



Teacher Training in ICT and LKT in Education: A Bibliometric Analysis

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ABSTRACT: This bibliometric analysis examines the scientific production on teacher training in Information and Communication Technologies (ICT) and Learning and Knowledge Technologies (LKT) in education between 2003 and 2024. Using the PRISMA 2020 framework, the study analyzed 23 documents selected from ten national and international databases. Results show a strong research presence in Latin America, particularly Colombia (50%) and Spain (25%), with most publications appearing between 2022 and 2023. Master's theses (39.1%) and journal articles (30.4%) dominated the output, with higher education being the most studied level (39.13%). Methodologically, mixed methods were most common (40%), reflecting an integrative approach to digital teacher training.

The analysis reveals a dominant focus on ICT (61.90%), with fewer studies addressing LKT independently (14.29%). Key themes include digital skills, learning platforms, and teacher competencies. However, a notable portion of studies lacked institutional affiliation (30.30%), suggesting a fragmented academic landscape. Keyword trends confirmed ICT, learning technologies, and digital competencies as central topics.

Findings indicate that while interest in teacher training in ICT and LKT is growing, the field remains underdeveloped, particularly in terms of international collaboration, K–12 education focus, and peer-reviewed dissemination. The study calls for expanded research in diverse regions, stronger institutional partnerships, and more pedagogically grounded explorations of LKT. These insights are intended to inform educational policy and curriculum development in teacher education programs worldwide.

Keywords: Teacher training, Information and Communication Technologies (ICT), Learning and Knowledge Technologies (LKT), Education

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1. Introduction

In recent decades, the rapid evolution of Information and Communication Technologies (ICT) and Learning and Knowledge Technologies (LKT) has profoundly transformed educational environments, demanding that teachers acquire not only digital skills but also pedagogical strategies for effectively integrating these tools into their teaching practices. The inclusion of ICT and LKT in teacher training programs has become a global educational priority, as it directly influences teaching quality and student learning outcomes (Mar & Martí, 2006; De Luca, 2022).

ICT refers broadly to digital technologies that support the processing and communication of information, while LKT focuses specifically on the use of technologies to facilitate learning and construct knowledge. The distinction between these concepts highlights the pedagogical dimension of technology use in education, beyond mere technical competence (Henríquez Coronel, 2002; Díaz-Guecha & Márquez-Delgado, 2020). Consequently, teacher education programs are increasingly called to incorporate both ICT and LKT perspectives to foster holistic digital competence among educators (Santana Sanabria, 2023; Nobles Pérez et al., 2023).

Despite the growing emphasis on this area, the scientific production concerning teacher training in ICT and LKT remains scattered across various regions, languages, and institutional contexts. Previous studies have explored diverse aspects such as digital literacy (Castaño Obando & Sandoval Pérez, 2020), TPACK model implementation (Díaz M. et al., 2022), and ICT-mediated pedagogical innovation (Ojeda-Chimborazo et al., 2020). However, a comprehensive overview of the academic landscape is still lacking. A bibliometric analysis offers a strategic approach to synthesize this body of literature, identify publication patterns, and highlight emerging research trends (Aria & Cuccurullo, 2017).

This study aims to analyze the scientific production on teacher training in ICT and LKT within educational contexts, focusing on publications indexed between 2003 and 2024. By examining metadata such as publication type, authorship, institutional affiliation, thematic trends, and geographic distribution, the research seeks to uncover dominant lines of inquiry, underexplored areas, and the evolution of scholarly interest over time. The methodological framework follows the PRISMA 2020 guidelines (Page et al., 2021), adapted for bibliometric analysis, to ensure transparency and reproducibility in the identification and selection of relevant documents across national and international databases.

Through this study, the researchers aim to contribute to the understanding of how teacher training in educational technologies has been conceptualized, developed, and documented in scholarly discourse, particularly in the Latin American and European contexts. The findings are intended to inform future research, educational policy, and curriculum design for teacher education programs seeking to address the demands of 21st-century digital learning environments.

2. Methodology

This study utilized a bibliometric analysis to investigate the scientific literature concerning Teacher Training in Information and Communication Technology (ICT) and Learning and Knowledge Technologies (LKT) within educational settings. The methodological framework was designed following the PRISMA 2020 statement (Page et al., 2021), which offer contemporary standards for conducting transparent and reproducible systematic reviews. While bibliometric analyses differ methodologically from conventional systematic reviews, the PRISMA protocol was adapted to enhance the rigor and transparency of the processes involved in the identification, screening, and selection of relevant publications.

The first table provides an overview of the database search process conducted in the project. It outlines the start and end dates of each search, the time period analyzed, and the specific databases consulted.

Table 1. Dates and databases searched

Start date of database search	September 10 th , 2024.	October 23 rd , 2024.
End date of database search	October 22 nd , 2024	November 28 th , 2024.
Analyzed time period	2003-01-01 - 2024-08-31	2003-01-01 - 2024-08-31
Consulted database	Google Scholar, Dialnet, Redalyc, Scopus, Web of Science.	Teseo, Red De Bibliotecas Virtuales Latam Y Caribe, Colombian Universities Repository, ProQuest Dissertations Express

Note: Own elaboration.

The following table presents the key words used from three thesauri, European of Education, UNESCO, and the European Union in Spanish and English. It highlights terms related to education and technology, such as Educación, TIC, TAC, and their English equivalents like ICT, LKT, and Education, demonstrating the multilingual approach in the research keyword selection process.

Table 2. Selected key words

Thesaurus	Key word - Spanish	Key word - English
<i>European of Education</i>	Educación	Education
		Information and communication technologies
		ICT
<i>UNESCO</i>	Educación	Education
	TIC	
	TAC	
<i>European Union</i>	Tecnologías para el aprendizaje y el conocimiento	Learning and knowledge technologies
	Tecnologías de información y comunicación	Information and communication technologies
	TAC	LKT
	TIC	ICT
	Educación	Education

Note: Own elaboration.

The search was conducted across ten national and international databases using four structured Boolean search equations. These equations combined keywords in English and Spanish related to learning and knowledge technologies (LKT/TAC), information and communication technologies (ICT/TIC), education, and teacher training. Boolean operators (AND, OR) and parentheses were used to structure the queries. A total of four different search equations were used and, using the inclusion criteria, 23 articles were finally selected for inclusion in the review.

Table 3. Records retrieved based on the search equations and inclusion criteria

Search Equations/Database	Dialnet	Redalyc	Scholar	Scopus	Web Of Science	Teseo	Colombian Universities Repository	Red De Bibliotecas Virtuales Latam Y Caribe	Proquest Dissertations Express	Total
("Learning and knowledge technologies" OR "LKT") AND ("Information and communication technologies" OR "ICT") AND ("education" AND "teacher training")	3	2	63	4	0	0	0	0	0	72
("Learning and knowledge technologies" OR "LKT") OR ("Information and communication technologies" OR "ICT") OR "education"	54	2	123	14	2	7	0	0	0	202

OR "teacher training"										
("Tecnologías para el aprendizaje y el conocimiento" OR "TAC") AND ("tecnologías de información y comunicación" OR "TIC") AND ("educación" AND "formación docente")	34	5	71	0	0	0	1	0	0	111
("Tecnologías para el aprendizaje y el conocimiento" OR "TAC") OR ("tecnologías de información y comunicación" OR "TIC") OR "educación" OR "formación docente"	34	2	5	0	0	0	19	0	0	60
Total records retrieved by limiting the search using the search equations and inclusion criteria	125	11	262	18	2	7	20	0	0	445
Total number of articles selected after removing duplicates and analyzing titles and abstracts.	7	2	7	0	0	0	7	0	0	23

Note: Own elaboration.

Table 4 outlines the categories, indicators, and inclusion criteria used for article analysis. The review focused on general information about the documents (such as database source, publication language, year, and type of document), author-related data (including institutional affiliation and country), and thematic trends. The inclusion criteria specified documents published in English or Spanish between 2003 and 2024, and included undergraduate theses, master's theses, doctoral theses, and journal articles. The analysis incorporated sources from national and international databases.

Table 4. Selected categories and indicators

Category	Studied indicators	Inclusion criteria for the article analysis
1.General information of the document	1. Databases where the articles were found	Dialnet, Redalyc, Google Scholar, Scopus, Web Of Science, Teseo, Colombian Universities Repository, Red De Bibliotecas Virtuales Latam Y Caribe, ProQuest Dissertations Express.
	2. Publication language	English and Spanish
	3. Publication year	2003 - 2024
	4. Type of documents	Undergraduate theses, doctoral theses, articles and Master's theses.
2. Author	5. Number of authors	All documents were included in the analysis
	6. Authors genre	
	7. Type of institution of the authors' affiliation.	
	8. Full name of the affiliated institution	
	9. Country of the affiliated institution	

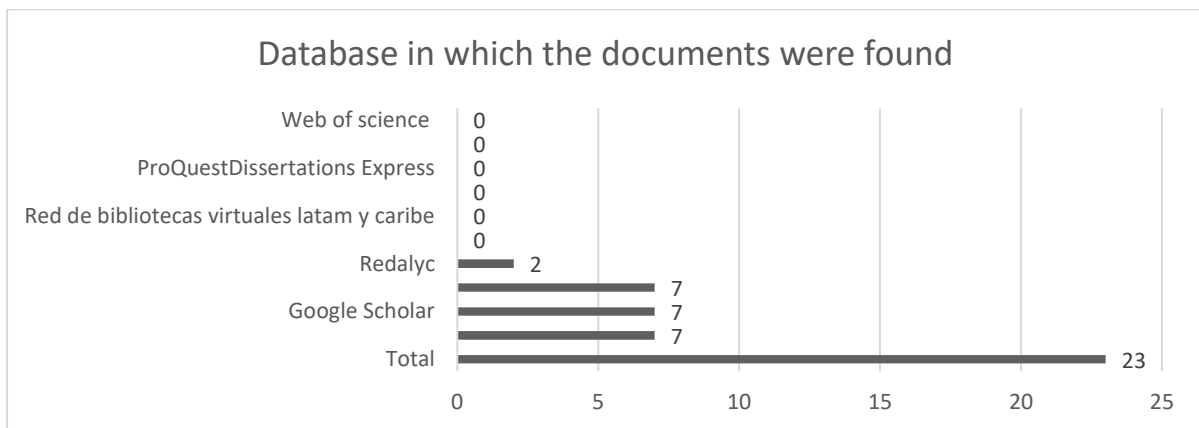
	10. Most prolific authors	
3. Thematic trends	11. Thematic trends	Learning and Knowledge Technologies (LKT), Information and Communication Technologies (ICT), and education.

Note: Own elaboration.

3. Synopsis of the Main Research Outcomes

A total of 23 relevant documents were identified during the literature search and review. Most were retrieved from Colombian university repositories, Google Scholar, and Dialnet, each contributing seven documents (30.4%). Redalyc accounted for two documents (8.7%). Although some documents were initially found in databases such as Web of Science, Scopus, ProQuest Dissertations Express, the Networked Digital Library of Theses and Dissertations, the Latin American and Caribbean Virtual Libraries Network, and TESEO, none met the inclusion criteria, resulting in 0% of the final selection.

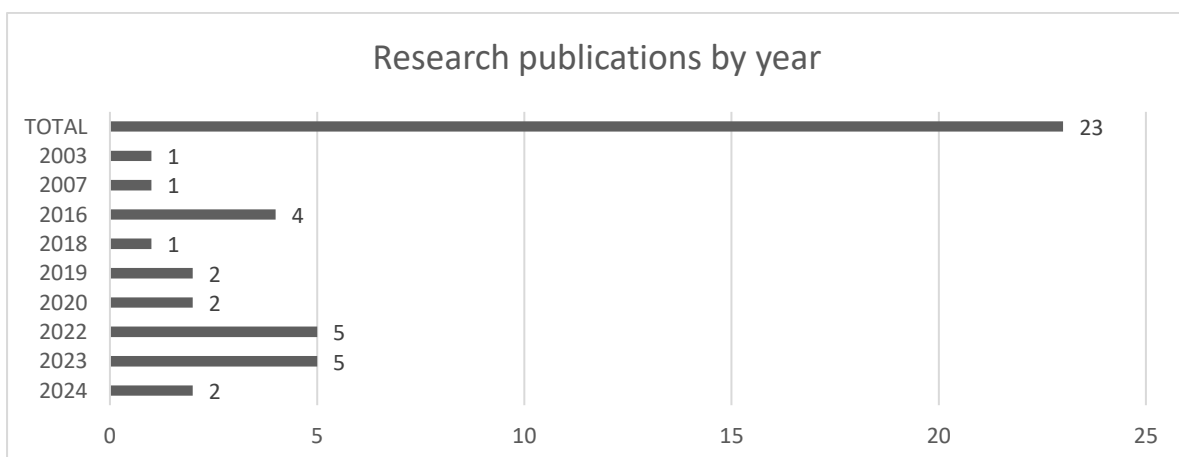
Figure 1. Database in which the documents were found



Note: Own elaboration.

The documents found are distributed according to year of publication as described in the following table. 8.70% of the articles were published in 2024, while 21.74% correspond to 2023, and another 21.74% to 2022. In both 2020 and 2019, 8.70% of the studies were published each year. 4.35% of the articles were published in 2018, while 17.39% of the research was focused in 2016. Finally, 4.35% of the studies were published in 2007 and 2003, respectively. This indicates that the majority of the research (43.48%) was concentrated between 2022 and 2023, while previous years show a lower production in this field.

Figure 2. Research publications by year



Note: Own elaboration.

The documents found are organized according to their country of origin as described below. 50% of the articles come from Colombia, while Spain represents 25% of the research. On the other hand, Venezuela, Peru, Mexico, El Salvador and Ecuador each contributed 5% of the total number of documents. This indicates that most of the studies have been carried out in Colombia and Spain, while the other countries have an equal but smaller representation in research production.

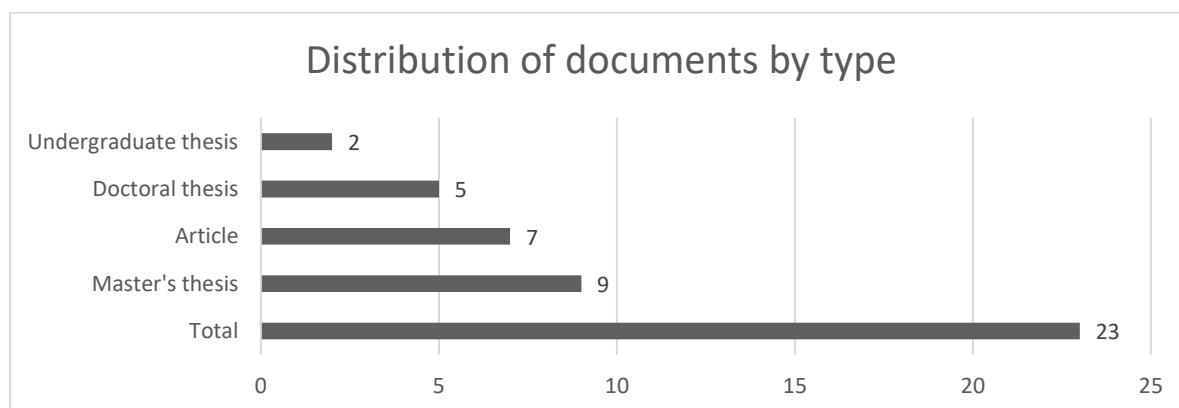
Figure 3. Research publications by country



Note: Own elaboration.

The documents discovered are distributed according to their type as shown below. Of the papers, 30.4% are articles, while 39.1% correspond to master's theses. On the other hand, 21.7% are doctoral theses, and 8.7% are undergraduate theses. This indicates that most of the research is focused on master's theses and articles, while bachelor's and doctoral theses are less represented in the total research output.

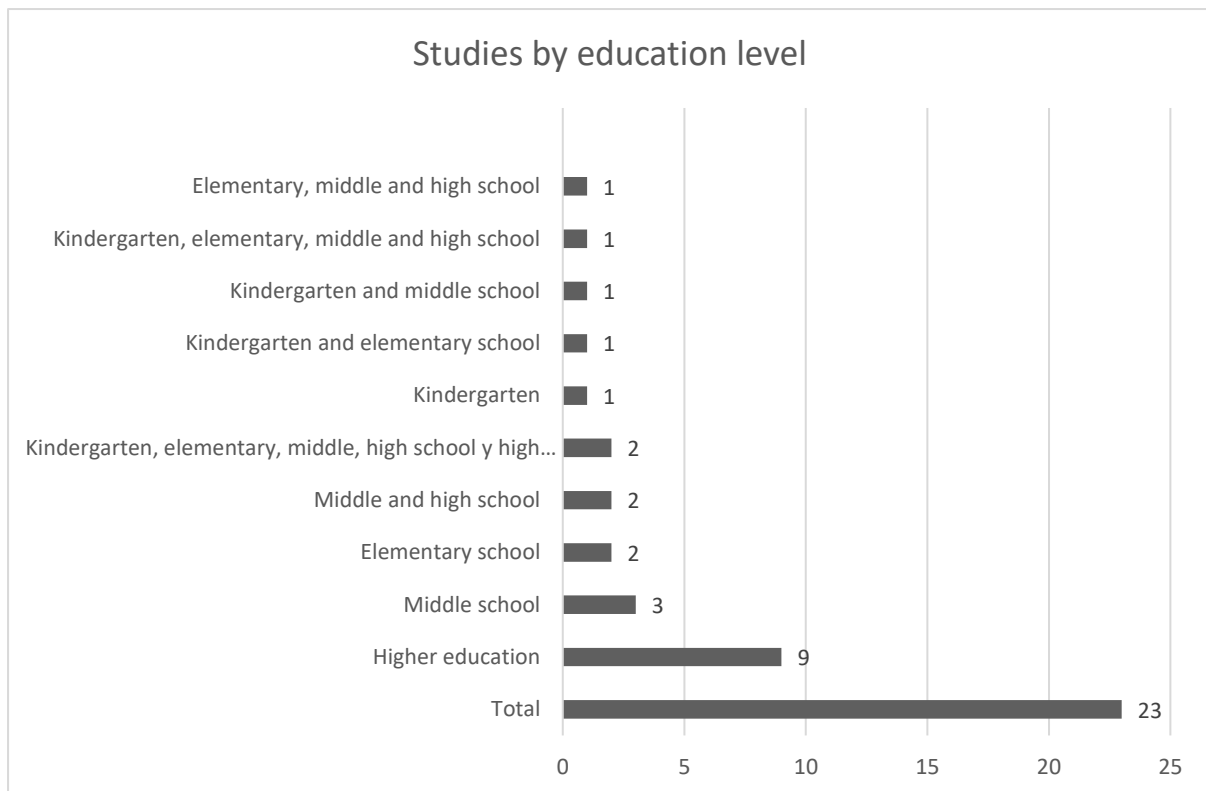
Figure 4. Distribution of documents by type



Note: Own elaboration.

Most studies focus on higher education with 39.13%, followed by middle school education 13.04%. Kindergarten, elementary, and middle school levels, individually or combined, each represent between 4.35% and 8.70%. It highlights a stronger research focus on higher education.

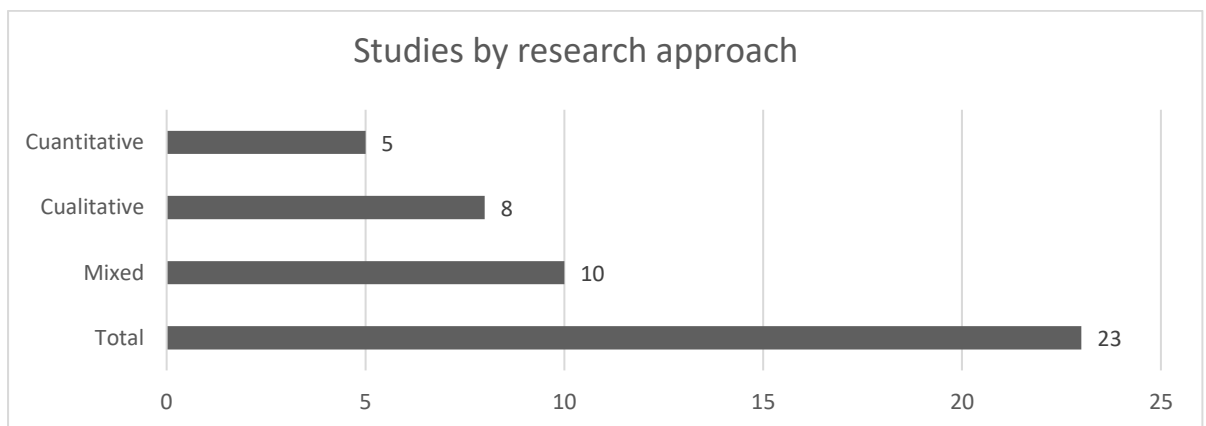
Figure 5. Studies by education level



Note: Own elaboration.

The majority of studies use a mixed methods approach with 40%, followed by qualitative research 32% and quantitative research 28%. This suggests a preference for integrating qualitative and quantitative approaches, with fewer studies relying on numerical data.

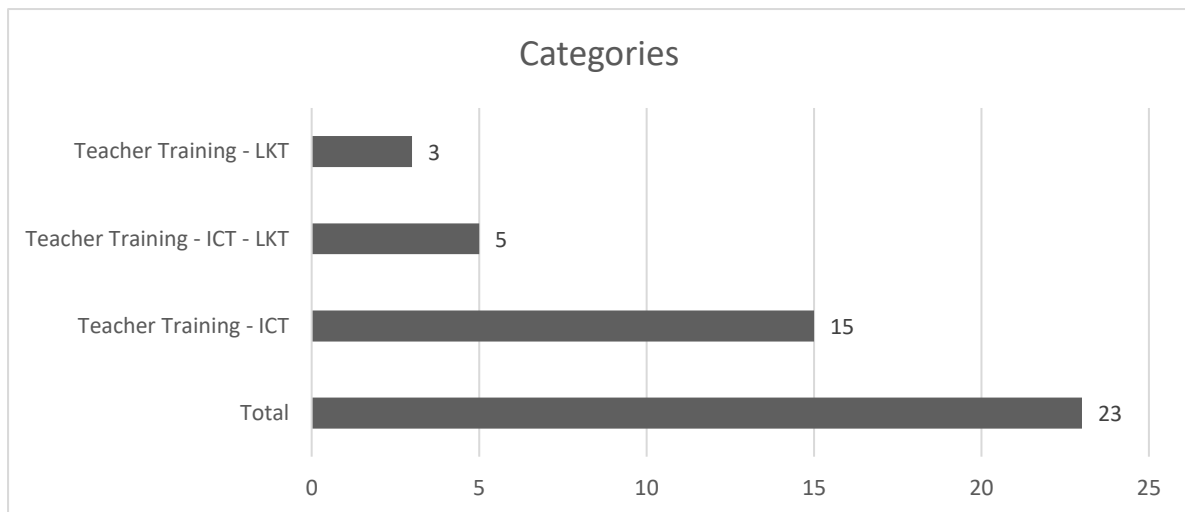
Figure 6. Studies by research approach



Note: Own elaboration.

Distribution of teacher training sessions across three categories. ICT represents the largest share at 61.90%, followed by ICT-LKT with 23.81%, and LKT with 14.29%. This highlights a strong focus on ICT training, with ICT-LKT and LKT playing smaller but complementary roles.

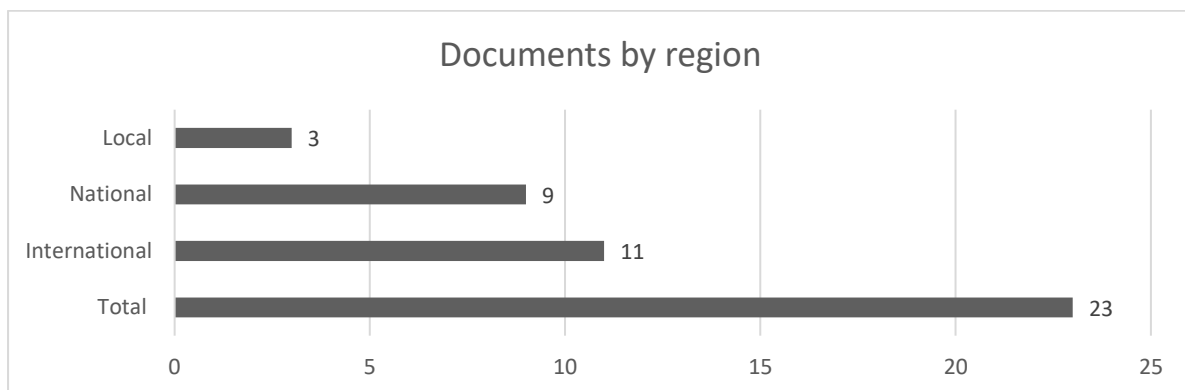
Figure 7. Categories



Note: Own elaboration.

The next figure illustrates the research by region. Nearly half are international with 47.83%, followed closely by *national documents* with 39.13%. Local documents represent 13.04%.

Figure 8. Documents by region



Note: Own elaboration.

The data reveals that the research papers were written by a single author corresponding to the 47.83%, showing a preference for individual work. Two-author papers follow with 30.43%, while three and four-author collaborations are less frequent, at 17.39% and 4.35% respectively.

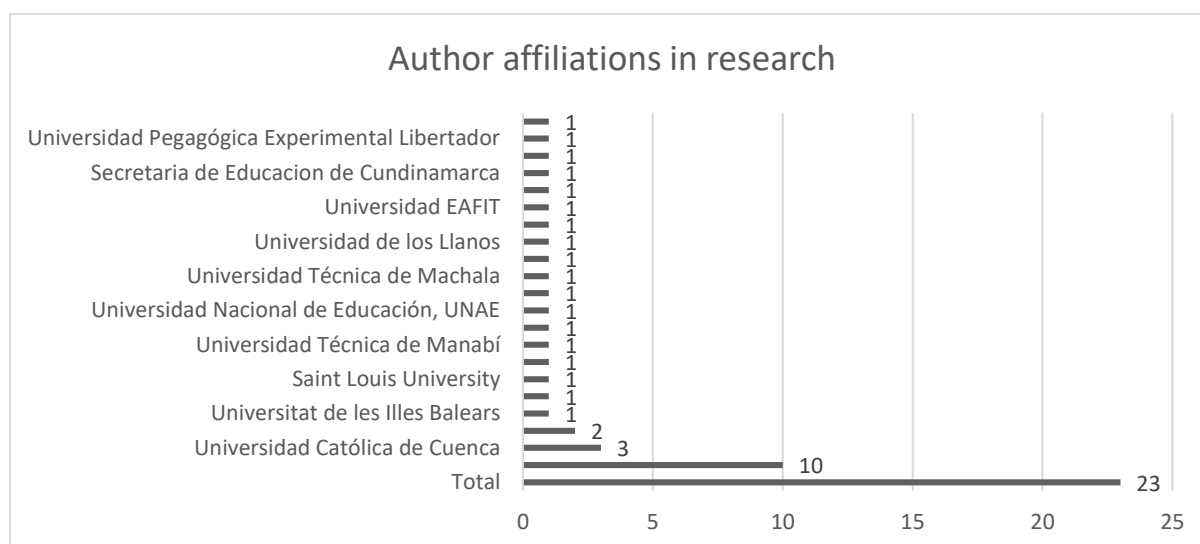
Figure 9. Number of authors by research



Note: Own elaboration.

The data shows that a significant portion of the authors that had no institutional affiliation with 30.30%, suggesting a strong presence of independent researchers. The Universidad Católica de Cuenca contributed the most among institutions with 9.09%, followed by Universitat Rovira i Virgili 6.06%. The remaining institutions each contributed a single author, indicating a wide but shallow distribution of institutional representation across the dataset.

Figure 10. Author affiliations in research



Note: Own elaboration.

The data shows that ICT is the most mentioned concept with 26.19%. Learning Technologies follows with 16.67%, reflecting strong interest in digital learning tools. Digital Skills account for 7.14%, highlighting the relevance of tech competencies. Moodle and Digital Literacy, each at 4.76%, show moderate significance. The remaining concepts, all at 2.38%, indicate a broad but equally distributed approach to educational technology and pedagogy.

Figure 11. Key words with higher frequency

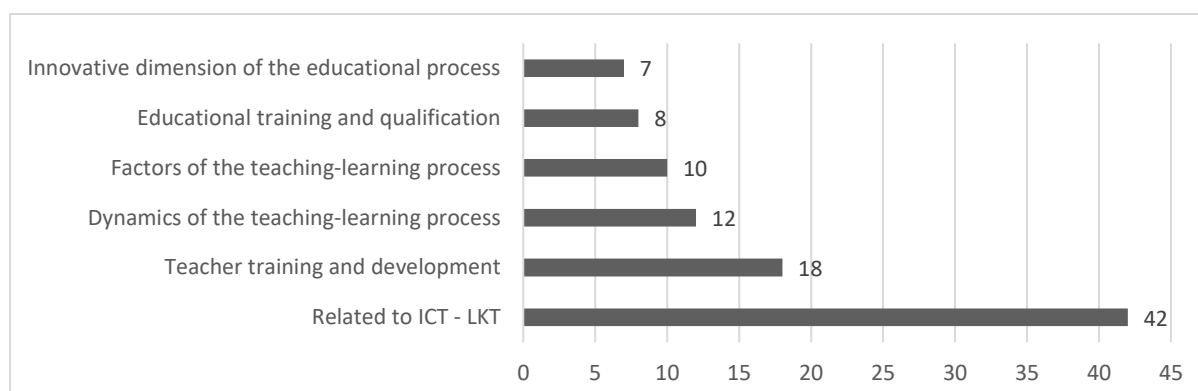


Note: Own elaboration.

The category related to ICT-LKT leads with 43.30%, focusing on information and communication technologies (ICT), digital skills, and learning technologies. This is followed by teacher training and development 18.56%, which highlights the teacher's role and qualifications. The dynamics of the teaching-learning process represent 12.37%. Factors influencing the teaching-learning process account for 10.31%, primarily referencing teacher preparation. Educational training and qualification make up 8.25%,

emphasizing educational innovation. Lastly, the innovative dimension of the educational process comprises 7.22%, reflecting an interest in creative teaching approaches.

Figure 12. Categories



Note: Own elaboration.

4. Discussion and conclusions

The findings of this bibliometric analysis reveal several noteworthy trends and patterns in the scholarly output related to teacher training in Information and Communication Technologies (ICT) and Learning and Knowledge Technologies (LKT). Despite the recognized importance of integrating digital technologies into teacher education, the overall volume of publications remains modest, with only 23 documents identified over a 21-year period (2003–2024). This suggests that, although the topic is gaining traction, it remains an emergent area of focused academic inquiry across many institutional contexts.

A prominent observation is the geographic concentration of research activity. Half of the selected studies originate from Colombia (50%), followed by Spain (25%), with other Latin American countries—including Venezuela, Ecuador, Mexico, Peru, and El Salvador—each contributing 5% (Figure 3). This distribution corroborates prior reports highlighting Latin America’s increasing engagement with digital competence and innovation in teacher training (Díaz M. et al., 2022; Santana Sanabria, 2023). However, the limited international diversity of contributions may constrain the generalizability of findings and impede the broader exchange of effective practices.

Regarding document types, master’s theses constitute the largest proportion (39.1%), followed by journal articles (30.4%), doctoral theses (21.7%), and undergraduate theses (8.7%) (Figure 4). This distribution underscores the pivotal role of postgraduate research in advancing both theoretical frameworks and practical insights into ICT and LKT integration in teacher education. Nonetheless, the comparatively lower representation of peer-reviewed journal articles indicates a need to promote wider dissemination of research findings through established academic channels.

In terms of educational level focus, a significant share of studies target higher education settings (39.13%), whereas research addressing K–12 education is notably scarce (Figure 5). This gap points to an underexplored area concerning the application of ICT and LKT at the elementary and secondary levels, despite documented initiatives emphasizing digital literacy and pedagogical innovation in secondary education (Nobles Pérez et al., 2023; Copete Copete & Helías Hoyos, 2022).

Methodologically, mixed methods approaches predominate (40%), followed by qualitative (32%) and quantitative (28%) designs (Figure 6). This methodological diversity reflects a balanced interest in capturing both quantifiable outcomes and contextually rich understandings of teacher training programs, aligning with previous case-based studies (Espinoza Freire & Guamán Granda, 2019).

Thematic analysis reveals a dominant focus on ICT, which accounts for 61.9% of the documents, while combined ICT-LKT topics represent 23.81%, and LKT alone comprises only 14.29% (Figure 7). This pattern suggests that LKT is frequently subsumed within the broader ICT framework, potentially

underrepresenting its specific pedagogical dimensions (Díaz-Guecha & Márquez-Delgado, 2020; Henríquez Coronel, 2002).

Temporal trends indicate a marked increase in research output during 2022 and 2023, which together constitute 43.48% of the total publications (Figure 2). This surge likely reflects post-pandemic shifts in digital education, which have intensified the demand for effective teacher training models tailored to virtual and hybrid learning environments (Espinoza Varela, 2024).

An analysis of institutional affiliation reveals a high proportion of unaffiliated researchers (30.3%) and a relatively dispersed institutional representation, with only a few institutions, such as Universidad Católica de Cuenca and Universitat Rovira i Virgili, appearing more than once (Figure 10). This pattern may suggest a decentralized and independently driven research field, lacking strong institutional research clusters.

The keyword frequency analysis confirms ICT as the most dominant concept (26.19%), followed by Learning Technologies (16.67%) and Digital Skills (7.14%) (Figure 11). However, low-frequency terms such as “digital literacy,” “Moodle,” and “technology integration” reveal an opportunity for expanding thematic depth and diversifying research agendas in this field.

Finally, this bibliometric study provides a comprehensive overview of the academic landscape surrounding teacher training in ICT and LKT from 2003 to 2024. The analysis confirms an increasing interest in this domain, especially in the last five years, yet reveals several limitations that merit further attention.

- The concentration of studies in Colombia and Spain highlights the need for broader geographic participation, particularly from underrepresented regions such as Africa, Asia, and other parts of Europe.
- The dominance of ICT over LKT calls for more research that critically explores pedagogical frameworks and not just technological access or usage. Future research should distinguish between ICT as a tool and LKT as an approach to knowledge construction.
- The limited presence of peer-reviewed journal articles underscores the importance of encouraging publication in indexed journals to strengthen the visibility and impact of this research field.
- Given the predominance of postgraduate theses, institutional strategies should promote collaborative, cross-institutional research that can be scaled and applied in diverse educational settings.
- Lastly, the lack of institutional affiliations in nearly one-third of the studies suggests that academic networks and funding opportunities for independent researchers must be reinforced to professionalize and centralize research on digital competencies in teacher training.

This research contributes to the growing body of knowledge on digital education by identifying patterns, gaps, and directions for future work. As educational systems continue adapting to technological transformations, the development of coherent and evidence-based training programs for teachers in ICT and LKT will remain a cornerstone of educational innovation.

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