Mapping of Digital Competence in Education through the Lens of Bibliometric Analysis by using VOS viewer

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Abstract

This study explores the evolving concept of "digital competence" within the education sector. It is the first bibliometric analysis focused on digital competence in education, utilizing the open-access Lens.org database to examine the growth of knowledge, thematic changes, and to derive overarching insights. A search combining the keywords "DigComp," "DigCompEdu," "digital competence," and "education" yielded 8,230 scholarly documents, including articles, book chapters, and reports. The analysis reveals a significant increase in published documents from 2006 to 2025. Additionally, metadata was assessed using the VOSviewer software tool to extract relevant publication metrics and visualize the existing research network.

Keywords: Digital Competence, Education, Bibliometric analysis, Lens.org, Dig Comp, Dig Comp Edu.

1.   Introduction

The nationwide lockdown in India led to an urgent shift toward virtual teaching, utilizing platforms such as Zoom and Google Classroom. This drastic change posed challenges for educators who were unfamiliar with e-learning tools, highlighting the pressing need to enhance digital competence within educational frameworks. This concept goes beyond basic digital literacy, encompassing a deeper understanding and strategic use of technology in pedagogical settings. The European Commission's Dig Comp and Dig Comp Edu frameworks have established "digital competence" as a key component of educational reform. Digital competence is a complex and multifaceted concept, essential for individuals who wish to participate in society actively (European Commission, 2018; Ala-Mukta, 2011). Various authors and organizations have built upon the European Commission's foundational document, expanding the definition of digital competence from fundamental tools and applications to include advanced skills, attitudes, and knowledge. Calvani et al. (2010) describe '**digital competence**' as the ability to use information society technologies in a confident, thoughtful, and responsible manner to support activities related to work, recreation, and communication. Ala-Mukta (2011) echoes this definition, referencing the 2006 European recommendations on key competences as indicative of the evolving nature of the digital competence concept, which is essential for full involvement in 'society and the economy'. Furthermore, Ferrari and Redecker (2013) describe digital competence as the "confident, critical and creative use of Information Communication Technology" in their report on DIGCOMP, to achieve goals associated with employment, employability, study, relaxation, inclusion and/ societal involvement. As such, digital competence encompasses a range of skills, including digital, cognitive, and technical abilities. It also involves social, emotional, and ethical awareness. Mastering digital technologies fosters effective communication, problem-solving, critical and creative thinking in various aspects of life (Srivastava and Dangwal, 2021). The European Commission's DigComp 2.0 defines it as the "confident, critical and responsible use of digital technologies for learning, work and participation in society" (Vuorikari et al., 2022, p. 6). Bibliometric analysis has emerged as a popular approach for exploring and analyzing a vast body of published literature. Over recent years, its use has grown significantly among scholars who seek to uncover research trends, journal performance, impact of research papers, and overall intellectual performance of authors, institutions, and countries within a specific field of research (Donthu et al., 2021; Liu, Ali, and Lee, 2025). In this study, Lens.org, an open scholarly database indexing over 225 million records from sources such as Crossref, PubMed, and patent datasets, was utilized to investigate the scholarly landscape regarding the structure and evolution of digital competence in education.

2. Literature Review

Very limited studies have been conducted on the concept of digital competence; however, it is crucial to explore the published literature on this topic in the digital era, particularly in the field of education. Nurazmi et al. (2025) examined the digital competence of high school physics teachers in Malaysia. Their findings revealed that while 65% of educators felt confident in using basic digital tools. However, only 45% demonstrated proficiency in advanced skills. Challenges such as limited access to technology and inadequate professional development were noted. Similarly, Liu, Chen, and Zhao (2025) explored the perceptions of teachers in China, revealing that approximately 65% of those situated in well-equipped digital environments reported a high level of digital competence. Yadav (2024) investigated those strategies for improving teachers' digital competencies in India, discovering that collaborative learning and digital training significantly enhanced teacher confidence and likelihood of adopting pedagogical methods. In their study, Gupta and Awasthi (2024) highlighted gender disparities among Bachelor of Education trainees in Uttar Pradesh, India. Their research findings revealed that male trainees exhibited greater confidence in utilizing advanced digital skills, while female trainees demonstrated stronger capabilities in digital communication tools. This underscores the necessity for equitable access to digital competence development. Schroot, Cavaletto, and Ricucci (2024) found that although 65% of teachers were proficient in basic digital skills, only 35% effectively integrated technology into their pedagogy. Challenges, including cultural differences and uneven access to resources, were also significant concerns, emphasizing the necessity for targeted training interventions. Saha, Karmakar, and Chattopadhyay (2024) evaluated the digital competency levels among postgraduate students at Burdwan University in India, identifying gaps in advanced digital competencies. Their findings suggest the need for enhanced training in digital research and the use of collaborative tools. These studies underscored the importance of comprehensive support systems and equitable access to resources for strengthening digital competence within educational settings.

3. Objectives

The primary objectives of this study are as follows:

1) To analyze the annual growth trends of publications focusing on digital competence in education.
2) To identify the leading authors, countries, and journals contributing to this field.
3) To assess the citation metrics associated with these publications.
4) To explore the relationships among various research components, such as citation analysis, bibliographic coupling, co-word network visualization, and co-authorship analysis.

4. Research Methodology

This study employs 'A bibliometric analysis of research publications' focused on digital competence in education, utilizing data from the Lens database. The analysis generates bibliometric visualizations and various metrics related to publications. The bibliographic data enables the mapping of co-authorship, bibliographic coupling, keyword occurrences, and co-citations. A systematic review of the literature was conducted on November 1, 2025, focusing on publications from the past 20 years, specifically from 2006 to 2025. The Lens database, accessible at Lens.org, contains over 292,562,032 million scholarly works and is known for its user-friendly interface (Lens.org, 2025). The bibliographic data of the publications were extracted into a CSV file and analyzed using VOSviewer software, providing insights into research trends and network visualization.

5. Searching Database:

The bibliometric analysis initiated on November 1, 2025, aimed to evaluate numerous documents related to digital competence in education retrieved from lens.org. Initially, relevant keywords corresponding to the paper's title were identified, leading to the formulation of the final search string:

((digcomp OR digcompedu "digital competenc*" OR "digital literac*" OR "digital skill*" OR "digital readiness" OR "e-competenc*" OR "ICT competenc*" OR "digital capability") AND (educat* OR school*

OR teacher* OR "higher education" OR university OR "K-12" OR "primary school" OR "secondary school" OR "teacher education"))

This search generated a total of 8,230 scholarly works. To enhance the relevance of the findings, further inclusion was limited to the language English and publication year. Subsequently, the author selected scholarly research published from 2006, when the European Commission first introduced the concept of digital competence as one of the key competences to the year 2025, followed by a filter for publication types such as journal articles, book chapters, and reports, resulting in 6,378 relevant scholarly works. The metadata was meticulously extracted from the Lens database, and each publication was manually reviewed to eliminate non-relevant articles. In the final steps, the metadata was organized in MS Excel, where 154 duplicate entries were removed, resulting in a refined dataset of 6,224 documents for detailed analysis. The cleaned metadata was then processed using VOSviewer, a user-friendly bibliometric tool for mapping and visualising network structure (Van Eck & Waltman, 2014). This paper use the PRISMA flow chart for bibliometric analysis. The findings from the study were thoroughly discussed, ultimately leading to the drawing of conclusions.
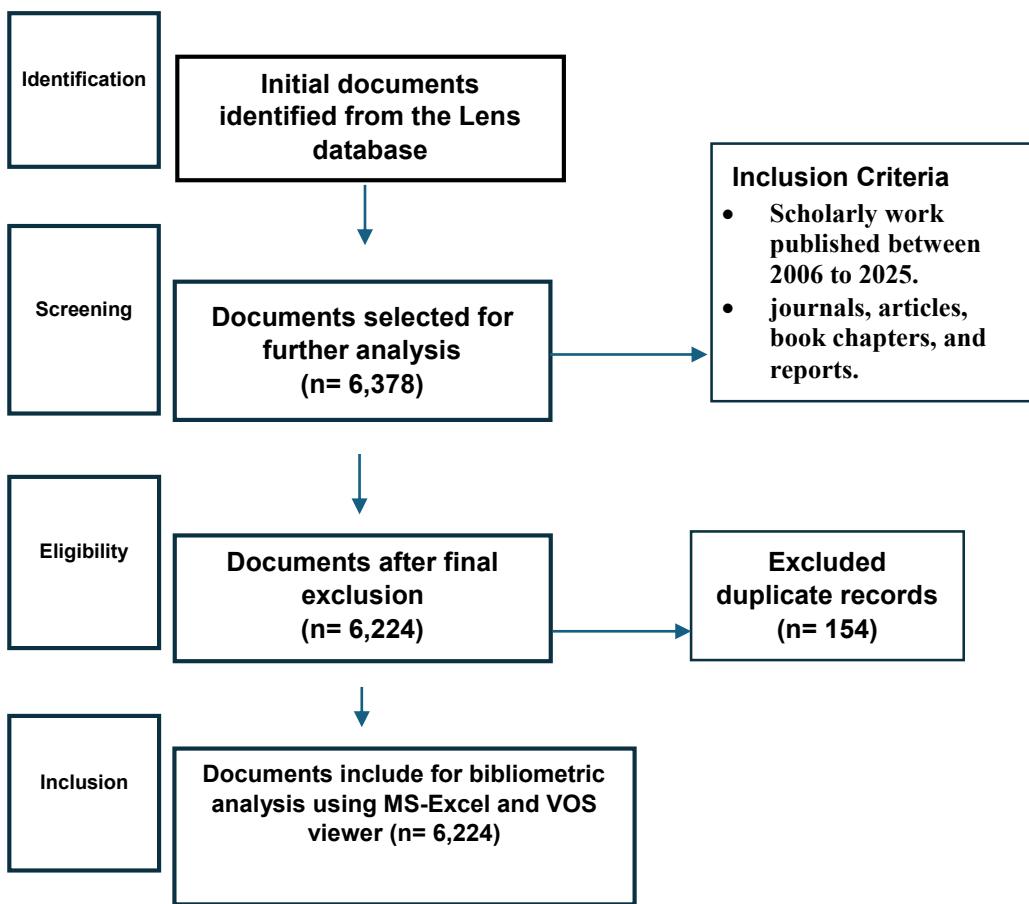
Fig.1. PRISMA Flow Diagram

6. RESULTS AND DISCUSSION

The results are presented according to the research questions. The first part of the analysis aims at shedding light on the worldwide status of scholarly publications on digital competence in education, the most influential Scholarly work based on citation impact, the geographical distribution of scholarly publications, authors who have made significant contributions, top journals/sources, the annual Relative Growth Rate (RGR), and the corresponding doubling time of scholarly research from 2006 to 2025. The second part utilizes VOSviewer to construct a network visualization that reflects the current state of research on digital competence in the field of education, including keyword co-occurrence network mapping, co-authorship network analysis, keyword co-occurrence analysis, citation analysis, and bibliographic coupling.

6.1. Worldwide status

Table 1 provides a summary of the key metrics related to scholarly publications on digital competence in education between 2006 and 2025.

Table 1: Overview of Scholarly Publications on Digital Competence in Education	
Metric	**Publications**
Total Scholarly Works	6,224
Total Citing Works Count	35,780
Average Citations per Paper	5.75

Source: Data from Lens.org

As shown in Table 1 above, the dataset includes a total of 6,224 scholarly publications, which collectively have garnered 35,780 citations. This results in an average of 5.75 citations per publication.

6.2 Citing Work Count

Table 2 highlights the most influential Scholarly work based on citation impact.

Table 2: Top 10 Scholarly Publications by Citing Work Count					
Rank	**Title**	**Author/s**	**Source Title**	**Year**	**Citing Work Count**
1	Online Learning and Emergency Remote Teaching: Opportunities and Challenges	Fernando Ferri et al.	Societies	2020	670
2	'Conceptualizing and Testing a Social Cognitive Model of the Digital Divide'	Kwok-Kee Wei et al.	Information Systems Research	2011	450
3	Aligning teacher competence frameworks to 21st century challenges…	Francesca Caena; Christine Redecker	European Journal of Education	2019	430
4	Annual Research Review: Harms experienced by child users…	Sonia Livingstone; Peter K. Smith	Journal of child psychology…	2014	420
5	Digital transformation challenges: strategies emerging…	Federico Brunetti et al.	The TQM Journal	2020	326

6	Healthcare professionals' competence in digitalisation…	Jenni Konttila et al.	Journal of Clinical Nursing	2018	322
7	The dark side of generative artificial intelligence…	Krzysztof Wach et al.	Entrepreneurial Business…	2023	318
8	Using the Internet: Skill-related problems…	Alexander J. A. M. van Deursen; Johannes A.G.M. van Dijk	Interacting with Computers	2009	313
9	Teachers' AI digital competencies and twenty-first-century skills…	Davy Tsz Kit Ng et al.	Educational technology research…	2023	290
10	Rethinking Internet skills: The contribution of gender…	Alexander J. A. M. van Deursen; Johannes van Dijk; Oscar Peters	Poetics	2011	280
Total Scholarly citations from the top 10 publications					**3819**

Source: Data from Lens.org

Table 2 presents the overall status of the top 10 publications in the field of digital competence, based on scholarly citation counts. Notably, the journal *"Societies"* has the highest citation count among these source top 10 publications. The paper titled *"Online Learning and Emergency Remote Teaching: Opportunities and Challenges,"* authored by *Fernando Ferri et al.,* published in 2020, stands out with the highest scholarly citation count of 670, reflecting the rapid growth of online learning during the COVID-19 pandemic. Collectively, these top 10 publications account for approximately 10.67% of the total citation count in scholarly literature on digital competence in education, i.e., 35,780 articles.

6.3 Country-Wise Distribution

Table 3 represents the geographical distribution of scholarly publications on digital competence in the education sector for the period from 2005 to 2025.

Table 3: Top 10 Countries/Regions by Scholarly Publications			
Rank	**Country/Region**	**Total Publications**	**Percentage (%)**
1	United Kingdom	453	7.28
2	United States	195	3.13
3	Switzerland	149	2.39
4	Germany	105	1.69

5	Netherlands	97	1.56
6	Spain	76	1.22
7	Canada	45	0.72
8	Portugal	16	0.26
9	Turkey	15	0.24
10	Australia	14	0.22
Total		**1165**	**18.72**

Source: Data from Lens.org

Table 3 shows that the United Kingdom is at the forefront, contributing 453 scholarly publications, which represent 7.28% of the total output in the field of digital education. It is noteworthy that the top 10 countries/regions collectively account for approximately 18.72% of the overall publications, totaling 6,224.

6.4 Author-wise Distribution

Table 4 presents the authors who have made significant contributions to the field of digital competence in education, highlighting their research publications.

Table 4: Top 10 Authors by Scholarly Publications			
Rank	**Author**	**Total Publications**	**Percentage (%)**
1	Antonio Palacios-Rodríguez	22	0.35
2	Julio Cabero-Almenara	21	0.34
3	Maria Perifanou	14	0.22
4	Null OECD	14	0.22
5	Ana García-Valcárcel Muñoz-Repiso	11	0.18
6	Margarida Lucas	10	0.16
7	Sara Dias-Trindade	10	0.16
8	Anastasios A. Economides	9	0.14
9	Juan Jesús Gutiérrez-Castillo	9	0.14
10	Rafael López	9	0.14
Total		**129**	**2.07**

Source: Data from Lens.org

According to the data presented in Table 4, the leading contributors to the field of digital competence in education are Spanish researchers *Antonio Palacios-Rodríguez and Julio Cabero-Almenara,* who have made significant contributions with 22 and 21 scholarly publications, respectively. Their work aligns with various initiatives by the European Commission, such as DigComp and DigCompEdu. It's noteworthy that the top 10 authors collectively account for approximately 2.07% of the scholarly publications in this area, i.e., 6,224 publications on digital competence in education.

6.5 Journals/Source-wise Distribution

Table 5 outlines the distribution of the top journals/sources based on the quantity of scholarly publications correlated to digital competence in education.

Table 5: Top 10 Journals/Sources by Scholarly Publications			
Rank	**Journal/Source Name**	**Total Publications**	**Percentage (%)**
1	Education Sciences	66	1.06
2	Sustainability	65	1.04
3	SSRN electronic Journal	59	0.95
4	International Journal of Research and Innovation in Social Science	36	0.58
5	Education and Information Technologies	34	0.55
6	Frontiers in Education	32	0.51
7	Advances in Educational Technologies and Instructional Design	31	0.50
8	Communications in computer and information science	26	0.42
9	Zenodo (CERN European Organization for Nuclear Research)	24	0.39
10	Computers & Education	23	0.37
Total		**396**	**6.36**

Source: Data from Lens.org

Table 5 indicates that *Education Sciences* and *Sustainability* are the two leading journals in this field, with 66 and 65 publications, respectively. They are followed by the SSRN Electronic Journal, which has published 59 articles. Notably, only 6.36% of the total scholarly publications, totalling 6,224, are covered by the top 10 journals/sources related to digital competence in education.

6.6 Scholarly Publications in Respect of Annual Relative Growth Rate (RGR) and Doubling Time (Dt)

Sr No	Year	Pub Count	Cumulative	LN (Cum)	LN (Prev)	Diff	RGR	Dt
			Table 6: Annual Relative Growth Rate and Doubling Time of Scholarly Publications					
1	2006	1	1	0	-	-	-	-
2	2007	4	5	1.61	0	1.61	1.61	0.43
3	2008	4	9	2.2	1.61	0.59	0.59	1.18
4	2009	9	18	2.89	2.2	0.69	0.69	1
5	2010	13	31	3.43	2.89	0.54	0.54	1.28
6	2011	13	44	3.78	3.43	0.35	0.35	1.98
7	2012	25	69	4.23	3.78	0.45	0.45	1.54
8	2013	22	91	4.51	4.23	0.28	0.28	2.5
9	2014	35	126	4.84	4.51	0.33	0.33	2.13
10	2015	58	184	5.21	4.84	0.38	0.38	1.83
11	2016	81	265	5.58	5.21	0.36	0.36	1.9
12	2017	80	345	5.84	5.58	0.26	0.26	2.63
13	2018	116	461	6.13	5.84	0.29	0.29	2.39
14	2019	225	686	6.53	6.13	0.4	0.4	1.74
15	2020	423	1,109	7.01	6.53	0.48	0.48	1.44
16	2021	600	1,709	7.44	7.01	0.43	0.43	1.6
17	2022	756	2,465	7.81	7.44	0.37	0.37	1.89
18	2023	917	3,382	8.13	7.81	0.32	0.32	2.19
19	2024	1,343	4,725	8.46	8.13	0.33	0.33	2.07
20	2025	1,499	6,224	8.74	8.46	0.28	0.28	2.52

Source: Data from Lens.org

Table 6 presents an overview of the annual Relative Growth Rate (RGR) and corresponding doubling time of scholarly research from 2006 to 2025. RGR reached its peak in 2007, with a value of 1.61, before stabilizing around 0.30 after 2020. The findings indicate that both the annual RGR and doubling time of scholarly work are variable, exhibiting fluctuations rather than a consistent growth trend. Notably, 2017 recorded the lowest

annual RGR at 0.26, alongside the highest doubling time of 2.63. In contrast, 2007 showcased the highest annual RGR of 1.61and the lowest doubling time of 0.43. On average, the RGR and doubling time values were 0.47 and 1.80, respectively, reflecting a strong annual growth trend.The study employs VOSviewer to constructs keywords co-occurrence network that reflects the current state of research on digital competence in the field of education.

7. Network Mapping

7.1 Co-Authorship Network

In the bibliometric analysis conducted using the VOSviewer software, network maps were generated based on bibliometric data extracted from Lens.org. This allowed for the bibliometric coupling of documents to identify the leading publications and understand the state of the art of the concept in the application of digital competence in education. The co-authorship analysis reveals the presence of four distinct collaboration clusters. Based on the Lens database and considering the centrality of authors within these networks, one author emerges as the most influential, serving as a key hub from which multiple collaborative relationships originate. These interactions are organized into four central nodes. This section, therefore, examines the structure and nature of collaborative patterns among authors in the selected body of literature.
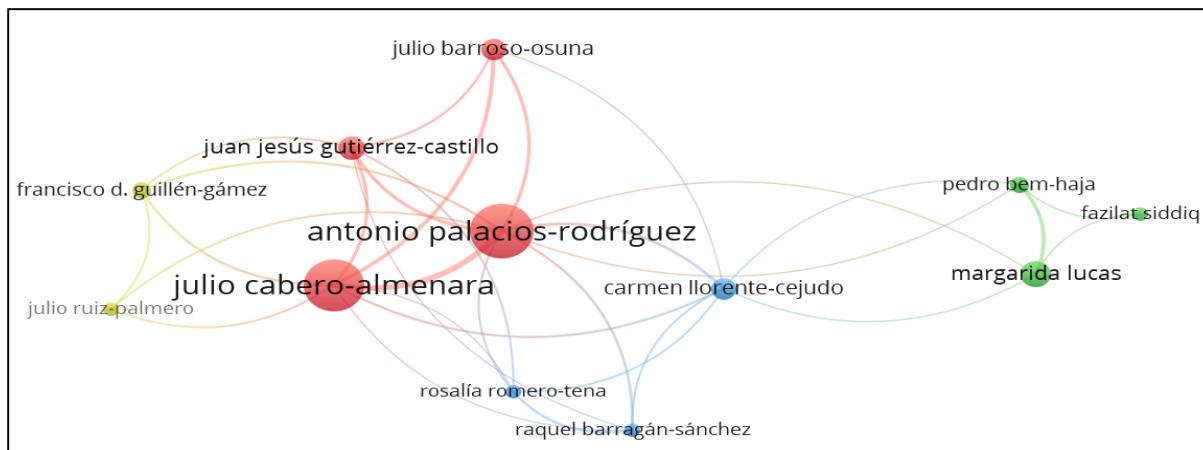
Figure 2: Network visualization of Author Co-authorship network

Figure 2 illustrates the network of co-authorship among researchers, where each node represents an author, while connections (edges) depict the collaborative ties formed through joint publications. The density of connections among nodes indicates the strength and extent of collaborative efforts among various authors, making it easy to identify key players in the research community. In the VOSviewer software, out of the total 16169 authors, 51 meet the thresholds. For network visualization, the relationship between a minimum 5 numbers of authors and a minimum 5 numbers of citations of an author, indicating that for each of the 51 authors, the total strength of the co-authorship links with other authors has been calculated. However, some of the 51 items in the network are not connected to each other. The largest set of connected items consists of 12 items with a minimum occurrence threshold, which were selected for analysis, and their co-authorship relationships are examined. In the network, five clusters are formed with four different colours, 31 co-authorship links, and a total strength of the co-authorship links with other authors is 94, as illustrated in Figure 2.

7.2 Keyword Co-occurrence Analysis

A keyword co-occurrence clustering view was generated to examine research trends in the field of e-Agriculture using the VOSviewer software. Keywords provide critical insight into the core themes and focus areas of the published studies. In the visualization, each node and its label represent a keyword, with node size indicating its relative significance based on frequency of occurrence. Different colours are used to distinguish thematic clusters, while the spatial distance between keywords reflects the strength of their interrelationships. The overall prominence of the field increases with the number of nodes represented in the network.
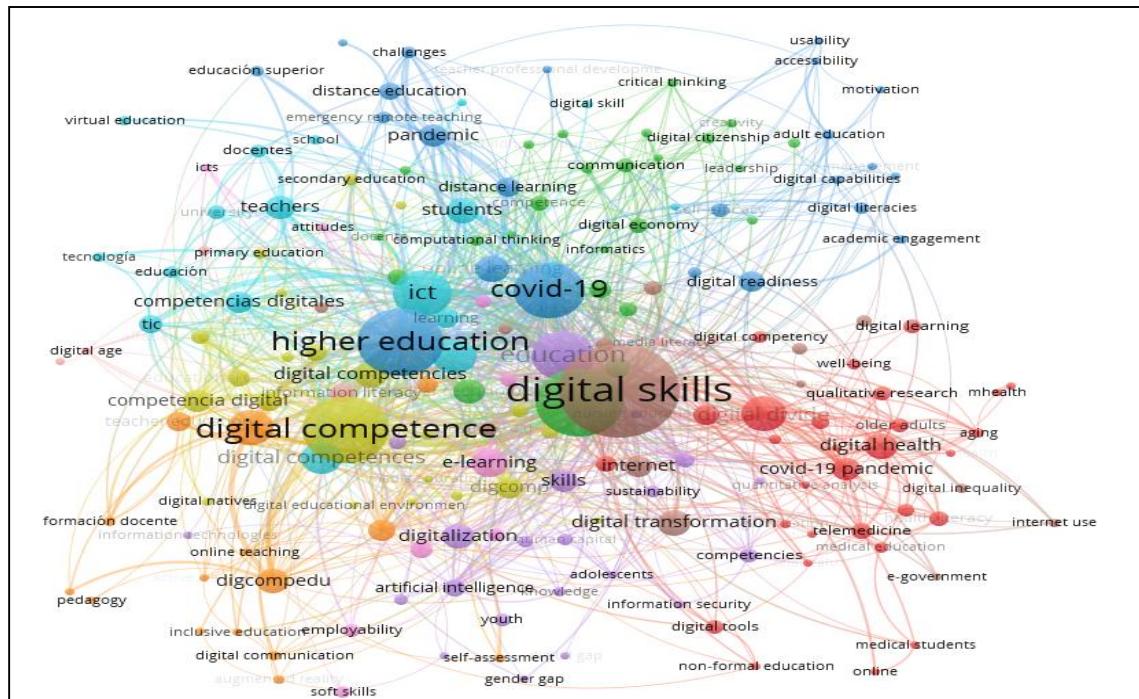
Figure 3: Keyword Co-occurrence Analysis

In the VOSviewer software for keyword co-occurrence analysis, out of the 4647 keywords, 183 identified keywords meet the threshold. The analysis was conducted with a minimum of 5 numbers of occurrences of the keyword, indicating that the total strength of co-occurrence links with other keywords has been calculated for each of the 183 keywords. However, some of the 51 items in the network are not connected to each other. In the network, there are 10 clusters are formed with different colours, 1886 connected links, and a total strength of the keyword links with other keywords is 3001, as illustrated in Figure 3.

7.3 Citation Analysis

This section analyzes the citation patterns across the literature, addressing citations to documents, sources, and individual authors. Citation analysis is a vital metric for assessing the impact and relevance of scholarly work.

1) **Citation with Document Analysis**

Figure 4: Network visualizations of Citation-Document

Figure 4 displays the frequency of citations across different documents. Out of the 6224 documents, 1193 meet the threshold. The visual highlight of which documents are foundational or more influential in the field. In the VOSviewer software, network visualizations of citations document relationships between a minimum of 5 documents and 5 citations of each document, indicating that the number of citation links to other documents has been calculated for each of the 193 documents. The document with the largest number of links will be selected. In the network, there are 1000 items and 1000 clusters each with a different colour but no connected links are found, as illustrated in Figure 4.

2) **Citation with Sources Analysis**
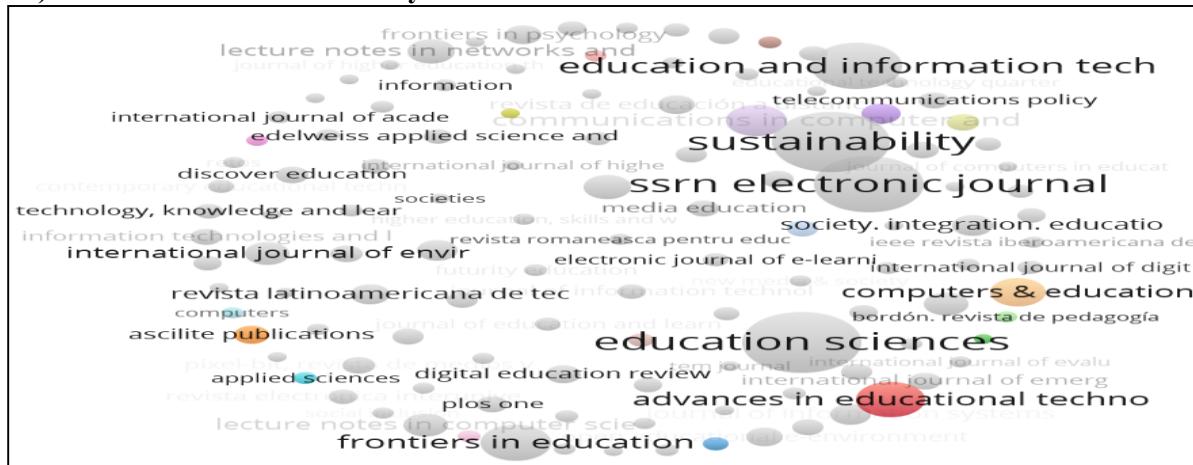
Figure 5: Citation with Sources Analysis

Figure 5 displays the frequency of citations across different sources, highlighting which sources are foundational or more influential in the field. Out of the 3514 sources, 119 meet the threshold. In the VOSviewer software, network visualizations show the relationship between a minimum of 5 documents of a source and 5 citations of a source, indicating that the total strength of the citation links with other sources has been calculated for each of the 119 sources. The sources with the largest number of links will be selected. In

Scopus

the network, there are 119 items and 119 clusters with different colours, but no connected links were found. Figure 5 provides insight into the citations of sources within the literature, revealing the pivotal sources that underpin a significant portion of the research.

3) Citation with Author Analysis

Figure 6: Citation with Author Analysis

In the VOSviewer software, network visualizations depict the relationships between a minimum of 5 documents by an author and 5 citations by an author, indicating that out of the 16169 authors, 51 authors meet the threshold. The above Figure 6 provides insights into the citations with authors within the literature on the topic of digital competence in the field of education. In the network there are 51 items and 51 clusters with different colours but no connected links found.

7.4 Bibliographic Coupling
1) Bibliographic Coupling with Document Analysis
Bibliographic Coupling is a method of assessing the relationship among scholarly works based on their shared references.


Figure 7: Bibliographic Coupling with Document Analysis

1797

Figure 7 shows a network diagram that shares citations. Each node represents a document, and edges connect documents that reference the same sources. This visual illustrates the interconnections between documents, facilitating the identification of clusters of related research. In the VOSviewer software, network visualizations with a minimum 5 citations of a document are depicted, showing that out of the 6224 documents, 1193 meet the threshold. Some of the 1000 items in the network are not connected to each other. The largest set of connected items consists of 859 items, 16 clusters with different colours, 22,230 connected links, and 32,487 total link strength found in the network visualization.
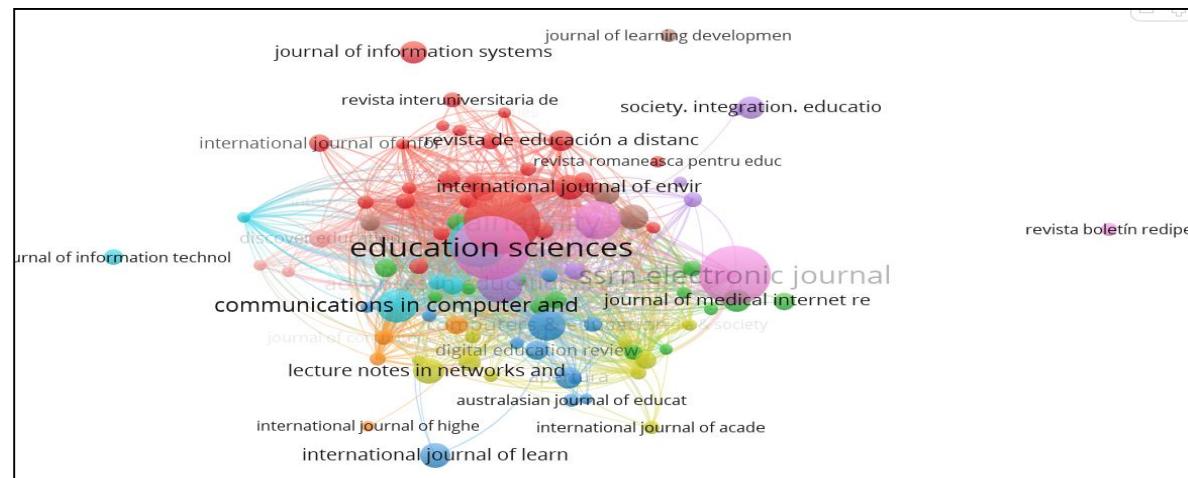
Figure 8: Bibliographic Coupling with Sources Analysis

Figure 8 illustrates a network diagram that shows how different sources are coupled based on their appearance in various documents, facilitating the identification of clusters of related research. This image provides insight into the literature landscape, indicating which sources are frequently cited together. In the VOSviewer software, network visualizations indicate the relationship between a minimum 5 documents of a source and a minimum 5 citations of a source, depicting that out of the 3512 sources, 119 meet the thresholds. For each of the 119 sources, the total strength of the bibliographic coupling links with other sources has been calculated. Some of the 119 items in the network are not connected to each other. The largest set of connected items consists of 91 items, 10 clusters with different colours, 2118 connected links, and 2118 total link strength, as shown in the network visualization.

3) Bibliographic Coupling with Authors Analysis

COMMON GROUND

*Figure 9: Author's Bibliographic Coupling Network*
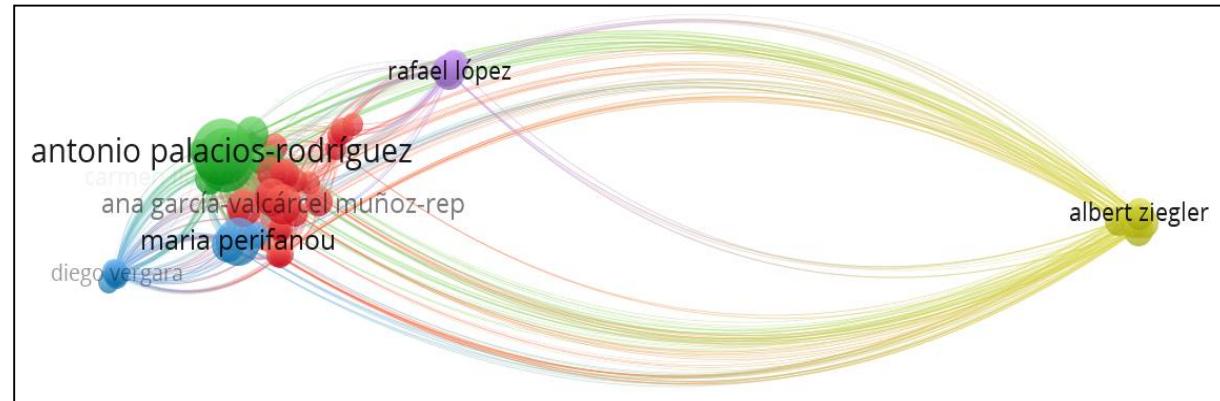
Figure 9 shows a network diagram that maps authors based on their shared citations to documents. Nodes; represent authors, and connections between them indicate shared bibliographic references. In the VOSviewer software, network visualizations, indicate the relationships between a minimum 5 documents by an author and a minimum 5 citations by an author, depicting that out of the 16169 authors, 51 meet the thresholds. For each of the 51 authors, the total strength of the bibliographic coupling links with other authors has been calculated. Some of the 51 items in the network are not connected to each other. The largest set of connected items consists of 48 items, 5 clusters with different colours, 700 connected links, and a total link strength of 21401 found in the network visualization.

8. Limitations of the Study

The study is a bibliometric analysis using the Lens database on the evolving topic of digital competence in education. However, it has many limitations that are helpful for future researchers. Firstly, it has examined scholarly publications limited to the English Language only. Secondly, the data were sourced from a freely available open-source Lens database. Thirdly, the scope of "document type" of this study is limited to journal article, book chapters and reports while book, conference proceedings, and dissertations are excluded. The study was limited to the range from 2006 to 2025. Another limitation might be attributed to the keyword strings applied in this bibliometric review. Lastly, map generation was conducted in VOSviewer software.

9. Summary & Conclusion:

This bibliometric analysis highlights the rapid evolution of digital competence in the education sector. The study encompasses a total of 6,224 scholarly works, including research papers, book chapters, and reports related to the topic. Notably, the number of published scholarly works has increased significantly from 1 publication in 2006 to an impressive 1,499 in 2025. Key findings from the analysis indicate that the United Kingdom is the most active country among the top ten geographical regions. Antonio Palacios-Rodríguez and Julio Cabero-Almenara emerged as the most highly cited authors. In terms of publication venues, Education Sciences and Sustainability were identified as the leading journals, closely followed by the SSRN Electronic Journal. The paper, titled "Online Learning and Emergency Remote Teaching: Opportunities and Challenges, "authored by Fernando Ferri et al. and published in 2020, acknowledged the highest scholarly citations. When examining annual Relative Growth Rates (RGR) and doubling times, 2017 exhibited the lowest annual RGR value (0.26) and the highest doubling time value (2.63). Conversely, 2007 showed the highest annual RGR value (1.61) and the lowest doubling time value (0.43). Overall, this bibliometric study serves as a valuable resource for policymakers, researchers, and educational institutions, offering insights into the existing body of scholarly publications on digital competence in education and guiding future research endeavours in this domain.

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