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INFORMATION & COMMUNICATIONS TECHNOLOGY IN EDUCATION | REVIEW ARTICLE

Research trends on ICT integration in Education: A bibliometric analysis

Issah Baako^{1*} and W. K. Abroampa¹

Abstract: This research paper conducts a comprehensive bibliometric analysis of ICT integration in education, investigating trends, author prominence, institutional contributions, and thematic focus within this domain. Through the Dimensions academic research database, 1790 pertinent publications from 2014 to 2023 were identified. VOSviewer, a robust bibliometric analysis tool, was employed to visualize and explore bibliometric networks among these publications. Analyzing data encompassing citations, co-keyword occurrences, and co-citations, we constructed networks to unveil underlying scholarly patterns. The study unveils prolific authors, leading journals, contributing countries, and influential publications. Furthermore, evolving research themes over time are identified, shedding light on ICT integration's research focus. This research's significance extends to both academia and practical application. Scholars gain a comprehensive overview of research themes and trends, while practitioners receive insights for informed educational technology implementation. Uniquely, this study employs bibliometric analysis and knowledge mapping to monitor research growth and development. Our analysis distinguishes itself by offering an extensive, current review, providing a valuable resource for understanding ICT integration's progress. Innovative visualizations through bibliometric analysis facilitate an understanding of keyword network structures and their evolution. This research advances the existing literature by offering an updated review through bibliometric analysis and knowledge maps, fostering further strides in this critical and evolving field.

Subjects: CAD CAE CAM - Computing & Information Technology; Information & Communication Technology (ICT); Technology; Teaching & Learning; Continuing Professional Development; Education Policy & Politics; Higher Education; Philosophy of Education; Research Methods in Education

Keywords: bibliometrics; knowledge maps; ICT in education; VOSviewer; co-citations; thematic focus; research trends

1. Introduction

In recent decades, Information and Communication Technology (ICT) has emerged as a transformative force in education, reshaping the way knowledge is disseminated and acquired. The integration of ICT in education has a rich history that dates to the mid-20th century when

early computer-assisted instruction programs laid the foundation. Over the years, the advent of personal computers, the internet revolution, and the rise of mobile technologies have accelerated this integration, culminating in the 21st century's diverse and interconnected digital learning environment (Voogt et al., 2013). The integration of ICT in education has transformed teaching and learning processes, offering new opportunities to enhance educational experiences and outcomes (Curran et al., 2015). As technology continues to advance, the use of ICT in education has gained increasing attention from researchers, policymakers, and educators worldwide (Al-Mamary, 2020). Understanding the global research trends and directions in ICT integration in education is crucial for identifying the progress made in this field and guiding future research and practice.

This review aims to present a comprehensive knowledge mapping and an in-depth analysis of ICT integration in education, focusing on the period between 2014 and 2023. By conducting a bibliometric analysis, this study will provide insights into the research landscape, emerging trends, and key areas of focus in the field of ICT integration in education. The use of ICT in education has been a topic of interest for researchers for many years. However, the past decade has witnessed significant advancements and transformations in educational technology, leading to an increased emphasis on understanding its integration and impact on teaching and learning. By focusing on the period between 2014 and 2023, this review aims to capture the most recent developments in the field and provide an up-to-date analysis of the research landscape.

These studies demonstrate the value of bibliometric analysis in understanding the research trends and knowledge dissemination in the context of ICT integration in education. By analyzing publication outputs, citation patterns, and collaboration networks, researchers could gain insights into the influential authors, institutions, and research topics in this domain. This analysis will provide a quantitative overview of the global research output, identify influential authors, institutions, and journals, and map the collaboration networks among researchers in the field of ICT integration in education. Strategic decisions rely on data frequently obtained from scholarly citation databases. While these tools inform the future research direction, it is widely recognized that they have limitations and are not yet refined enough (Fink, 2019).

In this study, we have chosen to utilize the bibliometric analytical method because it offers the necessary tools to address our research inquiries pertaining to the fundamental principles and subjects within our research field. Employing the bibliometric method has several advantages, notably objectivity and quantifiability, which helps us avoid any subjective biases (Linnenluecke et al., 2020). This justifies the appropriateness of adopting this methodological approach. Bibliometrics involves applying mathematical and statistical techniques to measure and analyze the bibliographic details of publications (Phillips & Ozogul, 2020). By leveraging this bibliographic information, researchers can establish connections between authors or papers (Ivanović & Ho, 2019). Traditionally, bibliometric studies have relied on reliable citation data from databases such as Thomson Reuters Web of Science (WoS) and Elsevier's Scopus.

Science maps, also known as bibliometric or knowledge maps, are essential in visualizing bibliometric networks and understanding the structure and developments within a specific research field. They provide a spatial representation of how research elements such as authors or citations are interconnected. Various software tools are available for constructing science maps, and different approaches can be used to extract a bibliometric network based on the chosen unit of analysis. Largely, science maps have been a significant technical development in the field of bibliometrics, offering valuable insights into the conceptual, intellectual, and social aspects of a research field.

Co-citation analysis involves studying how often two earlier documents are cited together by later documents (Roblek et al., 2022). It helps identify important concepts within a research field when certain documents are frequently co-cited. This analysis can reveal the core literature in a specific area of study. Co-keyword analysis measures the frequency of co-occurrence of two

keywords in the same literature (SadatMosavi et al., 2020). When sets of keywords are frequently used together by different authors in a certain area, it indicates a significant relationship between these keywords within the research field. Co-keyword analysis directly extracts major themes and connections between them without relying on predefined definitions, thus revealing the conceptual structure and major research themes in the area (Muritala et al., 2020). The strength of a co-citation link depends on how many citing authors reference two earlier works together. Consequently, co-citation relationships are not permanent and the co-citation network pattern evolves over time (Ding et al., 2009). The same applies to co-keyword analysis, where vocabulary co-occurrences in a field can change, causing the co-word patterns to shift (Radhakrishnan et al., 2017). As a field evolves and interests and intellectual patterns change, both co-citation and co-word patterns in that field will also change.

In summary, the interdisciplinary nature of the study distinguishes it from other studies in the literature. ICT integration in education involves multiple disciplines, including information and communications technology, psychology, economics, computer science, and curriculum development (Goldhaber, 2021; Mlambo et al., 2020; Suleimen, 2019). By considering a wide range of disciplines, the study can provide a comprehensive understanding of the various factors influencing ICT integration in education. This interdisciplinary approach allows for a more holistic and nuanced analysis of the topic. This study also includes recent publications in this rapidly growing field, as most of the reviewed documents were published within the past three years. Finally, the novel contribution of this work lies in the combination of thematic tables and the analysis of some perspectives of the knowledge network maps from VOSviewer structure, providing a better understanding of the research field development and current state. The study would identify the emerging research trends, gaps, and challenges in ICT integration in education and shed light on the areas that have received significant attention and those that require further exploration.

In this study, we contribute to the bibliometric knowledge by presenting statistical information to the research of ICT integration in education. This bibliometric analysis of 1790 documents published between 2014 to 2023 could be the first to present comprehensive statistical insight into the research status and trends on the subject. It could enable researchers and policymakers to identify the most cited studies, influential journals, and emerging research areas. This information can inform decision-making processes, funding allocation, and the identification of fruitful areas for further research.

The bibliometric analysis will be guided by the following objectives:

- (i) Identify key trends and research directions in the field of ICT integration in education.
- (ii) Evaluate the research impact of authors and institutions in the field of ICT integration in education.
- (iii) Identify opportunities for future examination of under-researched phenomenon of certain aspects of ICT integration in education.

2. Literature review

The integration of Information and Communication Technology (ICT) in education has gained significant attention in recent years. To gain a comprehensive understanding of the research landscape and trends in this field, a bibliometric analysis research paper was conducted on ICT integration in education for the period 2014 to 2023 using VOSviewer.

One study by Mlambo et al. (2020) examined the effects of educators' ICT self-efficacy on their pedagogical use of ICTs in classrooms. The findings suggested that interventions aimed at increasing educators' ICT self-efficacy have the potential to enhance the integration of ICTs in resource-constrained contexts. This highlights the importance of designing educator training curricula that emphasize practical lesson planning incorporating ICTs as seamless resources in the classroom.

In terms of research methodology, Sergi et al. (2020) emphasized the integration of systematic literature review with bibliometric analysis. They argued that qualitative literature analysis can be subject to researcher bias and lack rigor. By incorporating bibliometric methods, researchers can enhance the objectivity and rigor of their analysis, providing a more comprehensive understanding of emerging themes and future trends in the field of intellectual capital.

Sabiri (2020) conducted a systematic literature review focusing on ICT integration in English as a Foreign Language (EFL) teaching and learning. The review covered various aspects, including ICT tools, barriers and challenges to ICT integration, and teachers' perceptions. This study highlighted the importance of considering the specific context of EFL education when examining ICT integration, as it presents unique challenges and opportunities.

In addition to the role of educators, the integration of ICT in specific disciplines, such as nursing education, has also been explored. Nwozichi et al. (2019) conducted a systematic literature review on the integration of ICT in nursing education in Southeast Asia. Their review utilized a thematic analysis approach and identified relevant studies from databases such as Medline, Scopus, and PubMed. The review highlighted the importance of incorporating ICT in nursing education to enhance learning outcomes and prepare students for the digital healthcare environment.

The attitude of teachers towards ICT integration in higher education curriculum has been a topic of interest. Suleimen (2019) conducted a study on the attitude towards ICT integration and usage in Kazakhstani higher education curriculum. The study utilized a mixed methods design, including questionnaires and interviews, to gather data on instructors' attitudes towards ICT integration. The findings emphasized the need for continuous professional development and support for instructors to effectively integrate ICT tools into the curriculum.

These studies provide valuable insights into the various aspects of ICT integration in education. However, to gain a comprehensive understanding of the research landscape, a bibliometric analysis using VOSviewer is necessary. By analyzing the co-citation and co-authorship networks, as well as keyword co-occurrences, researchers can identify key authors, influential publications, and thematic clusters within the field of ICT integration in education. This approach allows for a holistic view of the research landscape and can inform future research directions and policy decisions.

The bibliometric analysis research paper on ICT integration in education for the period 2014 to 2023 using VOSviewer offers a unique and comprehensive approach to understanding the research landscape in this field. The use of VOSviewer in the bibliometric analysis research paper is a distinguishing feature of this study. By integrating bibliometric analysis with VOSviewer, researchers can identify emerging trends, key authors, and thematic clusters, providing valuable insights for future research and policy development in ICT integration in education.

3. Methodology

3.1. Bibliometric analysis

The bibliometric analysis was conducted to identify the most influential, impactful, and prominent articles, research institutions, journals, countries, and authors in terms of publication numbers and citation metrics in the field of ICT integration in education. The typical bibliometric process involves stages such as gathering publications, processing data, creating visualizations and networks, and conducting analysis. This is represented conceptually in Figure 1.

3.2. Data collection

Dimensions, which is a research database that provides a comprehensive collection of linked research data in a single platform, was regarded as the most ideal data source for this bibliometric investigation. Dimensions has been used for bibliometric analysis by many researchers (García-Sánchez et al., 2019; Guerrero-Bote et al., 2021; Hook et al., 2018, 2021; Mouratidis, 2019; Singh et al., 2021).

Figure 1. Bibliometric conceptual framework for the study.

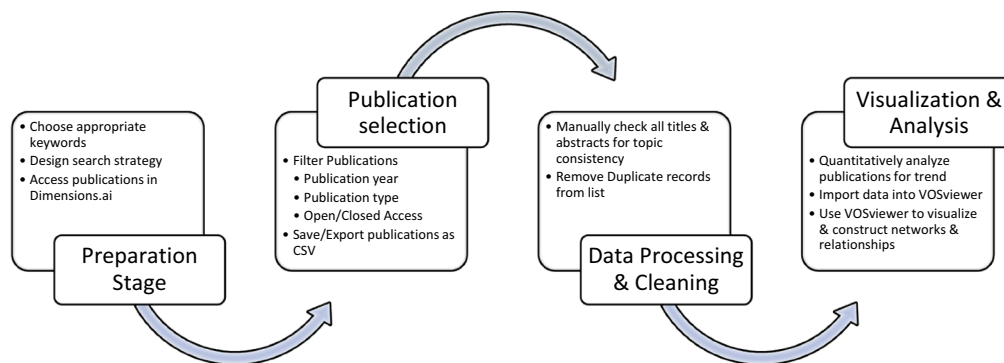


Table 1. Publication search criteria

Criteria	Description
Source Database	Dimensions
Years	2014–2023
Search string	“ICT integration”, OR “slum schools”, OR “ICT in education” OR “technology use in education” OR “ICT implementation in education” OR “ICT in slum schools” OR “ICT use in Schools” OR “TPACK”
Inclusion criteria	Article or Chapter or Proceeding
Publication Language	English
Exclusion criteria	Editorial materials, Book reviews, Meeting abstracts
Export Date	NaN Invalid Date
Documents size	1790
Search in	Title and abstract

Dimensions Scientific Research database is an up-to-date academic database and highly rated for its excellent and comprehensive metrics as well as having exhaustive list of journal articles than its counterparts (Guerrero-Bote et al., 2021; Singh et al.,). The data search process for publications for this bibliometric analysis started on NaN Invalid Date NaN. The search string was specified as “ICT integration”, OR “slum schools”, OR “ICT in education” OR “technology use in education” OR “ICT implementation in education” OR “ICT in slum schools”, OR “ICT use in Schools” OR “TPACK”. The detailed search information is summarized in Table 1.

The topic search string was specified into the keywords’ text box as: “ICT integration”, OR “slum schools”, OR “ICT in education” OR “technology use in education” OR “ICT implementation in education” OR “ICT in slum schools”, OR “ICT use in Schools” OR “TPACK”. Other specified search criteria were; Years: 2014–2023, Search Database: Dimensions, Maximum number of Results: 1790. After the search, the results were downloaded and saved as Dimensions csv file in a spreadsheet format. The year range (2014–2023) was selected to retrieve the most current studies as these are more likely to reflect the most recent developments, findings, and trends in the research field of ICT integration in education. Newer studies may have considered changes in the research landscape, such as new methods, new technologies, or new theoretical perspectives, that may not have been available to earlier studies. It could ensure up-to-date accurate analysis and provide a more accurate and comprehensive overview of existing knowledge and research gaps.

3.3. Data analysis

The bibliometric analysis was done using the VOSviewer software. It was used to create a term co-occurrence map based on text data on the titles and abstracts of the publications. The analysis included the identification and appraisal of the research discipline in terms citation data, author

prominence, the co-citation analysis of the articles, and the author co-citation analysis, journals, and countries. The bibliographic data of the selected articles were imported from the downloaded and saved Dimensions csv file into the VOSviewer software to identify published literature on ICT in education and network linkages.

3.4. Visualization and interpretation

The results of the bibliometric analysis were visualized using VOSviewer to create maps of the co-citation, keyword co-occurrence, organization citation and author co-citation networks in the map formats of Network visualization, Overlay visualization and Density Visualization. The maps and tables created from VOSviewer were interpreted to identify the most influential and impactful articles, countries, organizations, journals, and authors in the field of ICT integration in education based on citation metrics, publication data, network linkages and trends in the research.

4. Results and discussions

4.1. Research outputs over the period

The number of publications on “ICT integration in education” for the 2014–2023 period is presented in Figure 1. There is an obvious trend of the publication figures dropping slightly in 2015 from 2014 and a steady rise from 2016 to 2018. Over the entire period chosen for the analysis, 2020 recorded the highest number of publications. The reason could be the adoption of ICT tools to engage learners when COVID-19 disrupted face-to-face interactions in schools. Due to lockdowns and closure of schools preventing physical contact teaching modes, several schools adopted technology tools such as video conferencing, google classrooms and social media applications to engage learners (Adarkwah, 2021). These might have heightened the interest of researchers worldwide to focus more on “ICT integration in education” research. The decrease in publications in 2019 (196 publications) and the down slope in publication numbers for the years 2021 and 2022 (245 and 243 respectively) is also noticeable in the graph. It will be interest to understand what could have accounted for these finding.

4.2. Keyword occurrences of published papers

The analysis of keywords and indexed terms related to the abstracts and titles of published papers was aimed at revealing the hotspots in the ICT integration field. Keywords analysis has the strength to reveal deeper perspectives on the substance of the research field and to ascertain the hotspots in the present research and potential directions for the future. These keywords could also assist researchers in portraying the knowledge pattern of focus and visualizing forecasts of further trends. VOSviewer was used to visually examine the keywords of papers in the ICT integration in education research field and produce the keywords and the maps of keyword co-occurrence in the time zone view for determining the evolution in research focus as shown in Figure 2. Of the 28,415 keywords identified in abstracts and titles, 1128 of them met the minimum threshold of 10 occurrence of a term. Six hundred and seventy-seven terms were selected by VOSviewer based on terms relevance to the research field of ICT integration in education. The extent of visibility of a keyword and font size indicates the frequency of its occurrence and relevance or usage in the research under analysis. The data revealed that the terms “pandemic”, “country”, “computer”, “relationship”, “tpack”, “teacher education” and “internet” were among the most used terms in the research of ICT integration in education. However, in the time zone view of the terms (colour of text circle), terminologies such as “covid”, “pandemic”, “digital education”, “self-efficacy” and “behavioural intention” are in either green, light yellow or yellow indicating their first occurrence in the research field from 2020 demonstrating the research trend on the subject (see Figure 2).

4.3. Title terminologies/keywords

In bibliometric analysis, frequently occurring words in titles could be used to identify trends in research. For example, if a particular word or phrase appears in many titles, it suggests that this is a topic that is currently being investigated by researchers. This information could assist

4.3.1. Abstract terminologies/keywords

Abstracts provide summary of a journal article to readers with a quick overview of the article's content. It typically include the research question or hypothesis, methods of the study, main findings, and implications of findings. Like research titles, abstracts could provide data on the trends of research over time and the gaps in the field of study. The VOSviewer application identified 26,524 terms with 1041 meeting the threshold of terms occurring at least 10 times in the abstracts of the publications. Of this number, 625 terminologies were selected representing 60% of the most relevant terminologies to the research field. In the keyword visualization network created from VOSviewer, (Figure 4), the terms “country”, “system”, “computer”, “barrier”, “covid” and “child” were the most visible. This suggest that they were the significant terms or topics presented in abstracts of ICT integration in education research. In density visualization networks, the visibility and size of a term indicates its frequency in occurrence.

4.3.2. Publication citations

Table 2 presents data on the top 20 most cited publications on the research on ICT integration in education for the period 2014–2023 with a total of 6,466 citations. It is imperative to note that several factors influence the frequencies of citations per paper such as novelty of subject, quality of paper, research methodology and design, references, and journal related factors such as journal impact factor, scope of journal and language of journal and authors related factors such as authors' reputation and productivity and number of authors per publication. However, the quality of the paper, journal impact factor and accessibility and visibility of papers are the top valued predictors for citations (Linnenluecke et al., 2020; Mejia et al., 2021). This bibliometric analysis is based on the number of citations received by articles related to the integration of ICT in education.

The most cited article in this dataset is “Teaching and learning with technology: Effectiveness of ICT integration in schools” by Ghavifekr and Rosdy (2015), published in the *International Journal of Research in Education and Science*, with 1,327 citations. This implies the great importance of this paper which assessed the effectiveness of ICT integration regarding teaching and learning in schools. It also demonstrates the significant impact and influence the article has had on the research field. The second most cited article was “Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence” by Tondeur et al. (2017), with 1027 citations. The paper, in a qualitative approach, reviewed studies on the relationship between teachers' pedagogical beliefs and technology use in education. Lawrence and Tar (2018), with 468 citations, discussed the influencing factors of teacher's technology adoption and integration into teaching and learning process. In fourth

Figure 4. Overlay visualization network on publication title terminologies/keywords.

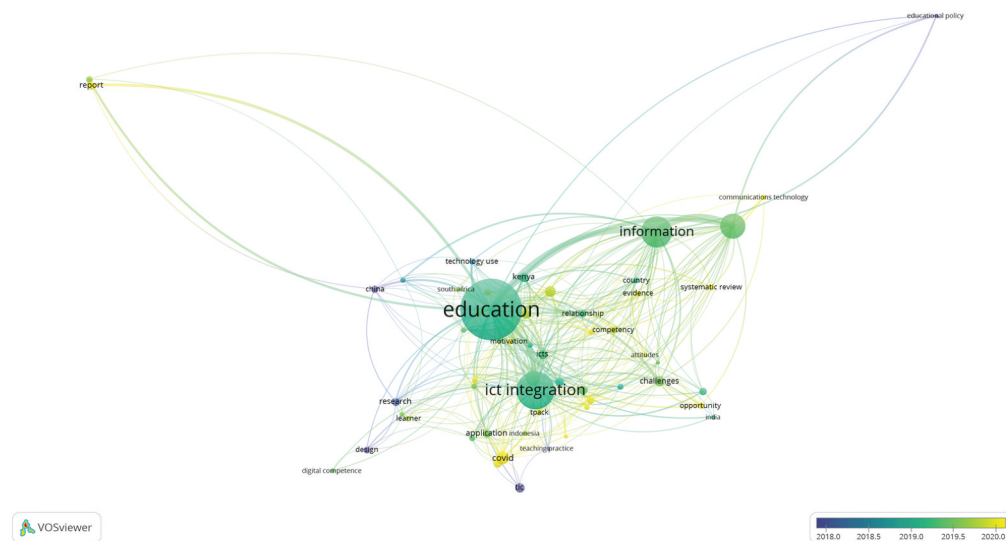


Table 2. Top 20 most cited publications

Cites	Authors	Title	Journal
1327	Ghavifekr and Rosdy (2015)	Teaching and learning with technology: Effectiveness of ICT integration in schools.	<i>International Journal of Research in Education and Science</i>
1027	Tondeur et al. (2017)	Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence	<i>Educational Technology Research and Development</i>
468	Lawrence and Tar (2018)	Factors that influence teachers' adoption and integration of ICT in teaching/learning process	<i>Educational Media International</i>
438	Ghavifekr et al. (2016)	Teaching and Learning with ICT Tools: Issues and Challenges from Teachers' Perceptions.	<i>Malaysian Online Journal of Educational Technology</i>
315	Albion et al. (2015)	Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice	<i>Education and Information Technologies</i>
324	Adarkwah (2021)	"I'm not against online teaching, but what about us?": ICT in Ghana post Covid-19	<i>Education and Information Technologies</i>
279	Tondeur et al. (2016)	Responding to challenges in teacher professional development for ICT integration in education	<i>Educational Technology and Society</i>
213	Brun, M., & Hinostrroza, J. E. (2014)	Learning to become a teacher in the 21st century: ICT integration in Initial Teacher Education in Chile	<i>Journal of Educational Technology & Society</i>
209	Mirzajani et al. (2016)	Teachers' acceptance of ICT and its integration in the classroom	<i>Quality Assurance in Education</i>
208	Tondeur et al. (2019)	Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education	<i>British Journal of Educational Technology</i>
205	Albugami, S., & Ahmed, V. (2015)	Success factors for ICT implementation in Saudi secondary schools: From the perspective of ICT directors, head teachers, teachers and students	<i>International Journal of education and development using ICT</i>
200	Vrasidas, C. (2015)	The rhetoric of reform and teachers' use of ICT	<i>British Journal of Educational Technology</i>
198	Vanderlinde, R., Aesaert, K., & Van Braak, J. (2014)	Institutionalised ICT use in primary education: A multilevel analysis	<i>Computers & Education</i>
196	Kihoza, P., Zlotnikova, I., Bada, J., & Kalegele, K. (2016)	Classroom ICT integration in Tanzania: Opportunities and challenges from the perspectives of TPACK and SAMR models	<i>International Journal of Education and Development using ICT</i>
172	Aslan, A., & Zhu, C. (2017)	Investigating variables predicting Turkish pre-service teachers' integration of ICT into teaching practices	<i>British Journal of Educational Technology</i>
158	Lubega, J. T., & Paul, M. (2014)	Adoption of the SAMR model to assess ICT pedagogical adoption: A case of Makerere University	<i>International Journal of e-Education, e-Business, e-Management and e-Learning</i>

(Continued)

Table 2. (Continued)

Cites	Authors	Title	Journal
149	Aslan, A., & Zhu, C. (2016)	Influencing Factors and Integration of ICT into Teaching Practices of Pre-Service and Starting Teachers.	<i>International Journal of Research in Education and Science</i>
143	Mulhim (2014)	The Barriers to the Use of ICT in Teaching in Saudi Arabia: A Review of Literature.	<i>Universal Journal of Educational Research</i>
124	Aslan, A., & Zhu, C. (2015)	Pre-Service Teachers' Perceptions of ICT Integration in Teacher Education in Turkey.	<i>Turkish Online Journal of Educational Technology</i>
113	Alemu, B. M. (2015)	Integrating ICT into Teaching-learning Practices: Promise, Challenges and Future Directions of Higher Educational Institutes.	<i>Universal journal of educational research</i>

place is Ghavifekr et al. (2016), with 438 citations, the paper drew on teachers' perceived challenges of teaching and learning with ICTs. Albion et al. (2015) assessment of Teachers' professional development for ICT integration that focused on the relationship between research and practice is in fifth place with 315 citations.

Most of the articles in the dataset (15 out of 20) with most citations were published between 2014 and 2016, indicating a peak interest of this topic on the research done during this period. Adarkwah (2021) examination of online teaching in Ghana post COVID-19 was the youngest paper with the most citations. Additionally, several articles focus on teacher professional development for ICT integration (Albion et al., 2015; Tondeur et al., 2016, 2019), suggesting that improving teachers' skills and knowledge is an important factor for successful ICT integration in education. Other common themes among the articles include the factors that influence teachers' adoption and integration of ICT (Lawrence & Tar, 2018; Mirzajani et al., 2016) and the challenges faced by teachers in integrating ICT in teaching and learning processes (Ghavifekr et al., 2016; Mulhim, 2014).

Two journals stand out as the most represented in this dataset: "British Journal of Educational Technology" and "International Journal of Research in Education and Science," with three and two articles, respectively. This suggests that these journals are prominent venues for publishing research on ICT integration in education. Several authors have multiple articles in the top 20, indicating their significant contributions to the field. Notable authors include Tondeur, Ghavifekr, Forkosh-Baruch, Albion, and Aslan. The dataset includes articles from various countries, such as Malaysia, Chile, Ghana, Saudi Arabia, Turkey, and Tanzania. This diversity highlights the global interest and relevance of research on ICT integration in education.

The articles cover various themes related to ICT integration in education, including the effectiveness of technology use in schools, teacher professional development, acceptance, and adoption of ICT by teachers, factors influencing ICT implementation, and challenges in integrating ICT in the classroom. The articles span from 2014 to 2021, indicating ongoing interest and research in this area over the years.

One article stands out as being published in 2021, suggesting that the field is continuously evolving and drawing traction especially after the covid pandemic. This article explores the impact of ICT in Ghana post-Covid-19 (see Adarkwah, 2021). The analysis of the citation ranking of the journal articles indicates a diverse range of topics and approaches within the broader theme of "ICT integration in education." Researchers in this field have explored various aspects of the topic, which has contributed to its significance and relevance in the educational research community.

The high citation counts of some articles demonstrate their influential role in shaping the understanding and advancement of ICT integration in education.

4.4. Prominent authors

On the author collaboration network, 3958 authors published at least one article within the period under study (2014–2023). Twelve authors published at least five articles. The author with the most publications and citations is Jo Tondeur from Ghent University, Belgium who has 12 publications and 972 citations. This indicates that the researcher has received significant attention and acknowledgment from other scholars in the field. Tondeur’s work appears to have a strong influence on the topic of ICT integration in education. In the second place for author prominence is Johan van Braak from Vrije Universiteit Brussel with 3 publications and 391 citations (see Table 3). Though the author has only three publications within the period of 2014–2022, the research work has made great impact on the ICT integration in education research as far as number citations is concerned. Ronny Scherer of University of Oslo, Norway, has five publications with 353 citations and placed as the third most cited author in the research field of ICT integration in education. While having fewer publications compared to Tondeur, the relatively high number of citations suggests that the author’s work has been well-received and highly cited by other researchers. It must be noted that no African author was found in the table of top 10 most cited authors with at least five or three publications (Tables 3 and 4). It is also observed in this study that, the publication, “I’m not against online teaching, but what about us?: ICT in Ghana post Covid-19” by Michael Agyemang Adarkwah published in 2020 has 152 citations demonstrating its

Table 3. Top 10 most cited authors (with at least three publications) in the research field of “ICT integration in education”

Rank	Author	Publications	Citations
1	Tondeur, Jo	12	972
2	Scherer, Ronny	5	353
3	Ghavifekr, Simin	5	351
4	Valtonen, Teemu	7	335
5	Sointu, Erkkko	5	307
6	Lim, Cher Ping	9	90
7	Yuen, Allan H. K.	5	28
8	Chen, Min	7	19
9	Huang, Ronghuai	6	15
10	Wu, Di	8	11

Table 4. Top 10 most cited authors with at least five publications on “ICT integration in education”

Rank	Author	Publications	Citations
1	Tondeur, Jo	12	972
2	van Braak, Johan	3	391
3	Scherer, Ronny	5	353
4	Ghavifekr, Simin	5	351
5	Valtonen, Teemu	7	335
6	Sointu, Erkkko	5	307
7	Siddiq, Fazilat	4	292
8	Baran, Evrim	3	271
9	Kukkonen, Jari	3	165
10	Aesaert, Koen	3	147

impact on ICT integration in education research. Though the number of publications and citations are essential indicators of an author's impact on the field and their contributions to advancing knowledge in this domain, it is worth noting that the impact of an individual's work may vary depending on factors such as the quality of their research, the relevance of their findings, and the visibility of their publications within the academic community.

4.5. Prominent institutions

The bibliometric analysis of "ICT integration in education" research reveals the top 10 institutions that have garnered the highest number of citations, considering only those with at least five publications (see Table 4). These institutions represent a diverse range of academic centers and have made significant contributions to the field, with their research being widely recognized and referenced by peers and scholars.

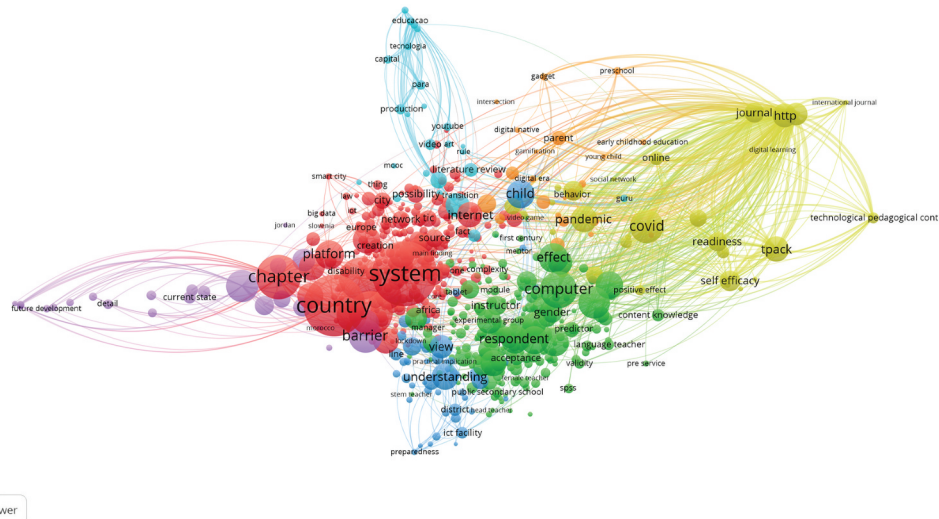
In the institution collaboration network, 863 institutions were identified with 39 meeting the minimum threshold of at least five publications to create the network. From the analysis, it can be observed that the Vrije Universiteit Brussel and Ghent University are the leading institutions in terms of citations, indicating their significant contributions to "ICT integration in education" research. However, it's important to note that this analysis only considers the number of citations and publications, and it does not account for the quality, impact, or relevance of the research conducted by these institutions. Vrije Universiteit Brussel contributed seven articles on "ICT integration in education" and has received a total of 689 citations. It stands out as the top institution in terms of both publications and citations. With 8 publications and 637 citations, Ghent University closely follows Vrije Universiteit Brussel in terms of citations. Although it has a higher number of publications, its citation count is slightly lower. The University of Oslo has published 6 papers and received 298 citations. While its publication count is lower than the previous two institutions, it still manages to secure the third spot in terms of citations. The Nanyang Technological University stands out as the institution with a higher number of publications (17) compared to the previous institutions. However, its citation count is relatively lower at 264.

The analysis reveals that Vrije Universiteit Brussel and Ghent University have a strong presence in the "ICT integration in education" research with high citation counts and a reasonable number of publications. Nanyang Technological University, with the highest number of publications, lags in citations. The data indicates that citation count can be a valuable metric to evaluate the impact of research output from different institutions in this specific field. However, it is essential to consider other factors like the quality of publications, the significance of research findings, and the journals in which the research is published to have a more comprehensive bibliometric analysis.

4.6. Network of co-citations for institutions

A network of co-citation for institutions refers to a visual representation of the relationships between organizations based on their co-citation patterns in research publications. Co-citation occurs when two or more organizations are cited together in the reference lists of scientific papers. When organizations are frequently co-cited, it indicates that they are closely related or have collaborated on research projects, publications, or initiatives. The essence of this analysis is to uncover important connections and collaborations among institutions within the research field of ICT integration in education. Understanding the connections between research organizations, researchers could better appreciate the dynamics of the research community, identify influential players, and explore potential avenues for collaboration and knowledge exchange. In the network, nodes represent research institutions, and the size of a node indicates the frequency of citation. A link between institutions shows that these research institutions cite each other and nodes with the same colour shows that they have often been cited together in the same research demonstrating their shared interest on research domains. For instance, it could be noticed from the network of co-citations (Figure 5) that University of Hong Kong, Education University of Hong Kong, Asian Development Bank and Nanyang Technological University have nodes with similar colours links showing their closed connectedness on research domains and citations.

Figure 5. Network visualization of terms co-occurrence on abstracts on publications on ICT integration in education.



4.7. Prominent countries

4.7.1. Countries with most citations

On the most prominent countries in terms of citations (see Table 5), Belgium has the highest number of citations (935) despite having a comparatively low number of publications (18). This suggests that research conducted in Belgium on ICT integration in education is highly cited, indicating its significance and impact in the field. Australia ranks second in terms of citations (787) and has a relatively higher number of publications (31) compared to Belgium. This indicates that Australian researchers are actively contributing to the field of ICT integration in education, and their work is well-received and influential. The United States follows closely behind Australia with 734 citations, although it has a higher number of publications (35). This implies that while the United States has a strong research output in the field, the impact of their publications may be slightly lower compared to Belgium and Australia.

China stands out with the highest number of publications (98), indicating a significant research output on ICT integration in education. However, despite its large number of publications, it ranks fourth in terms of citations (639), suggesting that the impact and influence of Chinese research in this specific area might be lower than expected. Spain, Malaysia, and Turkey occupy the 5th, 6th,

Table 5. Top 10 institutions with most citations (minimum of five publications)

Rank	Institution	Publications	Citations
1	Vrije Universiteit Brussel	7	689
2	Ghent University	8	637
3	University of Oslo	6	298
4	Nanyang Technological University	17	264
5	Open University of Israel	6	148
6	Universiti Sains Malaysia	6	148
7	University of Eastern Finland	7	135
8	Macquarie University	5	131
9	Ankara University	5	129
10	Tel Aviv University	7	127

and 7th positions, respectively, in terms of citations. These countries have notable research output in ICT integration in education, with varying degrees of impact and influence. Norway, Nigeria, and Israel have comparatively lower numbers of publications and citations. Nevertheless, their presence in the top 10 indicates that researchers from these countries have made significant contributions to the field, albeit on a smaller scale.

This analysis of top 10 countries with most citations on “ICT integration in education” research reveals that Belgium, Australia, and the United States are leading the way on citation impact, while China’s large number of publications does not translate directly into a proportional number of citations. It is essential to interpret these results carefully, as various factors can influence citation counts, such as the quality of research, international collaborations, and the publication venues chosen. Nonetheless, this analysis provides valuable insights into the research performance of different countries in this specific area of education and technology.

4.8. Countries with most publications

In the country’s collaboration network, it was observed that 116 countries published at least one study on ICT integration in education and 62 countries published at least five articles. The density visualization network for these 62 countries with at least five publications is shown in Figure 5 created from VOSviewer. There appear to be densely mature collaboration network between countries in this research field. In the network figure of collaboration, the bigger circle and font size represent prominence and significance in the field of “ICT Integration in Education”. China, Spain and India are the most prominent countries in the research field of “ICT Integration in Education”. China holds the top position with 98 publications on “ICT integration in education.” Although it has a significant number of publications, its citation count (639) is relatively moderate compared to some other countries on the list. This could indicate that while China is actively researching and publishing in this field, the impact of its research may vary. Spain ranks second with 66 publications and a citation count of 582. This suggests that Spanish researchers have been productive in this area, and their work is well-received and cited by the scholarly community. India ranks third with 56 publications and 221 citations. While India has a considerable number of publications, the lower citation count might imply that some of its research in this domain may need to gain more attention and recognition from the global academic community. With 52 publications and 572 citations, Malaysia demonstrates a relatively high citation impact compared to the number of publications. This indicates that the research from Malaysia on “ICT integration in education” is influential and has captured the interest of researchers worldwide.

The United States, despite being a prominent player in the field of education and technology, ranks sixth in this analysis (see Table 7). It has 35 publications, but its citation count is impressive at 734 (see Table 6). This indicates that research from the U.S. is highly influential and widely cited despite the lower number of publications. With 33 publications and 143 citations, South Africa shows potential in the field of “ICT integration in education.” However, compared to some other countries, its publication and citation numbers are relatively modest. The data shows that China has the highest number of publications, while the United States and Australia stand out with relatively fewer publications but high citation impact. Countries like Spain, Malaysia, and Turkey strike a balance between publication output and citation impact. This analysis highlights the global research landscape on “ICT integration in education” and provides valuable insights into the contributions and impact of various countries in this field. It is worthy to mention that though Belgium does not make the top ten countries’ list on publication numbers, it is in first position on number of citations (935 citations as seen in Table 7) demonstrating the research impact of its researchers in ICT integration in education.

4.9. Publications and citations on ICT integration in education in Africa

On the analysis for African prominence, South Africa leads the list with 33 publications, followed by Nigeria and Morocco with 15 publications each (as shown in Figure 6). The number of publications gradually decreases as we move down the list. Nigeria stands out with a significantly high number of citations (303), despite having the same number of publications as Morocco. This indicates that

Table 6. Top 10 countries based on number of citations

Rank	Country	Publications	Citations
1	Belgium	18	935
2	Australia	31	787
3	United States	35	734
4	China	98	639
5	Spain	66	582
6	Malaysia	52	572
7	Turkey	28	390
8	Norway	13	312
9	Nigeria	15	303
10	Israel	17	299

the research from Nigeria has been highly influential and cited by other researchers in the field. While South Africa has the highest number of publications, its citation count (143) is relatively lower than Nigeria's, which suggests that the research from South Africa might not have received as much attention and recognition from other scholars compared to Nigeria. The number of citations is an important metric to measure the impact of research. Higher citation counts imply that the research conducted in that country has been widely recognized and integrated into the broader academic discourse. It should be noted that South Africa is the only African country in the top 15 countries with the most publications in the field of "ICT Integration in Education" (see Figure 4).

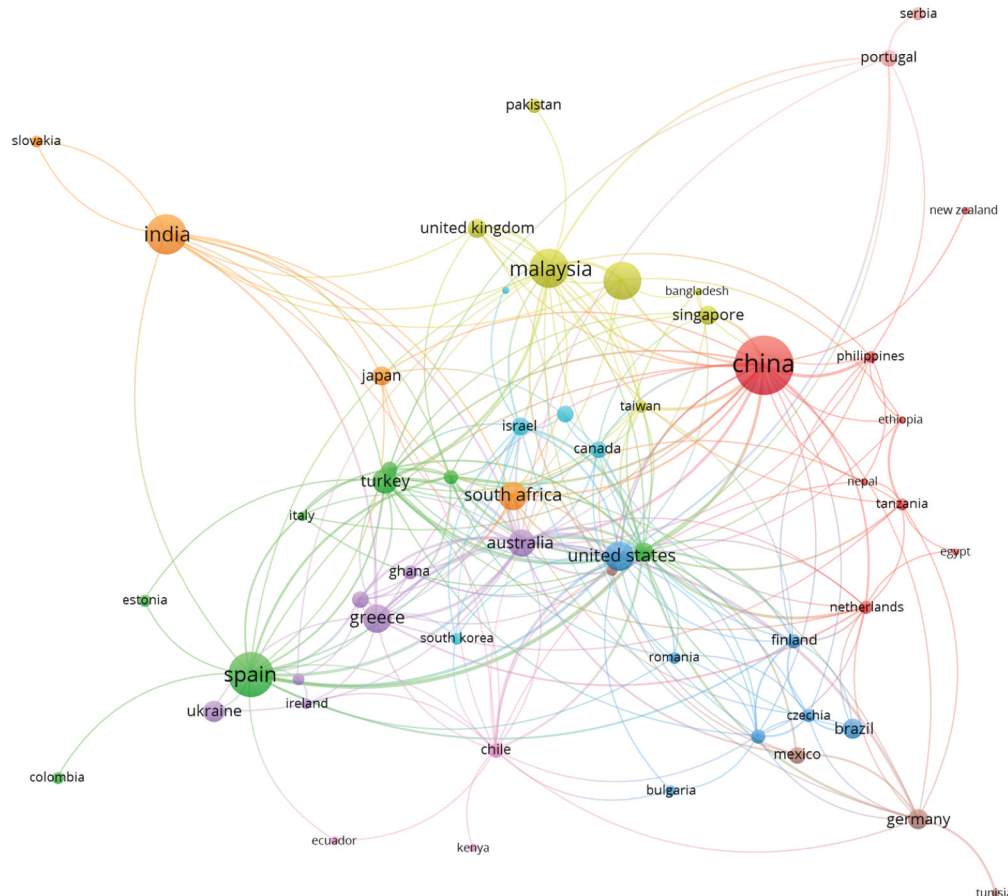
Smaller countries like Ghana, Tanzania, Tunisia, Kenya, Egypt, Ethiopia, and Botswana have also made contributions to the field with a smaller number of publications. While their publication counts are lower, some of them have received notable citations, especially Ghana and Tanzania, indicating that their research has been impactful. It is worth considering that the quality and impact of research can be influenced by factors like collaboration with international researchers, the prestige of the journals where the research is published, and the research methodologies employed. A deeper analysis would be required to determine these factors accurately.

A comprehensive bibliometric analysis would involve tracking research trends over time, identifying influential authors, institutions, and journals in the field, and analyzing the keywords and topics that are prominent in the publications. This data, however, does not include a time frame, so it's challenging to assess any trends. To improve research output and impact, countries with fewer publications could focus on increasing their research efforts, promoting collaborations, and targeting high-impact journals.

Table 7. Top 10 countries based on number of publications

Rank	Country	Publications	Citations
1	China	98	639
2	Spain	66	582
3	India	56	221
4	Malaysia	52	572
5	Indonesia	50	232
6	United States	35	734
7	South Africa	33	143
8	Australia	31	787
9	Turkey	28	390
10	Ukraine	22	63

Figure 6. Countries/Regions collaboration network with at least five publications in the research field of “ICT integration in education”.



Collaboration between countries within the African continent can also strengthen the research landscape and help address common educational challenges related to ICT integration.

4.9.1. Number of publications and citations per journal

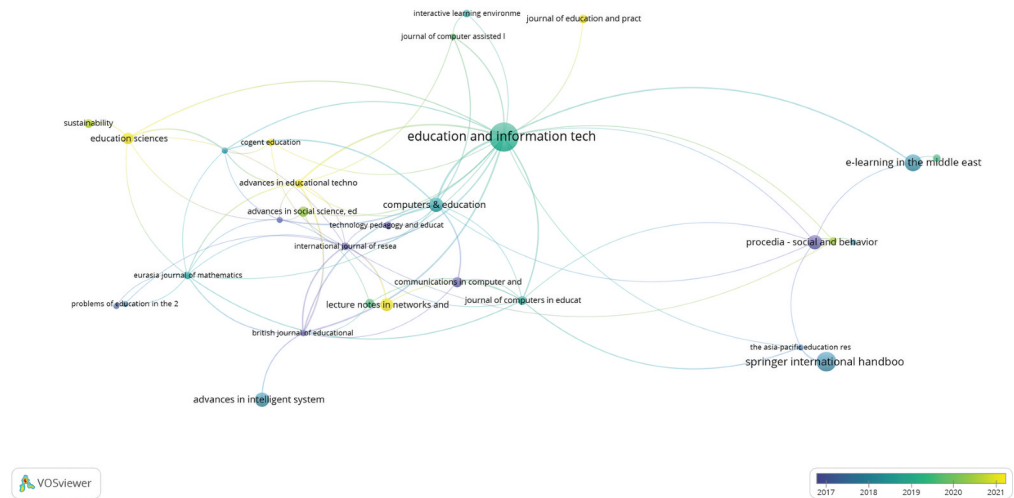
Out of the 1062 journals identified in the bibliographic data, 44 met the minimum threshold of five publications. These 44 were then selected by VOSviewer to create the journal co-occurrence network of citations for journals from which the publications were published (Figure 7). The visualization shows the relationships between journals based on their co-citation patterns in each dataset. Co-citation is a bibliometric measure that identifies the frequency with which two journals are cited together in the reference lists of other articles. When two journals are frequently co-cited, it suggests that they are related or share similar subject areas, themes, or topics. In this network visualization, where each node (circle) represents a journal, and each link (line) represents a co-citation relationship between two journals. The size of the nodes is proportional to the number of citations received by each journal in the dataset. The co-occurrence network of citations per journal could assist researchers to understand the landscape of academic journals in the specific research domain of ICT integration in education. It allows for the identification of journals that have significant influence and impact within the field, as well as the relationships and connections between them.

It is observed from the network (Figure 8) that the most influential journals (those with large nodes) are *Education and Information Technologies*, *e-Learning in the Middle East*, *Procedia-Social and Behavioral, Computer & Education*, *Springer International Handbook*, and *Advances in Intelligent Systems*. On the analysis of journal-article publication time zone, the journal of

Figure 7. African countries with at least five publications in the research field of “ICT integration in education”.



Figure 8. Journal co-occurrence network of citations per journal.



Education and Practice, Advances in Educational Technology, Education Sciences and Sustainability appear to have published the most current articles (from 2020 to date).

In the data (Table 8), *Education and Information Technologies* by Springer with 44 articles and 907 citations was the most cited journal. It indicates that this journal has a strong presence in the field, publishing a significant number of articles, and attracts a substantial number of citations, showcasing its influence and impact on the research community. With 15 publications and 641 citations, *Computers and Education* by Elsevier holds the second position. While it has fewer publications than the top-ranked journal, its relatively high citation count suggests that the research it publishes is highly regarded and influential. Despite having only five publications, *Educational Technology Research and Development* by Springer received 394 citations, making it a high-impact publication. This indicates that the research published in this journal is of significant interest and relevance to the field. With 6 publications and 393 citations, the *International Journal of Research in Education and Science* by ERIC is also highly cited, despite having a relatively small number of articles. It demonstrates that the research published in this journal is well-received and has a considerable impact on the academic community.

Table 8. Top 10 journals with most citations on the “ICT integration in education” research

Rank	Journal	Publications	Citations
1	Education and Information Technologies	44	907
2	Computers & Education	15	641
3	Educational Technology Research and Development	5	394
4	International Journal of Research in Education and Science	6	393
5	British Journal of Educational Technologies	5	275
6	Procedia-Social and Behavioral Sciences	16	248
7	Educational Media International	5	213
8	Sustainability	8	144
9	EURASIA Journal of Mathematics Science and Technology Education	6	139
10	Technology, Pedagogy and Education	6	93

Highlighting the top journals in this bibliometric analysis in terms of their publications and citations on “ICT integration in education” research reveals that some journals publish more articles than others, but citation counts are not solely dependent on the number of publications (Wilkins & Huisman, 2014). High citation counts indicate that the research published in these journals is influential and impactful, contributing significantly to the field of “ICT integration in education” (Hallinger & Kovačević, 2019) Researchers and policymakers in this domain may find these top journals valuable sources of up-to-date and well-regarded research.

Educators and curriculum developers could use these findings on trends to ensure that curriculum and teaching methods align with current research trends, ensuring that students are exposed to relevant and up-to-date educational technologies and strategies. The findings on the identification of areas with limited research or underrepresented topics to highlight potential research gaps could guide researchers and funding agencies in prioritizing areas where more research is needed, ensuring a more comprehensive understanding of ICT integration in education. The findings on influential authors, journals, and institutions have implications on the decisions by educators and researchers in identification of trusted sources of information for their practice. Researchers might also find the results on collaboration networks among researchers, institutions, and countries valuable in identifying opportunities for international collaboration and knowledge exchange.

5. Conclusion, limitations and future research

In this study, a bibliometric approach was used to examine the studies related to ICT integration in education. A total of 1,790 relevant documents from the Dimensions database published between 2014–2023, were analyzed. Keyword co-occurrence on publication titles and abstracts were analyzed to identify research thematic evolution in the research field. Author, organizational and country contribution, and prominence based on number of documents and citation metrics were examined to identify key players in the research field of ICT integration in education. Our study successfully expanded and updated the existing bibliometric literature by analyzing more studies and uncovering the major thematic focus of the research field using VOSviewer science maps. Through this bibliometric analysis, this research offered valuable quantitative complement to previous bibliometric analysis enhancing understanding in this rapidly advancing and changing field of ICT integration.

The researchers conclude that the research contributions on ICT integration in education for the period largely assume an upward curve from 2015 to 2022. The findings also suggest that ICT integration in education research is relatively not new with newer terminologies in the research area found to be covid, pandemic, self-efficacy and behaviour. The study also concludes that the most influential authors in ICT integration in education include Tondeur, J., Ertmer, P. A., Ghavifekr, S. and Rosdy, W.A.W.

One possible limitation of this research is that some authors might have included arbitrary keywords in the abstracts and titles of their papers, which do not accurately represent the actual content of the research. This situation could have impacted the accuracy of the keyword co-occurrence network map and the thematic evolution timeline map. The study also solely relied on the Dimensions database, potentially leading to the exclusion of relevant publications not indexed in the chosen database, though Dimensions as a highly indexed academic and scholarly literature (Singh et al., 2021). Ability to combine databases for analysis was not feasible due to the restrictions in VOSviewer, which only permits the use of bibliographic data from one database at a time. Future studies could attempt to perform bibliometric analyses on a combined dataset to overcome this limitation.

The findings of this research has practical and theoretical implications in the research and practice of ICT integration in education for educators, policy makers and researchers. The findings on research trends could inform the development of new ICT integration policy and programs, and educators could identify effective ICT integration and strategies and practices, as well as the findings enable policymakers to identify areas that most need ICT resources. Also, the findings of this bibliometric analysis could be used to develop a new policy that promotes the use of ICT for personalized learning in all schools and to develop a professional development program for teachers on how to use ICT in education.

The findings of this research have significant implications for research contributions and future research for the field of ICT integration in education. They illustrate the thematic development within this field offering new researchers a quick bird's-eye view of essential publications and the evolution of research themes up to 2022. It is critical to note that as research is an ongoing process, co-citation network map, keyword network map and author citations are not fixed but subject to change overtime. Therefore, future studies are necessary to monitor the shifts in the author citations, article citations, keyword themes and institutional contributions. Considering the role technology played in education during the COVID-19 pandemic, future studies could analyze the bibliometric data on publications that explored the subject to gain insights into the role of ICT integration in education during the pandemic.

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References

Adarkwah, M. A. (2021). "I'm not against online teaching, but what about us?": ICT in Ghana post covid-19. *Education and Information Technologies*, 26(2), 1665–1685. <https://doi.org/10.1007/s10639-020-10331-z>

Albion, P. R., Tondeur, J., Forkosh-Baruch, A., & Peeraer, J. (2015). Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice. *Education and Information Technologies*, 20(4), 655–673. <https://doi.org/10.1007/s10639-015-9401-9>

Albugami, S., & Ahmed, V. (2015). Success factors for ICT implementation in Saudi secondary schools: From the perspective of ICT directors, head teachers, teachers and students. *International Journal of Education and Development Using ICT*, 11(1).

Alemu, B. M. (2015). Integrating ICT into teaching-learning practices: Promise, challenges and future directions of higher educational institutes. *Universal Journal of Educational Research*, 3(3), 170–189.

Al-Mamary, Y. (2020). Examining the factors affecting the use of ICT in teaching in Yemeni schools. *Journal of Public Affairs*, 22(1). <https://doi.org/10.1002/pa.2330>

Aslan, A., & Zhu, C. (2015). Pre-service teachers' perceptions of ICT Integration in Teacher Education in Turkey. *Turkish Online Journal of Educational Technology-TOJET*, 14(3), 97–110.

Aslan, A., & Zhu, C. (2016). Influencing Factors and Integration of ICT into Teaching Practices of Pre-Service and Starting Teachers. *International Journal of Research in Education and Science*, 2(2), 359–370.

Aslan, A., & Zhu, C. (2017). Investigating variables predicting Turkish pre-service teachers' integration of ICT into teaching practices. *British Journal of Educational Technology*, 48(2), 552–570.

Brun, M., & Hinostroza, J. E. (2014). Learning to become a teacher in the 21st century: ICT integration in initial

- Teacher education in Chile. *Journal of Educational Technology & Society*, 17(3), 222–238.
- Curran, V., Reid, A., Reis, P., Doucet, S., Price, S., Alcock, L., & , and Fitzgerald, S. (2015). The use of information and communications technologies in the delivery of interprofessional education: A review of evaluation outcome levels. *Journal of Interprofessional Care*, 29(6), 541–550. <https://doi.org/10.3109/13561820.2015.1021002>
- Ding, Y., Yan, E., Frazho, A. E., & Caverlee, J. (2009). Pagerank for ranking authors in co-citation networks. *Journal of the American Society for Information Science and Technology*, 60(11), 2229–2243. <https://doi.org/10.1002/asi.21171>
- Fink, A. (2019). *Conducting research literature reviews: From the internet to paper* (4th ed.). Sage publications.
- García-Sánchez, P., Mora, A. M., Castillo, P. A., & Pérez, I. J. (2019). A bibliometric study of the research area of videogames using Dimensions.Ai database. *Procedia Computer Science*, 162, 737–744. <https://doi.org/10.1016/j.procs.2019.12.045>
- Ghavifekr, S., Kunjappan, T., Ramasamy, L., Anthony, A., & My, E. (2016). Teaching and learning with ICT tools: Issues and challenges from teachers' Perceptions. *Malaysia Online Journal of Educational Technology*, 4(2). www.mojet.net
- Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science*, 1(2), 175–191. <https://doi.org/10.21890/ijres.23596>
- Goldhaber, A. B. (2021). Impact of ICT integration on quality of education among secondary schools in USA. *Journal of Education*, 4(6), 53–61. <https://doi.org/10.53819/81018102t5015>
- Guerrero-Bote, V. P., Chinchilla-Rodríguez, Z., Mendoza, A., & de Moya-Anegón, F. (2021). Comparative analysis of the bibliographic data sources Dimensions and Scopus: An approach at the country and institutional levels. *Frontiers in Research Metrics and Analytics*, 5, 5. <https://doi.org/10.3389/frma.2020.593494>
- Hallinger, P., & Kovačević, J. (2019). A bibliometric review of research on educational administration: Science mapping the literature, 1960 to 2018. *Review of Educational Research*, 89(3), 335–369. <https://doi.org/10.3102/0034654319830380>
- Hook, D. W., Porter, S. J., Draux, H., & Herzog, C. T. (2021). Real-time bibliometrics: Dimensions as a resource for analyzing aspects of COVID-19. *Frontiers in Research Metrics and Analytics*, 5, 5. <https://doi.org/10.3389/frma.2020.595299>
- Hook, D. W., Porter, S. J., & Herzog, C. (2018). Dimensions: Building context for search and evaluation. *Frontiers in Research Metrics and Analytics*, 3, 3. <https://doi.org/10.3389/frma.2018.00023>
- Ivanović, L., & Ho, Y. S. (2019). Highly cited articles in the education and Educational research category in the Social Science citation index: A bibliometric analysis. *Educational Review*, 71(3), 277–286. <https://doi.org/10.1080/00131911.2017.1415297>
- Kihoza, P., Zlotnikova, I., Bada, J., & Kalegele, K. (2016). Classroom ICT integration in Tanzania: Opportunities and challenges from the perspectives of TPACK and SAMR models. *International Journal of Education and Development Using ICT*, 12(1).
- Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, 55(1), 79–105. <https://doi.org/10.1080/09523987.2018.1439712>
- Linnenluecke, M. K., Marrone, M., & Singh, A. K. (2020). Conducting systematic literature reviews and bibliometric analyses. *Australian Journal of Management*, 45(2), 175–194. <https://doi.org/10.1177/0312896219877678>
- Lubega, J. T., & Paul, M. (2014). *Adoption of the SAMR model to assess ICT pedagogical adoption: A case of*. Makerere University.
- Mejia, C., Wu, M., Zhang, Y., & Kajikawa, Y. (2021). Exploring topics in bibliometric research Through citation networks and semantic analysis. *Frontiers in Research Metrics and Analytics*, 6, 6. <https://doi.org/10.3389/frma.2021.742311>
- Mirzajani, H., Mahmud, R., Fauzi Mohd Ayub, A., & Wong, S. L. (2016). Teachers' acceptance of ICT and its integration in the classroom. *Quality Assurance in Education*, 24(1), 26–40. <https://doi.org/10.1108/QAE-06-2014-0025>
- Mlambo, S., Rambe, P., & Schlebusch, C. L. (2020). Effects of Gauteng province's educators' ICT self-efficacy on their pedagogical use of icts in classrooms. *Heliyon*, 6(4), e03730. <https://doi.org/10.1016/j.heliyon.2020.e03730>
- Mouratidis, R. W. (2019). Dimensions. *Journal of the Medical Library Association*, 107(3). <https://doi.org/10.5195/jmla.2019.695>
- Mulhim, E. A. (2014). The barriers to the use of ICT in teaching in Saudi Arabia: A review of literature. *Universal Journal of Educational Research*, 2(6), 487–493. <https://doi.org/10.13189/ujer.2014.020606>
- Muritala, B. A., Sánchez-Rebull, M. V., & Hernández-Lara, A. B. (2020). A bibliometric analysis of online reviews research in tourism and hospitality. *Sustainability (Switzerland)*, 12(23), 1–18. <https://doi.org/10.3390/su12239977>
- Nwozichi, C. U., Marcial, D. E., Farotimi, A. A., Escabarte, A. B. S., & Madu, A. M. (2019). Integration of information and communication technology in nursing education in Southeast Asia: A systematic literature review. *Journal of Education and Health Promotion*, 8.
- Phillips, T., & Ozogul, G. (2020). Learning Analytics research in relation to Educational Technology: Capturing learning analytics contributions with bibliometric analysis. *TECHTRENDS TECH TRENDS*, 64(6), 878–886. <https://doi.org/10.1007/s11528-020-00519-y>
- Radhakrishnan, S., Erbis, S., Isaacs, J., Kamarthi, S., & Braunstein, L. A. (2017). Novel keyword co-occurrence network-based methods to foster systematic reviews of scientific literature. *PLoS One*, 12(3), e0172778. <https://doi.org/10.1371/journal.pone.0172778>
- Roblek, V., Dimovski, V., Meško, M., & Peterlin, J. (2022). Evolution of organisational agility: A bibliometric study. *Kybernetes*, 51(13), 119–137. <https://doi.org/10.1108/k-11-2021-1137>
- Sabiri, K. A. (2020). ICT in EFL teaching and learning: A systematic literature review. *Contemporary Educational Technology*, 11(2), 177–195.
- SadatMosavi, A., Tajedini, O., Esmaili, O., Zadeh, F., & Khazaneha, M. (2020). Emerging trends and thematic evolution of breast cancer: Knowledge mapping and co-word analysis (preprint). *JMIR Cancer*, 7(4). <https://doi.org/10.2196/preprints.26691>
- Sergi, R., Bellucci, D., & Cannillo, V. (2020). A comprehensive review of bioactive glass coatings: State of the art, challenges and future perspectives. *Coatings*, 10(8), 757.
- Singh, V. K., Singh, P., Karmakar, M., Leta, J., & Mayr, P. (2021). The journal coverage of web of Science, Scopus and Dimensions: A comparative analysis.

- Scientometrics*, 126(6), 5113–5142. <https://doi.org/10.1007/s11192-021-03948-5>
- Suleimen, N. (2019). Appraising the attitude towards information communication technology integration and usage in Kazakhstani higher education curriculum. *Journal of Information Technology Education Research*, 18, 355–378. <https://doi.org/10.28945/4403>
- Tondeur, J., Roblin, N. P., van Braak, J., Voogt, J., & Prestridge, S. (2016). Preparing beginning teachers for technology integration in education: Ready for take-off? *Technology, Pedagogy & Education*, 26(2), 157–177. <https://doi.org/10.1080/1475939X.2016.1193556>
- Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology*, 50(3), 1189–1209. <https://doi.org/10.1111/bjet.12748>
- Tondeur, J., Van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Educational Technology Research & Development*, 65(3), 555–575. <https://doi.org/10.1007/s11423-016-9481-2>
- Vanderlinde, R., Aesaert, K., & Van Braak, J. (2014). Institutionalised ICT use in primary education: A multilevel analysis. *Computers & Education*, 72, 1–10.
- Voogt, J., Erstad, O., De de, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning*, 29(5), 403–413. <https://doi.org/10.1111/jcal.12029>
- Vrasidas, C. (2015). The rhetoric of reform and teachers' use of ICT. *British Journal of Educational Technology*, 46(2), 370–380.
- Wilkins, S., & Huisman, J. (2014). Stakeholder perspectives on citation and peer-based rankings of higher education journals. *Tertiary Education and Management*, 21(1), 1–15. <https://doi.org/10.1080/13583883.2014.987313>