine the search terms for article retrieval. The study was initiated by querying the Scopus database online and assembling 1754 articles. Afterwards, the query string (Table 1) was revised so that the search terms should be focused on students as learners. The refinement included 711 articles, which were used for bibliometric analysis. All papers about e-learning with a student focus that were found in the Scopus database as of December 2023 were included in the research. Table 2 shows the data search strategy.

**Table 1**

Scopus database

Scopus	TITLE-ABS-KEY ( digital AND ( learning OR determine OR enroll OR gain ) AND ( teacher OR assistant OR coach OR educator OR instructor ) AND ( teaching OR advise OR coach OR demonstrate OR develop OR direct OR explain OR instruct ) AND quality ) AND ( LIMIT-TO ( DOCTYPE, "ar" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) )
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**Table 2**

The selection criterion

Criterion	Inclusion	Exclusion
Language	English	Non-English
Document type	Article	Non-article
Source article	Journal (article)	Book, review, proceeding

## 3. Analysis

### 3.1 Data Analysis

VOSviewer, developed by Nees Jan van Eck and Ludo Waltman at Leiden University, Netherlands, is a user-friendly bibliometric software renowned for its visualisation and analysis of scientific literature, as stated by [14, 47]. It specialises in creating intuitive network visualisations, clustering related items, and generating density maps. With its versatility, researchers can examine co-authorship, co-citation, and keyword co-occurrence networks, gaining a comprehensive understanding of research landscapes. The software's interactive interface and regular updates enable efficient exploration of large datasets. VOSviewer's capabilities include metric computation, customisable visualisations, and compatibility with various bibliometric data sources, making it indispensable for scholars navigating complex research domains.

One of its standout features is its ability to transform complex bibliometric datasets into easily interpretable maps and charts. Focusing on network visualisation, VOSviewer excels at clustering related items, analysing keyword co-occurrence patterns, and generating density maps. Its user-friendly interface caters to both novice and experienced users, facilitating efficient exploration of research landscapes. Continual development ensures VOSviewer remains at the forefront of bibliometric analysis, providing valuable insights through metric computation and customisable

visualisations. Its adaptability to different types of bibliometric data, such as co-authorship and citation networks, solidifies its position as an indispensable tool for scholars seeking deeper understanding and meaningful insights within their research domains.

Datasets sourced from the Scopus database, containing information on publication year, title, author name, journal, citation, and keywords in PlainText format, were analysed using VOSviewer software version 1.6.19. Through VOS clustering and mapping techniques, the software facilitated the examination and generation of maps. According to [14, 48], unlike the Multidimensional Scaling (MDS) approach, VOSviewer situates items within low-dimensional spaces, accurately reflecting their relatedness and similarity. This method diverges from MDS by employing a more fitting normalisation method for co-occurrence frequencies, such as the association strength ( $AS_{ij}$ ), as described by [49].

## 4. Results

### 4.1 What are the Research Trends in Digital Learning and Teacher Teaching Quality According to the Year of Publication?

Figure 1 is a line graph that shows the number of documents indexed in Scopus by year for the title "Digital Learning and Teacher Teaching Quality." It covers the period from 1989 to 2022. Here are some observations about the trends and patterns in the graph:

- i. The number of publications appears to have increased steadily over time, with a particularly sharp increase in recent years. There are 12 documents published in 1989, and this number jumps to 175 in 2022.
- ii. There is a notable peak in the number of publications in 2020, with 192 documents published. This could be due to a number of factors, such as increased interest in digital learning due to the COVID-19 pandemic, or the publication of influential research in this area.

Here are some factors that may have influenced the fluctuations in publication rates:

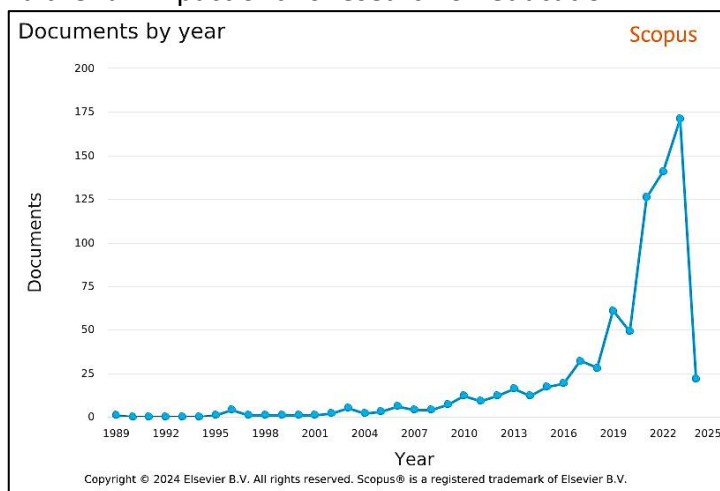
- i. Advancements in technology: The development of new technologies for digital learning, such as online learning platforms and educational games, may have led to increased interest in research in this area.
- ii. Changes in funding: Government or private funding for research in digital learning and teacher quality may have influenced the number of publications in this area.
- iii. Shifts in research priorities: There may have been a shift in research priorities towards digital learning and teacher quality in recent years, due to factors such as the growing importance of technology in education and the increasing focus on improving teacher quality.
- iv. Emerging trends in the field: The emergence of new trends in digital learning, such as personalised learning and artificial intelligence-powered tutoring, may have led to increased research activity in these areas.

The increasing number of publications on digital learning and teacher quality suggests that this is a growing field of research with important implications for education. This research could help improve the quality of teaching and learning, and make education more accessible and effective for all students.

It is important to note that the data in this graph is from Scopus, which is just one database of academic publications. There may be other relevant publications that are not indexed in Scopus.



Additionally, the graph only shows the number of publications and does not provide any information about the quality of the research. Overall, the trends in the graph suggest that digital learning and teacher quality are important and growing fields of research. However, more research is needed to understand the full impact of this research on education.

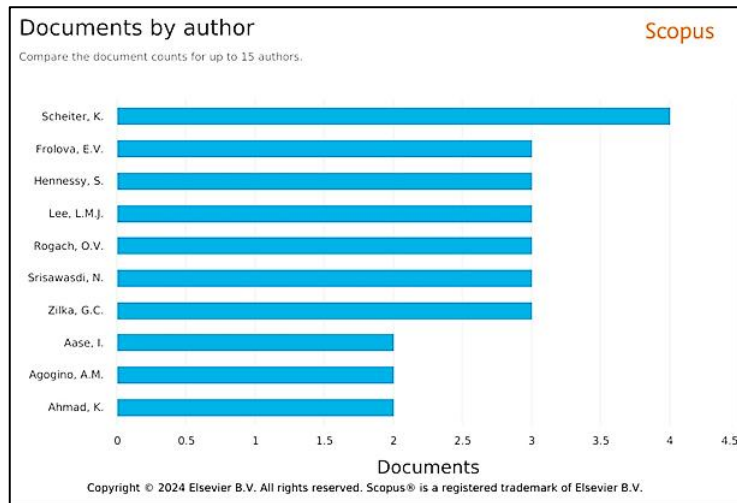


**Fig. 1.** Plotting document publication by years

#### 4.2 Who Writes the Most Number of Articles?

The Figure 2 shows a bar graph of the top 10 most prolific authors in this field, along with the number of documents they have published. The graph does not show a clear upward or downward trend in the number of publications over time. There is some fluctuation, but the number of publications per author is generally between 0 and 4. It is difficult to say for sure what factors may have influenced these fluctuations. However, some possible explanations include:

- i. **Advancements in technology:** As technology has improved, it has become easier for researchers to share their work with others. This may have led to an increase in the number of publications in some fields.
- ii. **Changes in funding:** Funding for research can vary over time. This can lead to fluctuations in the number of publications in a particular field.
- iii. **Shifts in research priorities:** Research priorities can change over time as new questions and challenges emerge. This can lead to changes in the number of publications on a particular topic.
- iv. **Emerging trends in the field:** New trends in a field can lead to an increase in research activity. This can also lead to fluctuations in the number of publications.



**Fig. 2.** Graph document number of article by authors

The trends observed in the graph could have a number of implications for the development of the field of digital learning and teacher quality. For example, if the number of publications continues to fluctuate, it may be difficult to identify clear trends and directions for future research. Additionally, if there is a decline in the number of publications, it could indicate a lack of interest in the field or a lack of funding for research. It is important to note that the graph only shows the number of publications by author for a small sample of authors. Therefore, it is difficult to draw any general conclusions about the trends in the field of digital learning and teacher quality. More research would be needed to determine the overall impact of these trends on the field.

#### 4.3 Who are the Top 10 Authors Based on Citations from Research?

A bibliometric analysis of the top 10 authors (Table 3) based on citation count for the topic "Digital Learning and Teacher Teaching Quality" reveals diverse research interests and ongoing activity in the field. Studies range from examining factors influencing teachers' integration of technology in education to exploring parental involvement in children's digital usage. Topics also include the efficacy of educational interventions like mobile apps and learning analytics, as well as advocating for aligning teacher competency frameworks with contemporary challenges.

**Table 3**

The top 10 authors based on citation by research

Authors	Title	Year	Source title	Cited by
[50]	Factors that influence teachers' adoption and integration of ICT in teaching/learning process	2018	Educational Media International	163
[51]	Efficacy of PRIME, a mobile app intervention designed to improve motivation in young people with schizophrenia	2018	Schizophrenia Bulletin	113
[52]	Parental involvement and attitudes towards young Greek children's mobile usage	2019	International Journal of Child-Computer Interaction	112
[53]	Using learning analytics to scale the provision of personalised feedback	2019	British Journal of Educational Technology	198
[54]	Understanding tablet computer usage among primary school students in underdeveloped areas: Students'	2016	Computers in Human Behavior	80

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	technology experience, learning styles and attitudes			
[55]	Predictors of teachers' use of ICT in school – the relevance of school characteristics, teachers' attitudes and teacher collaboration	2017	Education and Information Technologies	113
[56]	A mobile clinical e-portfolio for nursing and medical students, using wireless personal digital assistants (PDAs)	2006	Nurse Education Today	89
[57]	Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu)	2019	European Journal of Education	249
[58]	Medical students' acceptance and perceptions of e-learning during the Covid-19 closure time in King Abdulaziz University, Jeddah	2021	Journal of Infection and Public Health	99
[59]	Cloud computing A potential paradigm for practising the scholarship of teaching and learning	2011	Electronic Library	92

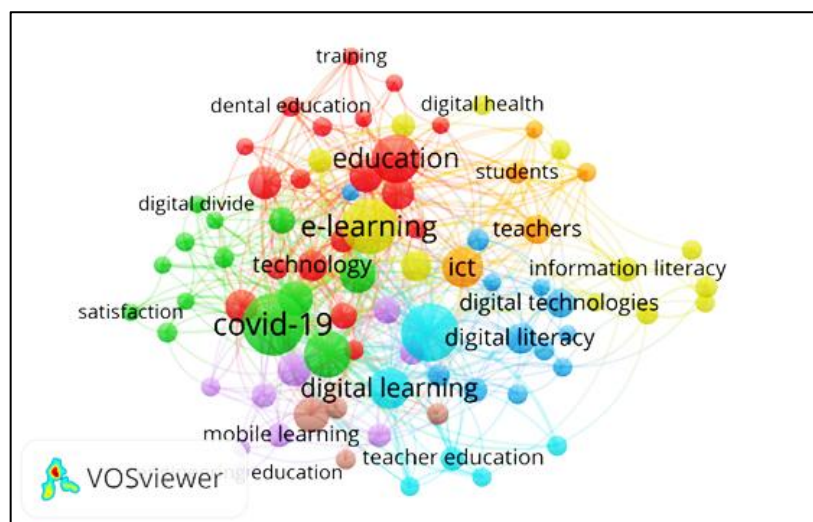
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The variation in publication years indicates sustained interest over time, with certain studies garnering significant attention and recognition within the scholarly community. Overall, this analysis underscores the breadth and impact of research contributions shaping the landscape of digital learning and teacher teaching quality. These findings suggest that research in the domain of digital learning and teacher teaching quality is multifaceted, addressing various aspects such as technology adoption, educational interventions, and competency framework alignment. The diversity of topics covered in the top-cited publications indicates the wide-ranging interests within the field. Moreover, the significant citation counts highlight the influence and relevance of these studies in academia. This bibliometric analysis provides valuable insights into the evolving landscape of research in digital learning, showcasing ongoing interest and contributions aimed at enhancing teaching quality through technology integration and innovative pedagogical approaches.

#### 4.4 What are the Popular Keywords Related to the Study?

The map in Figure 3 shows several clusters of keywords that represent the main themes and topics within the research literature. Here's a breakdown of some of the key clusters:

- i. Central cluster: The central cluster consists of keywords such as "digital learning," "teachers," "education," "students," and "technology." This cluster highlights the core concepts that are most frequently discussed together in the literature on digital learning and teacher teaching quality.
- ii. Connections between keywords: The connections between keywords show how they are related to each other. For example, the strong connection between "digital learning" and "teachers" suggests that these two concepts are often studied together. Similarly, the connection between "teachers" and "education" suggests that research on teacher quality is often situated within the broader context of education.
- iii. Peripheral clusters: The peripheral clusters around the central cluster represent emerging or specific areas of research within the broader field of digital learning and teacher teaching quality. For example, the cluster on the left side of the map includes keywords such as "mobile learning," "teacher education," and "training." This cluster suggests that there is growing interest in how digital technologies can be used to support teacher education and training.



**Fig. 3.** Network visualisation map of keywords' co-occurrence

Here are some additional points to consider:

- i. The size of the nodes in the network visualisation map represents the frequency of keyword occurrences. The larger the node, the more frequently the keyword appears in the analysed articles.
- ii. The colour of the nodes may represent different clusters or communities of keywords. The keyword co-occurrence analysis sheds light on the intricate relationships within the realm of digital learning and teacher teaching quality. Notably, frequent pairings such as "e-learning" and "online learning" underscore the heightened focus on digital education, particularly in response to the COVID-19 pandemic, suggesting an urgent need for effective remote teaching strategies. Additionally, keywords like "teacher" and "teaching" closely intertwine with "quality" and "professional development," underscoring the importance of supporting educators in upholding high standards in digital instruction.

Furthermore, the prevalence of terms like "digital competence" and "educational technology" highlights the imperative of fostering educators' proficiency in utilising digital tools effectively. The analysis also reveals a growing interest in leveraging technology for educational improvement, as seen in the associations between "learning analytics" and "assessment." Overall, these findings underscore the multifaceted nature of digital learning and its intersection with pedagogy and professional development, informing future research endeavours and policy initiatives aimed at enhancing digital learning experiences and supporting educators in navigating evolving educational landscapes.

#### 4.5 What are Co-Authorship Countries' Collaborations?

Here are some details that could be discussed in the article about the citation network by document type (Figure 4):

- i. The United States appears to be the most central and collaborating country, based on the number of connections it has with other countries. This suggests that the US is playing a central role in research collaborations in this field.
- ii. Other countries that appear to be collaborating actively include China, Turkey, Spain, Finland, and the United Kingdom. These countries may also be important players in the

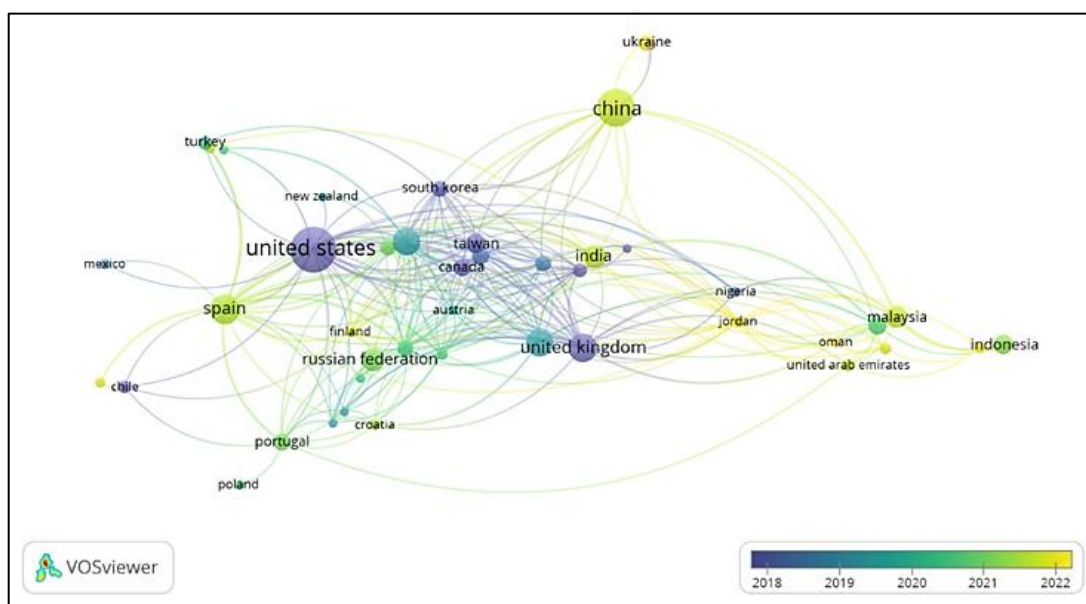
global research landscape on digital technology and teacher teaching quality.

- iii. There appear to be several smaller clusters of collaborating countries, such as the cluster around Mexico and the cluster around South Korea. These clusters may represent regional or thematic research collaborations.

It is important to note that the co-authorship network map only provides a snapshot of collaboration patterns at a specific point in time. The research landscape is constantly evolving, and so the collaboration patterns may change over time. Here are some additional questions that could be considered in the analysis:

- i. What are the specific research topics that are being addressed by the collaborations between these countries?
- ii. Are there any emerging trends in the research landscape that are reflected in the co-authorship network map?
- iii. What are the challenges and opportunities for international collaboration in research on digital technology and teacher teaching quality?

By addressing these questions, authors can gain a more nuanced understanding of the global research landscape in this field and the role that international collaboration plays in advancing knowledge and improving teacher teaching quality.



**Fig. 4.** The countries whose authors collaborate digital learning and teacher teaching quality

#### 4.6 What Network Mapping Based on Citation by Document Type?

Here are some details that could be discussed in the article about the citation network by document type (Figure 5):

- i. The network appears to show different clusters of documents, which are likely connected by citations. These clusters may represent different research topics or areas of focus within a broader field of digital technology and teacher teaching quality.
- ii. The size of the circles (nodes) in the network likely represents the number of citations each document has received. Larger circles likely represent more influential or highly cited documents.

- iii. The colour of the nodes may indicate the document type. For example, blue nodes might represent journal articles, green nodes might represent conference proceedings, and so on.

Here are some specific details that could be discussed in the article:

- i. Identify the most cited documents: Look for the largest nodes in the network. These documents are likely to be the most influential or important works in the field.
- ii. Analyse the clustering of documents: What are the major topics or areas of research represented by the different clusters? Are there any surprising or unexpected connections between different document types?
- iii. Compare citation patterns across document types: Do different types of documents, such as journal articles or conference proceedings, tend to be cited more frequently? What might this suggest about the dissemination of research in this field?

It is important to note that the citation network map only provides a snapshot of citation patterns at a specific point in time. The research landscape is constantly evolving, and so the citation patterns may change over time. Here are some additional questions that could be considered in the analysis:

- i. What are the most common citation practices in the field of digital technology and teacher teaching quality?
- ii. How do the citation patterns in this field compare to other fields of education research?
- iii. What are the implications of the citation network for understanding the flow of knowledge and influence in this field?

By addressing these questions, authors can gain a deeper understanding of the scholarly communication landscape in digital technology and teacher teaching quality. This information can help identify influential research, understand emerging trends, and inform a broader analysis of the field.

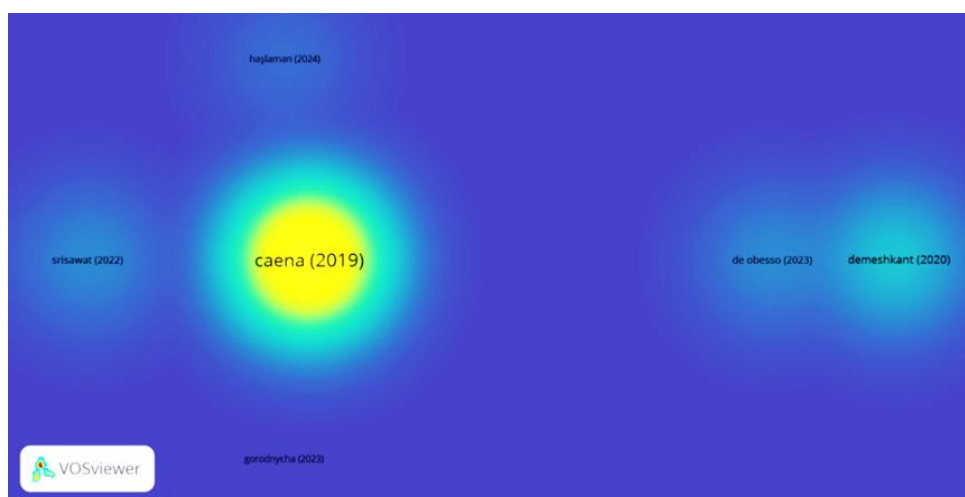


Fig. 5. Shows the countries whose citation by document type

## 5. Conclusions

The surge in publications on digital learning and teacher quality underscores its growing importance in education. However, relying solely on Scopus data has limitations, as it represents just one database and lacks information on research quality. Despite this, the trends indicate a

burgeoning interest in this field, with the potential to enhance teaching and learning outcomes. The fluctuation in publication rates among top authors may be influenced by various factors, including technological advancements, funding fluctuations, shifts in research priorities, and emerging trends. These fluctuations underscore the dynamic nature of research in this field and emphasise the need for further investigation to understand the underlying patterns and implications. Moreover, the bibliometric analysis highlights the diversity of research interests within the domain.

The network visualisation map of keyword co-occurrence offers valuable insights into the interconnections among various themes in digital learning and teacher teaching quality research. Central keywords like "digital learning," "teachers," and "education" underscore the core concepts frequently explored in literature. Moreover, the map highlights emerging areas such as "mobile learning" and "teacher education," signifying evolving research interests and priorities. The co-authorship countries' collaboration analysis reveals the United States as a central player, with active collaborations observed among countries like China, Turkey, and Spain. These collaborations indicate a global effort to advance research on digital technology and teacher teaching quality, with potential implications for policy and practice worldwide. This collaborative effort reflects a shared interest in strengthening the global educational landscape.

The citation network analysis by document type elucidates the influence and dissemination of research in this field. Larger nodes representing highly cited documents provide insight into pivotal works shaping scholarly discourse. Moreover, the clustering of documents reveals major research topics and areas of focus, offering a comprehensive view of the scholarly landscape. In conclusion, while the increasing number of publications and the breadth of topics covered in top-cited studies reflect the evolving landscape of research in digital learning and teacher teaching quality, more comprehensive research is required to fully grasp the field's impact on education. This necessitates continued exploration of emerging trends and challenges, along with efforts to ensure research quality and relevance in addressing contemporary educational needs.

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