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Educational innovation in elementary school: a bibliometric analysis

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ABSTRACT

This article presents the results of a bibliometric analysis to answer the research question: What educational innovations have been applied worldwide and published in articles in indexed journals? There were 83 Scopus records obtained, of which, after applying the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodology, 6 were excluded, obtaining a total of 77 articles for analysis. This analysis focused on trends such as annual productivity, geographic distribution, most relevant journals, thematic areas, and co-occurrence of author keywords. Subsequently, a review of the 10 most relevant articles on the subject was carried out. A decrease in productivity was observed during 2021, the year after the COVID-19 pandemic. Additionally, educational innovation has been articulated with different areas of knowledge. The analysis of the documents highlights the need to train teachers in using tools that facilitate the integration of educational innovation in the classroom. It is recommended that future studies based on the geographic distribution of academic productivity explore the different experiences these countries have had in incorporating educational innovation in the classroom and analyze the public policies that have promoted it.

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1. INTRODUCTION

The factors such as economic, political, social, and cultural have driven changes in society and even in the educational system [1], [2], which thanks to the innovation of media technology, has generated a new digital literacy that has become the cornerstone of the new educational system, calling the above an educational revolution framed in educational innovation, and which can boost the growth of the economies of countries based on the concept of "knowledge economy" [3], [4]. Involving educational innovation in the teaching and learning process strengthens the relationships between teachers and students, promotes and stimulates commitment to learning, and improves learning outcomes, autonomy, and motivation [5]–[7]. Additionally, a relationship of trust between students and teachers allows students to strengthen their skills with intrinsic motivation to work collaboratively, while promoting their learning outcomes [8]. The change generated by educational innovations aims to improve students' learning processes [9], [10], but to do so, teachers must have attitudes of creativity, resourcefulness, and dynamism in using the resources available in educational institutions, including information and communications technologies (ICT) [11]–[13]. Thus, the teacher plays a fundamental role in the transformation of pedagogical practices, having the ability to adapt

their teaching methods to meet the learning needs of students and achieve innovative, effective, and relevant pedagogical practices for the learning process.

Additionally, the teacher can interpret the educational context to positively impact the learning process, since as mentioned in study [14], the success of innovation starts precisely from the teacher's interpretation of the context, according to which, it is possible to plan strategies that benefit each particular educational scenario. Primary school teachers interpret the context and make use of ICTs, considering that these allow the generation of an innovative learning environment [9], [15]. Additionally, the use of ICTs and different technological resources leads to an increase in the teaching and learning process, and students expand their knowledge [16]–[18].

Some of the trends in educational innovation in primary education include the use of artificial intelligence, Edmodo, Kahoot, flipped classroom learning, and mobile learning [19]. However, it is essential to recognize that the innovative nature of educational practice is conditioned by the particular sociopolitical and cultural context of each region [20]. The above leads to the research question (what educational innovations have been applied worldwide and have been published in articles in indexed journals?) which raises the need to carry out the present study, to recognize the different educational strategies that are being deployed in different regions of the world as educational innovations at the basic primary education level. It defines the novelty by providing information the incorporation of educational innovation processes at the basic primary education level, in such a way that the different actors in the educational system can learn about these processes and make decisions about their possible incorporation in their classrooms.

To address the need raised, a quantitative approach was applied with a bibliometric analysis and a thematic review of productivity related to educational innovation at the primary level. The results are presented in this article. The records were examined in terms of annual productivity, geographic distribution, most relevant journals, thematic areas, co-occurrence of keywords of authors, and the most relevant articles on the topic. Finally, to prepare the literature report, the preferred reporting items for systematic reviews and meta-analyses (PRISMA) [21], [22] methodology was applied.

2. METHOD

2.1. Review structure

The bibliometric analysis was carried out to understand the trends in scientific productivity regarding educational innovation at the primary basic level, considering that bibliometry consists of the application of statistical concepts and allows, based on quantitative results, to understand the intellectual structure of a field of knowledge [23]–[25]. To carry out a cleaning process of the records obtained, the PRISMA methodology [21], [22] was applied, as can be seen in Figure 1. The analysis was carried out using the R studio program and its Bibliometrix package [26], [27] with VOSviewer [28], [29].

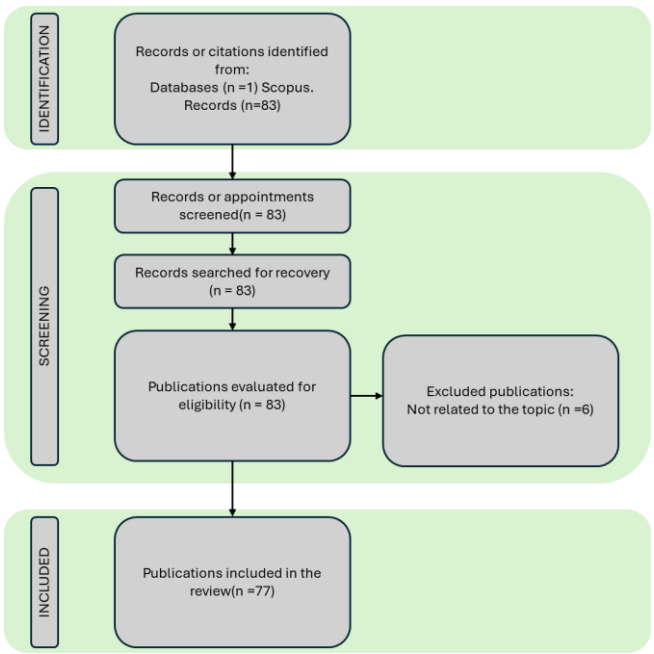

Figure 1. PRISMA applied methodology

2.2. Data collection

The database consulted was Scopus, one of the largest curated databases with access to a significant number of references, more than 1.7 billion, being a valuable base for obtaining detailed information on scientific productivity, necessary for bibliometric analyses. The search equation applied was: "("educational innovation" OR "education innovation") AND ("elementary school" OR "primary school")". With this equation, 83 records were detected, and the exclusion criterion "not related to the topic" was applied, to obtain 77 articles. The exclusion criterion allowed filtering published articles that were included in the initial results, but which after a reading were determined not to deal with the topic of educational innovation in primary school. Additionally, only articles published in scientific journals were considered as sources for the study.

3. RESULTS AND DISCUSSION

3.1. Trend analysis

Figure 2 shows the productivity trend. It was possible to observe that since 2004, in terms of the accumulated percentage of publications, there has been an increase in the slope, indicating that since that year, more publications related to the topic have been made in the world. In 2020, there was a peak in productivity with eight articles, followed by a decrease in 2021 with three articles. The behavior can be found associated with lockdowns implemented by different governments to stop the spread of the COVID-19 virus during the 2020 pandemic. The lockdown caused teachers to innovate in their practice to continue teaching their classes remotely. The year 2020 possibly reports publications that were generated in 2019 but due to publication times of the journals they were published in 2020, later during the pandemic productivity decreased and was reflected in the following year, it is 2021.

On the other hand, the pandemic provided an opportunity to restructure and innovate the educational system [30], in response to which teachers made innovations. These innovations were applied during 2020 and possibly the preparation of the articles reporting the results of the innovations was during 2021, therefore, these articles again boosted productivity in 2022, with the generation of 8 articles. Additionally, during 2020, several conferences were canceled, impacting publication in some areas of knowledge as mentioned in research Casey *et al.*[31], and also in 2020, some authors in other areas reported an increase in that year, but with a decrease in productivity in subsequent years [32]–[34]. The low productivity observed in 2021, following a peak in 2020, raises questions about the impact of the COVID-19 pandemic on educational innovation. While the decline could be attributed to journal publication timelines, it is crucial to consider that the pandemic may have affected researchers' ability to conduct studies and publish their findings. Furthermore, the increase in productivity in 2022 suggests a potential recovery in educational innovation research following the pandemic. Future research should be conducted to thoroughly analyze how the pandemic has influenced educational innovation in the long term.

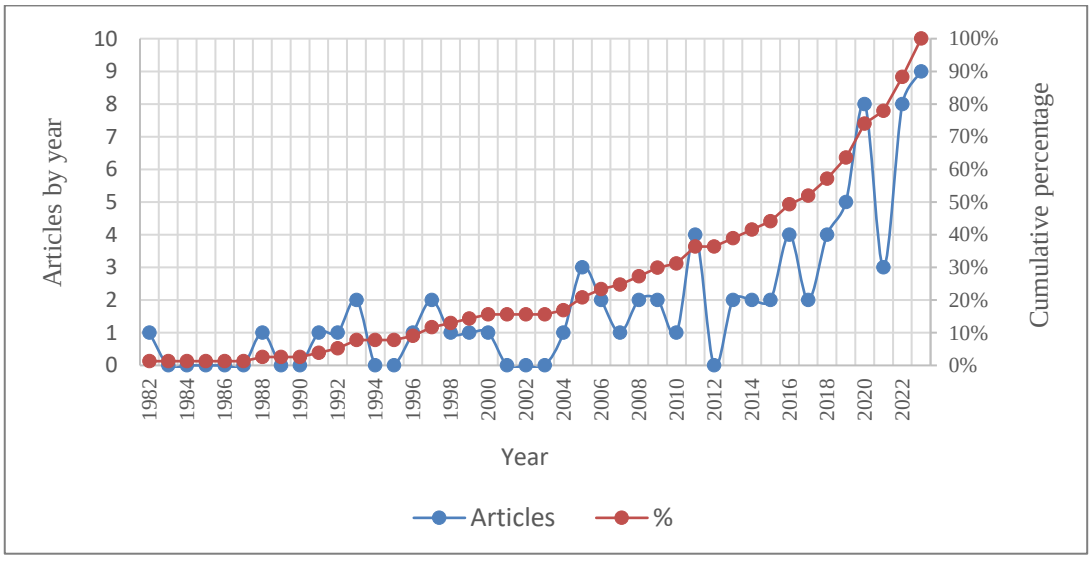

Figure 2. Publication progression and cumulative percentage

Regarding the geographical distribution of the authors, this can be seen in Figure 3. The authors are distributed across 33 countries, Spain leads the author metric (40 authors), followed by the USA (22 authors) and Mexico (21 authors), these three countries account for 43% of the authors. The above indicates that the authors' metric does not exactly reflect the behavior of the countries in the global innovation index (GII), where Spain is ranked 29th, the United States 3rd, and Mexico 56th [35], [36]; but it does make evident the academic effort that is being made in Spain to continue to rise in the GII and strengthen innovation in its classrooms. On the other hand, 9.42% of the published records are found in the ten most relevant journals, which can be seen in Table 1.

The International Journal of Educational Development of Elsevier has three publications, 3.89% of the total records obtained. This journal focuses on aspects associated with economic development and how this can be achieved through education since it allows students to develop different skills necessary to face the changing world, as well as critical thinking that is possible to mobilize the economy of the regions, even more so in an emerging digital society [37]. Figure 4 shows the distribution of the journals' subject areas. Social sciences lead with 50%, followed by computer science and psychology, both with 9%. It is interesting to observe how educational innovation in primary education is related to other subject areas such as medicine (2%) and environmental sciences (2%), among others that can be observed in Figure 4 which exposes the interdisciplinary nature of educational innovation and the transversalization of knowledge.

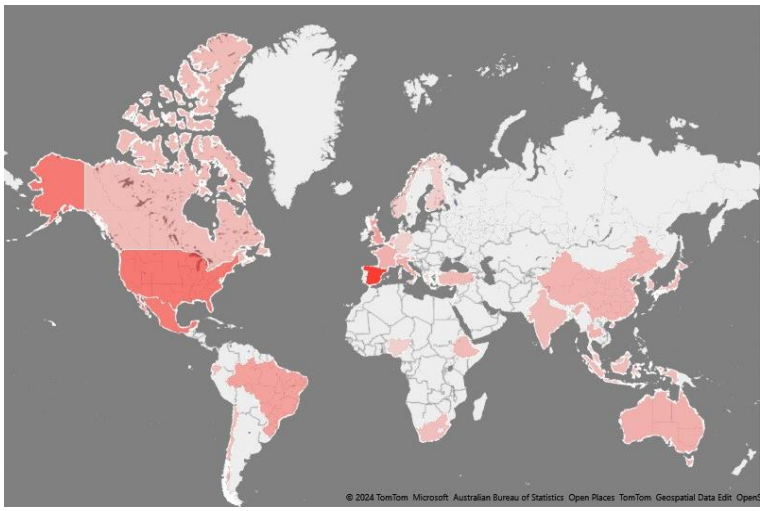

Figure 3. Global author's distributions

Table 1 Most relevant articles

Title	Year	Journal	Total citations
Sustaining knowledge building as a principle-based innovation at an elementary school	2011	Journal of the Learning Sciences	161
Digging deeper: Understanding the power of "student voice	2016	Australian Journal of Education	60
Confidence and perceived competence of preservice teachers to implement biodiversity education in primary schools—four comparative case studies from Europe	2011	International Journal of Science Education	52
Managing systemic curriculum change: a critical analysis of Hong Kong's target-oriented curriculum initiative	1997	International Review of Education	44
A new ICT curriculum for primary education in Flanders: defining and predicting teachers' perceptions of innovation attributes	2011	Journal of Educational Technology & Society	43
Knowledge and degree of training of primary education teachers in relation to ICT taught to students with disabilities	2019	British Journal of Educational Technology	42
Conceptions or misconceptions? Primary teachers' perceptions and use of computers in the classroom	1998	Education and Information Technologies	38
Ten things higher education needs to know about GIS in primary and secondary education	1997	Transactions in GIS	37
Cross-national policy borrowing and educational innovation: improving achievement in the London Borough of Barking and Dagenham	2006	Oxford Review of Education	36
Capturing the *différance*: Primary school teacher identity in Tanzania	2008	International Journal of Educational Development	34

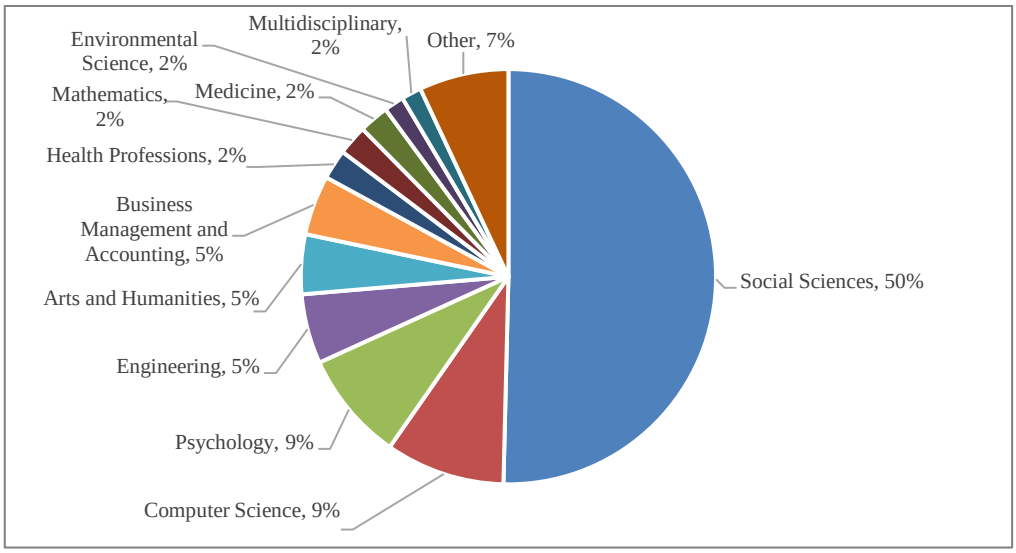

Figure 4. Subject area distribution

Regarding the authors' keywords, it is possible to observe in Figure 5 a relevant cluster (blue) with its core in the word "education innovation", which has a strong relationship with a second cluster (red) through the word "ICT", which indicates that to a large extent educational innovation is being deployed through strategies that make use of ICT. In the same cluster (blue), education innovation is related to teacher education, indicating the need for academic components to be incorporated into teacher training itself to train them in educational innovation. Other relationships are observed with some tools that teachers use in their educational innovation processes and that become support for education, such as the relationship between "education innovation" and "assistive education", "gamification" and "robotics". Finally, although there is not such a strong relationship between "education innovation" and "sustainability", it is a topic that shows that educational innovation can contribute to the need of having a more sustainable world.

The strong relationship between educational innovation and the use of ICT is noteworthy, as evidenced by the co-occurrence of these keywords. This finding highlights the importance of ICT as tool to facilitate and promote innovation in primary education. Furthermore, a connection between educational innovation and teacher training is observed, suggesting the need to train educators in the effective use of ICT for pedagogical innovation. This implies that educational institutions and those responsible for teacher training should invest in professional development programs that enable teachers to integrate ICT in innovative ways into their pedagogical practices.

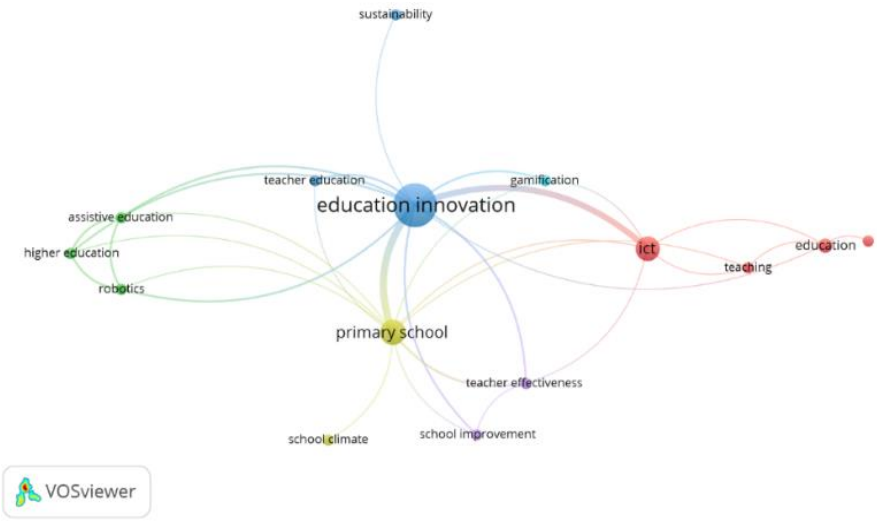

Figure. 5 Author keyword co-occurrence

3.2. Articles analyzed

To understand the relationships, 10 most relevant articles were explored, which are recorded in Table 2. With the largest number of citations (161), in study of Zhang *et al*. [38], they propose a strategy to generate a collective construction of knowledge as an educational innovation, in which teachers and students of a primary school walk in search of a shared objective and a common language. This construction of knowledge goes beyond the teacher-student relationship since it involves other actors in the educational system and the local community. This generates positive impacts on the training processes of students, motivating them during the process. With 60 citations, Quinn and Owen [39] explored the importance of student's voice in the educational process, finding that voice has a positive impact on engagement with learning, thanks to the fact that students can get involved in decision-making by participating in spaces that were not previously available to them, which the authors called a "break from the ordinary". This was innovative for the educational environment of the school in which it was applied, managing to have the voice of students as an integral part of the process. With 52 citations, Lindemann-Matthies *et al*. [40] analyzed a curricular innovation that consisted of introducing biodiversity education in primary schools.

Table 2. Top 10 journals and their performance metrics

Sources	Articles	Publisher	ISSN	CiteScore	Quartile ranking	Subject area
International Journal of Educational Development	3	Elsevier	0738-0593	4.2	Q1	Social Sciences: Sociology and Political Science, Education, Development
Education Sciences	2	Multidisciplinary Digital Publishing Institute (MDPI)	2227-7102	4.8	Q2	Social Sciences: Education, Public Administration; Health Professions: Physical Therapy, Sports Therapy and Rehabilitation; Computer Science: Computer Science (miscellaneous), Computer Science Applications; Psychology: Developmental and Educational Psychology
Educational Review	2	Taylor & Francis	1465-3397	7.9	Q1	Social Sciences: Education
International Journal on Interactive Design and Manufacturing	2	Springer Nature	1955-2513	4.0	Q2	Mathematics: Modeling and Simulation; Engineering: Industrial and Manufacturing Engineering
Journal of Educational Computing Research	2	SAGE	0735-6331	11.9	Q1	Social Sciences: Education; Computer Science: Computer Science Applications
Oxford Review of Education	2	Taylor & Francis	0305-4985	5.2	Q1	Social Sciences: Education
Teaching and Teacher Education	2	Elsevier	0742-051X	6.5	Q1	Social Sciences: Education
Acta Scientiae	1	Lutheran University of Brazil	1517-4492	0.7	Q3	Multidisciplinary; Social Sciences: Education
Australian Journal of Education	1	SAGE	0004-9441	3.2	Q2	Social Sciences: Education
BMC Pediatrics	1	Springer Nature	1471-2431	3.7	Q2	Medicine: Pediatrics, Perinatology and Child Health

Some of the findings indicate the need for teachers in training to be prepared to carry out training from biodiversity, so that when they become teachers, they can develop some of their activities outdoors, allowing students to interact with the environment. With 44 citations, Carless [41] presented a curricular innovation related to a goal-oriented curriculum (TOC) and related some of the challenges for the deployment of innovations in the educational system. Some of the challenges arise because the TOC framework is complex and abstract, teachers do not feel empowered in the application of the innovation, and they lack of resources to execute the innovation. With 43 citations, Vanderlinde and Braak [42] conducted a study on teachers' perceptions about the implementation of an ICT curriculum that integrates the use of these technologies in all academic components. To examine perception, the authors use Rogers' theory of diffusion of innovation. In the field of educational innovation, this theory allows us to understand how new technologies, pedagogical methodologies, or educational policies are adopted by different actors in the educational system.

Some of the findings indicate that it is necessary to have better communication between those responsible for educational policies, schools, and teachers. On the other hand, for teachers to be able to incorporate ICT in the classroom, they need to feel competent in this area. With 42 citations, Fernández-Batanero *et al.* [43] analyzed the knowledge of primary school teachers to incorporate ICT in an

inclusive classroom with people with disabilities (functional diversity). The results indicated the need for training of teachers in ICT and its use with students with disabilities, which can be summarized in the generation of educational policies for initial and continuous training of teachers in the use of ICT with people with disabilities, in such a way that learning and educational innovation of students with disabilities can be favored. With 38 citations, Drenoyianni and Selwood [44] analyzed the perception of primary school teachers regarding the incorporation of computers in the classroom. The findings suggest that there is a correlation between teachers' beliefs about computer use and their actual patterns of use, indicating that educational innovations often have their roots in teachers' mindsets before they manifest themselves in practice. With 37 citations, Bednarz and Ludwig [45] studied an innovation that consisted of incorporating geographic information systems (GIS) in the teaching of concepts of geography and environmental sciences, encouraging the development of spatial thinking and awareness in primary school students. With 36 citations, Ochs [46] analyzed the incorporation of mathematics teaching practices developed in Switzerland in London primary schools.

The results indicate the need for teachers to be clear about the objectives and problems proposed by new policies or programs in the teaching of mathematics, and also to have a monitoring system that allows them to review the progress of the implementations. Finally, with 34 citations, Barrett [47] examined how teachers' perceptions and identities can contribute to educational innovation processes. Teachers' identities are influenced by age and gender, as well as by working conditions, therefore, according to the authors, innovations should respect these identities and existing teaching practices in such a way that past experiences are not viewed as innovations.

The analysis of the most relevant articles reveals a learning need for teacher training in educational innovation tools and strategies. Teachers must feel competent and empowered to implement innovation in the classroom. This implies not only the acquisition of techniques but also the development of an innovative mindset and the ability to adapt tools to the specific needs of their students. In addition, the importance of collaboration between the different actors in the educational system, including teachers, students, administrators, and educational policymakers, is highlighted to achieve a successful implementation of innovation. Fostering a culture of collaboration and continuous professional learning within schools is essential to promote educational innovation. This analysis is consistent with what has been stated by different authors who have pointed out that primary school teachers make use of ICTs, considering that they allow for the creation of an innovative learning environment, but at the same time they express the need for training on the proper use of these technologies in the teaching and learning process [9], [15].

Other authors have expressed the need to have a community of educational actors committed to the process, in such a way that knowledge is built between these actors or in some cases between teachers and students. In any case, this points to a distributed leadership such as the one proposed, in which the different systems interact at the government, group, and school levels to provide leadership in the implementation of the innovation [48]. Finally, to answer the research question initially posed, based on the results obtained, the educational innovations, both at the classroom level and at the curricular and administrative level, that have been reported in the 10 most relevant articles are: i) collective construction of knowledge; ii) student voice in decision-making; iii) education on biodiversity; iv) objective-oriented curriculum (TOC); v) integration of ICT in the curriculum and in inclusive classrooms; vi) GIS in teaching; and vii) relationship between teacher identity and educational innovation.

4. CONCLUSION

This study employed a mixed-methods approach, integrating quantitative bibliometric analysis and qualitative content analysis to explore key themes and trends in educational innovation. The findings reveal a multidisciplinary scope, highlighting the intersection of educational innovation with fields such as medicine, environmental sciences, and sustainability. Despite challenges like the COVID-19 pandemic, the research underscores the resilience and adaptability of educational innovation, with a notable emphasis on the growing role of ICT in enhancing teaching and learning. The use of digital tools, virtual learning environments, and educational games demonstrates the importance of fostering digital literacy and technological skills among educators and students.

A key insight is the need for comprehensive teacher training programs combining technical proficiency with an innovative mindset and promoting collaborative practices. The analysis also highlights the necessity for systemic approaches to innovation, advocating for coordinated efforts among educators, policymakers, and other stakeholders to create environments that enable sustainable advancements. These findings align with global trends, emphasizing the integration of ICT to foster collaborative learning, personalized instruction, and increased student engagement.

Finally, the results offer a framework for future studies, directing efforts toward emerging areas such as the intersection of ICTs with pedagogy and the role of leadership in driving innovation. Furthermore, an emphasis on teacher training and the cultivation of collaborative cultures is essential to implement innovations in diverse educational contexts successfully. As recommendations, it is suggested to prioritize the development of comprehensive teacher training programs that address both technical skills and the cultivation of an innovative mindset, enabling educators to effectively integrate ICTs into pedagogical practices. Future research could explore the long-term impacts of global disruptions, such as the COVID-19 pandemic, on educational innovation.

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Johanna Gallego Alvarez	✓	✓	✓		✓	✓			✓			✓	✓	
Lina Rosa Parra Bernal	✓								✓			✓		
Vladimir Henao Céspedes		✓						✓		✓				

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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