

Crowdsourcing in Educational Contexts: Growth Dynamics and Scientific Perspectives

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Abstract: Crowdsourcing is a distinct innovation strategy that invites contributions from external actors and represents a key form of collaborative innovation. It plays a vital role in enhancing the visibility of educational institutions and supporting territorial development. Drawing on a bibliometric analysis of publications indexed in the SCOPUS database, this study seeks to examine the extent to which crowdsourcing has been adopted within educational institutions, covering a variety of dimensions over a broad period from 1999 to 2023. This analysis provides an overview of the current state of the crowdsourcing field in relation to education. Using an extensive database, a combination of keywords and inclusion/exclusion criteria, we extracted 305 distinct articles. ScientoPy and VOSviewer were employed to explore and analyze the data collected. After a dip in 2016, a recovery in the volume of literature relating to crowdsourcing in educational institutions began to emerge in 2020. These results indicate the particular interest shown in the subject of open innovations in public and private institutions. The crowdsourcing theme was ranked in the top ten, with 28 publications before 2022 and a proportion of 20% between 2022 and 2023. Crowdsourcing in the academic context has been growing in recent years. However, the studies carried out in this area remain insufficient, particularly bibliometric studies analyzing crowdsourcing in educational establishments and learning in general. Practitioners and academics can take advantage of different research models in open innovation, crowdsourcing and education. Ultimately, this work aims to guide researchers and practitioners by mapping the current dynamics and major trends shaping this field.

Index Terms: Educational Establishment, Crowdsourcing, Education, Bibliometric Review, Open Innovation, VOSviewer.

1. Introduction

Education and teaching have proven to be fundamental pillars of any nation's economic and social development. To meet contemporary challenges, training skills, preparing citizens and stimulating innovation should be essential mechanisms for improving education and teaching. Today's education systems are faced with rapidly evolving technologies and growing societal needs. In this context, and in view of the demands of the 21st century, innovation is proving to be a strategic lever and a key to improving the quality of education. Crowdsourcing, based on the

mobilization of collective intelligence, is becoming an emerging approach on a large scale, while offering new creative solutions for the educational process.

Although innovation management and crowdsourcing have been studied separately in previous literature [1], and some scholars argue that crowdsourcing does not strictly constitute a form of open innovation [2], in the field of education the two concepts complement each other. Although crowdsourcing and open innovation are conceptually linked, this study adopts a clear analytical distinction between these notions. Crowdsourcing is seen as a specific technique and mechanism for the distributed mobilization of contributions, while open innovation is a broader organizational framework within which crowdsourcing can be mobilized, particularly in educational institutions. Thus, the bibliometric analyses and interpretations proposed in this article focus mainly on crowdsourcing, while mobilizing related concepts in a complementary and non-interchangeable way. This distinction is based on the different approaches and objectives of each concept, even if they involve external participation. The economist Joseph Schumpeter was one of the first researchers to highlight the notion of innovation in his 1942 book [3], defining it as creative destruction. Based on the type of innovation, Trott [4] and other researchers have offered modern definitions of innovation, stating that innovation involves managing all activities related to the generation of ideas, the development of technology, and the production and marketing of a new (or improved) product, manufacturing process, or piece of equipment. Tidd and Bessant [5] point out that there are four phases to this innovation process: research, selection, implementation and capture. Throughout these stages, crowdsourcing can be crucial in providing external ideas and input. However, it is essential to identify in which phases it really brings value to the innovation. Generally speaking, crowdsourcing can be effective and efficient when generating ideas in the research phase, yet will not be relevant in the other stages of innovation. As already mentioned, this depends on the approach and objectives of each establishment, institution, business sector or project.

Crowdsourcing is the concept of using the crowd as a source and resource to generate ideas and solve problems by leveraging collective intelligence. The concept was coined in 2006 by Jeff Howe, a journalist with *Wired* magazine, in his article *The Rise of Crowdsourcing* [6]. In the private sector, the concept has emerged notably in the United States. Dell Technologies, Inc. provides a typical example of the application of crowdsourcing in the private sector; the IdeaStorm service was launched in 2007, enabling users and stakeholders to suggest ideas, recommendations, solutions and opinions for improving the quality of products and services [7]. Today, and alongside social networks, Ideaken, IdeaConnection, and My Starbucks Idea have served as examples of crowdsourcing platforms focused on idea generation.

Like the private sector, the public sector is gradually establishing itself as a growing user of crowdsourcing. In the United States, a consortium of around 40 federal agencies used crowdsourcing to develop the U.S. Public Participation Manual, aimed at helping government managers evaluate and improve services through citizen participation and involvement [8]. Although in 2013 Brabham provided a definition of crowdsourcing, as well as its typologies and approaches, he reveals little about the challenges and issues facing public administrations, in particular, transaction costs.

In the field of management science, Howe [6] defined crowdsourcing as the process of assigning a task, previously carried out by internal employees, to an undefined group of individuals through an open call. In the context of education, Garrigos-Simon et al. [9] define crowdsourcing as the act of assigning a specific teaching or learning task or a related problem to a large group of individuals, either internal or external to the educational institution (including in-person or online participants), with or without an open call, in exchange for compensation that is not necessarily monetary.

In this context, information and communication technologies have a significant impact on the academic field (education and teaching), which is part of both the private and public sectors. To improve educational content and quality, the development of e-learning is beginning to incorporate crowdsourcing, calling on the crowd to create and enrich courses and educational programs. This link encourages the co-creation of knowledge between stakeholders, which is a type of crowdsourcing technique suggested in [10,11]. In the financial context, two concepts are linked to crowdsourcing, namely crowdfunding and crowdtuition, representing, according to [12], other types of crowdsourcing after crowdteaching and crowdlearning.

Universally, crowdsourcing has considerable potential to support socio-economic development, particularly in education. Its evolution in recent years has demonstrated its collaborative importance in meeting educational challenges and expectations.

Although there is relevant research on crowdsourcing such as the bibliometric analysis by Malik et al. [13], studies on crowdsourcing and its development in fields of science by Lenart-Gansiniec et al. [14], research on crowdsourcing management in language teaching and learning conducted by Garrigos and Narangajavana [11], the literature review on learning with crowdsourcing by Zhang [15], previous literature lacks relevant bibliometric studies on crowdsourcing adoption in educational institutions focusing on both administration, resources, management and infrastructure, in addition to teaching.

However, unlike existing bibliometric analyses that address crowdsourcing in a cross-cutting manner or in general organizational contexts, this study considers educational institutions as specific institutional environments, characterized by distinct actors, purposes and modes of governance. This differentiation justifies a dedicated bibliometric analysis, allowing us to identify the scientific dynamics specific to crowdsourcing in education, in

particular in terms of temporal evolution, thematic structuring and collaborative networks. By mobilizing an expanded set of bibliometric indicators (growth of scientific production, co-authoring structures, institutional diversity, cooccurrence and cocitation analyses), the study highlights research trajectories and scientific configurations specific to the educational field. In this sense, the article is not limited to descriptive mapping, but contributes to a better understanding of the research trajectories and scientific gaps specific to this field.

Given the relevance of crowdsourcing in educational institutions and the scientific gaps in the literature, this article aims to carry out an in-depth analysis of a sample composed of 305 well-filtered articles on this issue through a bibliometric analysis that provides a comprehensive overview of the field by measuring publication indicators such as volume, research methodology, and dissemination [16].

The main aim of this research, which uses bibliometric techniques to study and evaluate the adoption of crowdsourcing in educational institutions, is to provide statistical information on the sample examined, to determine the sources, dominant themes and most important publications on the subject, while exploring the impact of existing research on this field. To this end, bibliometric analysis will enable our authors to highlight the latest emerging models for advancing this field.

Table 1. Research question.

Number	Search question	Incentives
SQ1	How has the field of research on crowdsourcing in educational institutions been structured and transformed over time, in terms of publication dynamics, dominant themes and networks of scientific collaboration?	- Identify key growth trends and fundamental bibliometric metrics to pinpoint subject development trajectories; - Draw on influential sources and leading articles to analyze key contributions; - Distinguish dominant themes in previous research; - Mapping scientific publications and analyzing co-citations to identify subject development.
SQ2	What theoretical, thematic and methodological gaps emerge from bibliometric analysis, and what future research perspectives can be identified for crowdsourcing in an educational context?	- Highlight under-explored aspects; - Reveal research opportunities; - Fill gaps in the literature.

1.1. Outline

To fulfill the objectives of the study and address the research questions, in section 2 the paper first outlines the data sources and the methodology employed. The third section presents the results of the bibliometric analysis. This is followed by a discussion of the findings and implications in section 4, and the paper concludes in Section 5 with a presentation of the study's limitations and suggestions for future research.

2. Materials and Methods

2.1. Type of Analysis

In this study, we opted for bibliometric analysis being a quantitative method widely used and popular in academia across various fields, analyzing bibliographic data using statistical tools to present them in an accessible way [11]. To examine current developments in our subject on the basis of an analysis of grey literature, this paper adopts the recognized methodology of [17]. The measurement and quantitative study of bibliometric data should be carried out on a wide range of references. In their bibliometric studies, Merigó et al. [18,19] confirmed that the selected indicators, specifically the number of articles and the number of citations, were chosen because they are widely used in the literature to assess productivity and to identify the most relevant and influential articles and authors.

The analysis of publications and sources should also be taken into account. Mohd Sofian et al. [20,21] have indicated in their studies that this methodology often makes it possible to assess the impact of scientific research and select the most outstanding authors, journals or publications in a certain field.

2.2. Analysis Methods and Tools

Based on the guidelines established by Fahimnia et al. [22], the dataset generation involved browsing the SCOPUS database on August 23, 2024. The Scopus database was selected as the sole source for the collection of publications due to its popularity and broad multidisciplinary coverage, the quality of its metadata and its widely recognized use in contemporary bibliometric studies. Thus, the use of a single database is a common methodological practice aimed at ensuring consistency, homogeneity and comparability of results.

The search query contained various keywords related to crowdsourcing and educational institutions. Table 2 below illustrates the identification phase of our search:

Initially, and in order to meet the principle of exhaustiveness, documents related to our subject were extracted based on their year of publication. According to Arksey and O'Malley [23], exhaustiveness is all about delimiting the field. Only documents published between 1999 and 2023 were taken into account. Inclusion and exclusion criteria were then applied, using data cleaning techniques to eliminate duplicates and redundant data. As a result, there is an inherent

Table 2. Identification phase.

Letter	Key word (i)	Synonym 1 (ii)	Synonym 2 (iii)	Expression	Combination
A	Collaborative innovation	participatory innovation	Crowdsourcing	<i>TITLE – ABS – KEY (("open innovation</i>	<i>A(i) + A(ii)</i>
B	Territorial	local authority	territorial community	<i>* " OR "crowdsourcing" OR "collaborative innovation") AND ("educational institution</i>	<i>+ A(iii)</i>
				<i>* " OR "teaching" OR "institute"))</i>	<i>B(i) + B(ii) + B(iii)</i>

issue with the existence of duplicate entries relating to repetitive indexing of the same article or change in author name. In this sense, ScientoPy was one of the software packages used to merge and eliminate duplicates. In addition, articles and journals were retained, while all other document types were excluded. Moreover, our researchers excluded articles published in languages other than French and English. The restriction of the corpus to publications in English and French is based on methodological considerations aimed at ensuring the consistency and comparability of bibliometric and semantic analyses. The inclusion of publications in other languages would have required specific language treatments, which could introduce interpretation biases when analyzing abstracts and article results, given that English is the dominant language of international scientific communication and French occupies a structuring place in educational sciences. Finally, and following the inclusion criteria, manual screening was conducted on the titles, abstracts, and keywords of the collected articles to include only articles dealing with crowdsourcing in educational institutions in the final analysis. This step was carried out by experienced researchers, systematically following the inclusion criteria. Although it is considered to be one of the most reliable methods for identifying relevant content in a complex and multidisciplinary field, a complementary verification step has been carried out in order to reduce subjectivity biases. Tullu [24] confirmed in 2019 that extracting datasets on the basis of their titles is essential to highlight the advancement of the content and its structure of certain study topics [24]. Next, a new micro-level filtering was performed on the basis of the data obtained. After satisfying all our criteria, the captured query was converted into the following form:

*TITLE – ABS – KEY (("open innovation *
 " OR "crowdsourcing" OR "collaborative innovation") AND ("educational institution *
 " OR "teaching" OR "institute")) AND PUBYEAR > 1999 AND PUBYEAR < 2024 AND (LIMIT –
 TO (DOCTYPE , "ar") OR LIMIT – TO (DOCTYPE , "re")) AND (LIMIT –
 TO (LANGUAGE , "English") OR LIMIT – TO (LANGUAGE , "French"))*

For this study, a total of 1019 documents were first extracted to begin our research process. After applying our filtering techniques and manual selection, 305 articles were reviewed and selected for analysis.

During this study, the VOSviewer software was used by our researchers. Its purpose was defined by Van and Waltman [25] in the context of data mapping and the observation of structures, networks, and nodes in various analyses. The software is seen as a tool to help researchers apply bibliometric analysis techniques, such as authorship analysis, citation analysis, bibliographic coupling [26], and co-citation analysis [27] to examine published bibliographic data [28].

3. Results

In this section, the results of an in-depth bibliometric analysis of the literature are examined and presented by our researchers. This section elucidates several bibliometric analysis techniques.

3.1. Key Bibliometric Data

Analysis of the 305 articles selected revealed that, on average, 3.12 authors wrote articles collectively. The selected works were published in 160 separate journals, and their average annual growth rate was 21.7%, demonstrating a significant increase in the annual number of publications relating to our subject. The average citation per paper was 26.33, and the average age of the selected papers, calculated per paper, is 7 years. Table 3 provides all the key information on our samples.

Table 3. Bibliometric data.

	Description	Results
General characteristics	- Time span - Sources (Journals, Books..) - Documents - Multiplier coefficient - Average annual growth rate - Document Average Age - Average citations per doc - keywords Plus (ID)	1999 : 2023 160 305 34.54 % 21.7 % 7.098 26.33 1121
Authors	- Document authors - Authors of single-authored docs	972 64
Partnership & collaboration	- Single-authored docs - Co-Authors per Doc - Institutional Diversity Index (Top 10)	65 3.12 0.401360
Type of document	- Article - Review	280 25

3.2. Performance Analysis

The adoption of crowdsourcing in educational institutions has been a focus of scientific research. The publication trend (Figure 1) has seen peaks and troughs that can be attributed to various contextual factors. From 2005 to 2014, there was initial growth. From 2009 onwards, a more marked increase was noted, with 8 articles published in that year. 2015 represented a peak with 28 articles, followed by a period of stability; this could be due to an increase in interest in the subject following the 8th International Conference on Education, Research and Innovation held November 2015 in Seville. A drop in 2016 could be due to a temporary saturation of the subject or a shift of interest to other areas of research. A further increase was recorded in 2020, which could be explained by the importance given to innovation and the search for innovative pedagogical solutions at the time of the COVID-19 crisis. The year 2023 was characterized by a number of 26 articles after a peak in 2022, which could be due to external factors such as changes in educational policies. While factors such as political changes, the COVID-19 pandemic, and conferences may have positively influenced this trend, this hypothesis remains speculative and has not been empirically validated.

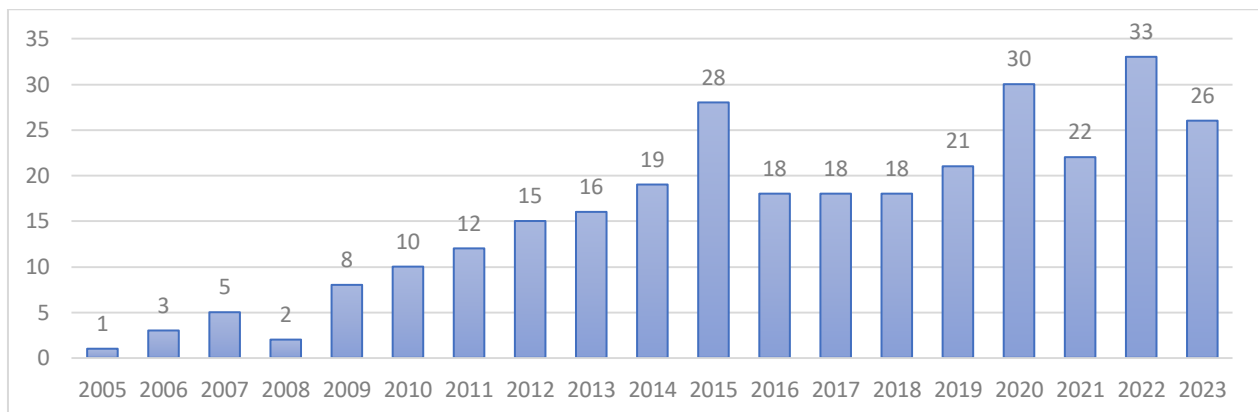


Fig. 1. Growth Trend.

3.3. Source Analysis

The papers were analyzed, as shown in Table 4, and the multidisciplinary nature of the reviews indicates that crowdsourcing in education has proved to be a topic of multidisciplinary interest, touching on technology management, innovation and sustainability, and even ethics. This table lists the ten most eminent and remarkable journals that have contributed to the influence of crowdsourcing in education.

Looking at this table, some journals can be considered leaders in this field. Research Technology Management and Journal of Open Innovation Technology Market and Complexity stand out clearly with 22 and 18 articles published respectively, and proved to be the main sources of publications. The percentage of publications per journal (PPJ) shows that, based on our selected articles, only two journals devote more than 5% of their publications to the field of crowdsourcing in education. This explains why these journals have become channels for disseminating knowledge about our subject. The multitude of journals with just 2 articles, such as the AMA Journal of Ethics and the Cochrane Database of Systematic Reviews, shows that the subject is also explored from a variety of angles, including ethical and methodological. Regardless of their frequency, their display in the table reveals the importance of considering methodological, ethical and other aspects in our subject.

Table 4. The Ten Eminent Sources.

Sources	Articles	PPJ
Research Technology Management	22	7.21
Journal Of Open Innovation Technology Market And Complexity	18	5.9
Sustainability Switzerland	8	2.62
IEEE Access	4	1.31
International Journal Of Technology Management	4	1.31
Journal Of Innovation Management	4	1.31
Journal Of Intelligent And Fuzzy Systems	3	0.98
Technological Forecasting And Social Change	3	0.98
Cochrane Database Of Systematic Reviews	2	0.66
AMA Journal Of Ethics	2	0.66

3.4. Analysis of Major Themes and Co-occurrence Map

The main themes presented in the co-occurrence map (Figure 3) and Figure 2 have been extracted from the keywords provided in previous searches. Figure 2 elucidates the top 10 keywords and their totals before 2022 and between 2022 and 2023. Innovation, study, research institutes, platform and crowdsourcing were the five most frequently used keywords before 2022. Moreover, between 2022 and 2023 the keywords study, innovation, and research institutes also saw an increase, showing the beginning of a remarkable introduction of innovation technologies in education, and a significant transformation towards more inclusive, collaborative and technologically advanced models, thus indicating that current educational research is focused on the adoption of techniques such as crowdsourcing and e-learning. The large proportion of publications over the last two years shows an increase in research on Teaching with a proportion of 38.46% compared to previous years, confirming that the current challenge is research into new teaching techniques such as crowdsourcing with a proportion of 20%.

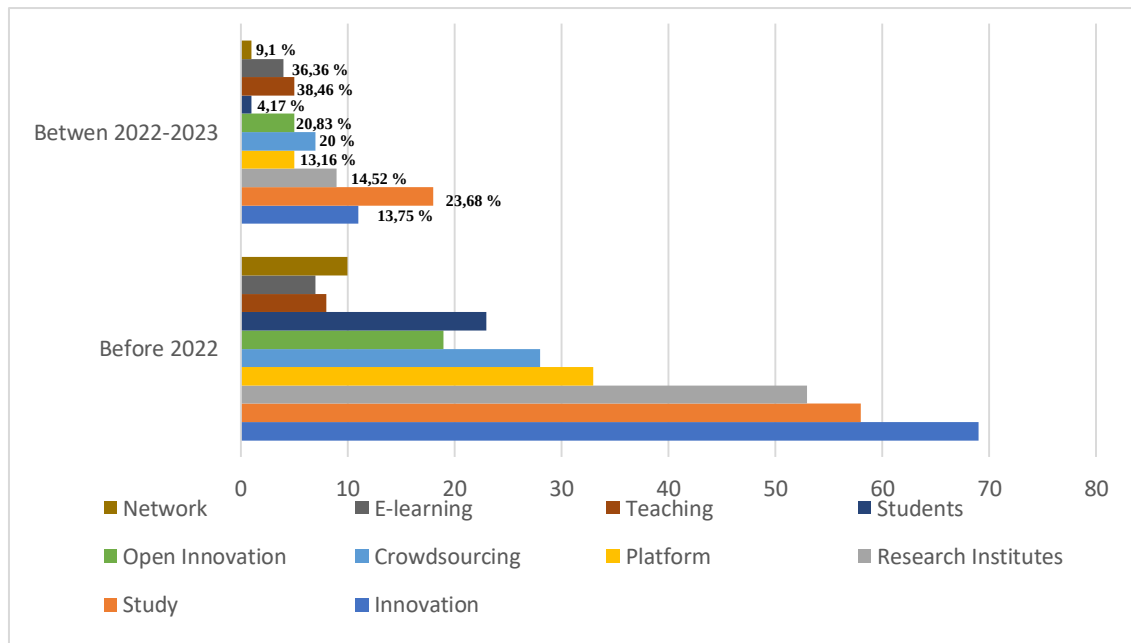


Fig. 2. The Ten Major Themes and Their Totals Before 2022 and Between 2022 and 2023, with Proportions.

To analyze this, we examined the dominance of the ten most frequently used keywords using VOSviewer software. Figure 3 shows a co-occurrence map of keywords appearing at least twenty times in the studies analyzed. The threshold of twenty occurrences was chosen to ensure a balance between readability of the network and thematic representativeness; exploratory tests with alternative thresholds showed stability of the main groupings. The size of the nodes varies according to their frequency. The larger the nodes, the higher their frequency. In addition, they are sorted in descending order, and the most frequently occurring keyword is innovation, with 271 occurrences, followed by study with 218. This shows that education is still an evolving field, requiring innovation tools to continue adapting to technological advances, such as AI and the adoption of crowdsourcing, in order to improve it. The keyword crowdsourcing appears with 90 occurrences, which suggests that it is strongly linked to other keywords, thus explaining that it is still emerging and in an evolutionary phase. The co-occurrence of terms refers to their association or simultaneous appearance in the totality of the data. This co-occurrence map provides essential insights for our study and future researchers. The red node on this map shows that crowdsourcing is strongly associated with learning, teaching,

platforms, efficiency, students, and schools. This is due to the adoption and integration of this technique in education to improve learning, teaching methods and the quality of education. Mapping these keywords can provide insight for future research.

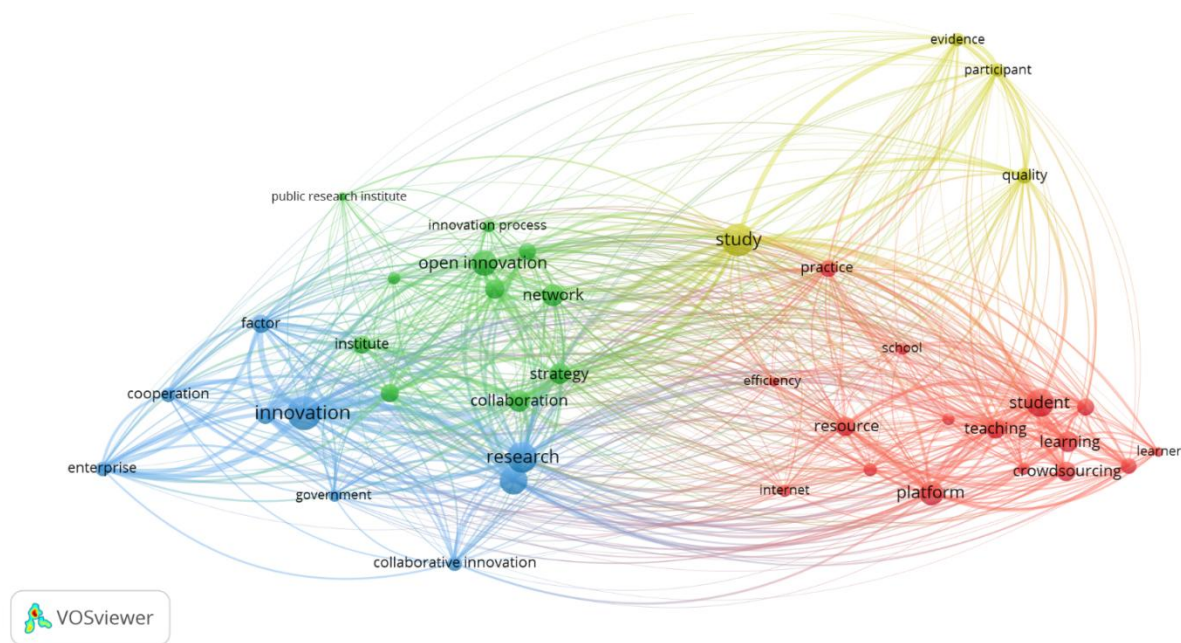


Fig. 3. Keyword co-occurrence map.

3.5. Crowdsourcing and Education: Most Influential Articles

Following our research process, the most cited articles in the field of crowdsourcing adoption in educational institutions are listed in Table 5. The article by Poetz and Schreier [29] entitled “The Value of Crowdsourcing: Can Users Really Compete with Professionals in Generating New Product Ideas?” is the most cited article in previous studies. It received 906 citations. The authors focused on the concept of crowdsourcing in the generation of new ideas for product innovation, making a comparison between professionals and users of crowdsourcing. This concept is to be applied to the generation of ideas for educational projects, the improvement of curricula, and the participation of students and teachers in collaborative research. “Decisions 2.0: The Power of Collective Intelligence” by Boimabeau [30] is the second article selected, with a total of 374 citations. The authors discuss the evolution of problem-solving approaches and how Web 2.0 technologies, the wisdom of crowds and collective intelligence facilitate more collaborative and innovative decision-making. In the context of educational institutions, Web 2.0 tools such as

Table 5. Most cited articles.

	Source	Authors	Document title	Total citations
1	JPIM	Poetz, M.K., Schreier, M. (2012)	The value of crowdsourcing: Can users really compete with professionals in generating new product ideas?	906
2	MIT SMR	Boimabeau, E. (2009)	Decisions 2.0: The power of collective intelligence	374
3	JKE	Komninos, N., Pallot, M., Schaffers, H. (2013)	Special Issue on Smart Cities and the Future Internet in Europe	244
4	JBR	Xie, X., Wang, H. (2020)	How can open innovation ecosystem modes push product innovation forward? An fsQCA analysis	175
5	ARS	van Hemert, P., Nijkamp, P., Masurel, E. (2013)	From innovation to commercialization through networks and agglomerations: Analysis of sources of innovation, innovation capabilities and performance of Dutch SMEs	132
6	IJEIM	Malecki, E.J. (2011)	Connecting local entrepreneurial ecosystems to global innovation networks: Open innovation, double networks and knowledge integration	120
7	JOI (TMC)	Ramírez-Montoya, M.S., Castillo-Martínez, I.M., Sanabria-Z, J., Miranda, J. (2022)	Complex Thinking in the Framework of Education 4.0 and Open Innovation—A Systematic Literature Review	121
8	CSE	Williamson, B. (2018)	Silicon startup schools: technocracy, algorithmic imaginaries and venture philanthropy in corporate education reform	110
9	EM	Shao, B., Shi, L., Xu, B., Liu, L. (2012)	Factors affecting participation of solvers in crowdsourcing: An empirical study from China	84
10	IJAIE	Dillenbourg, P. (2016)	The Evolution of Research on Digital Education	81

platforms, online forums, wikis and social networks can transform the way decisions are made, making them more innovative, creative and participative. Furthermore, they could foster an atmosphere of cooperation and commitment in the educational community. With a citation total of 81, Dillenbourg [31] conducted the study “The Evolution of Research on Digital Education”. In this study, the author focuses on the evolution of Artificial Intelligence in Education (AIED) over the last 25 years, and highlights six major trends influencing learning technologies, such as the physicality of interactions (interaction & physical space), the role of teachers and the General Evolution of Learning Technologies. The use of crowdsourcing methods and probabilistic models has led to the realization of less deterministic, more flexible and open learning environments, evolving from closed systems to interactive and dynamic ecosystems. These trends illustrate the progression of Artificial Intelligence in Education to comprehensively integrate the physical, social and collaborative aspects of the classroom, while harnessing advanced technologies to enrich the educational experience.

3.6. Co-citation Analysis and Gap-finding

The analysis of co-citations remains an indispensable analytical step in a bibliometric study. This analysis enables us to identify existing conceptual and thematic connections between scientific works dealing with the adoption of crowdsourcing in educational institutions, shedding light on trends and networks of influence in this field. Co-citation analysis highlights thematic and conceptual connections between scientific works, revealing research trends and networks of influence within a particular field. Donthu et al. [28] suggest that co-citation analysis demonstrates fundamental knowledge of a topic through the semantic connections of co-cited references. Figure 4 shows the co-citation map of references cited at least three times in the selected articles. The minimum threshold of three citations was chosen to capture a sufficiently representative network of central references. The red nodes form the core of our network, indicating the most influential contributions, otherwise representing the publications of the most frequently cited authors. References [32,33,34] and others (blue nodes) are frequently cited and form an integral part of the network, but are slightly less central than the red nodes. Although green nodes are less dominant, they occupy an intermediate role in terms of citations. They may correspond to studies and research filling gaps in the field. Yellow nodes, such as [35,36] and others, represent publications of particular importance, but may be more recent or less centralized.

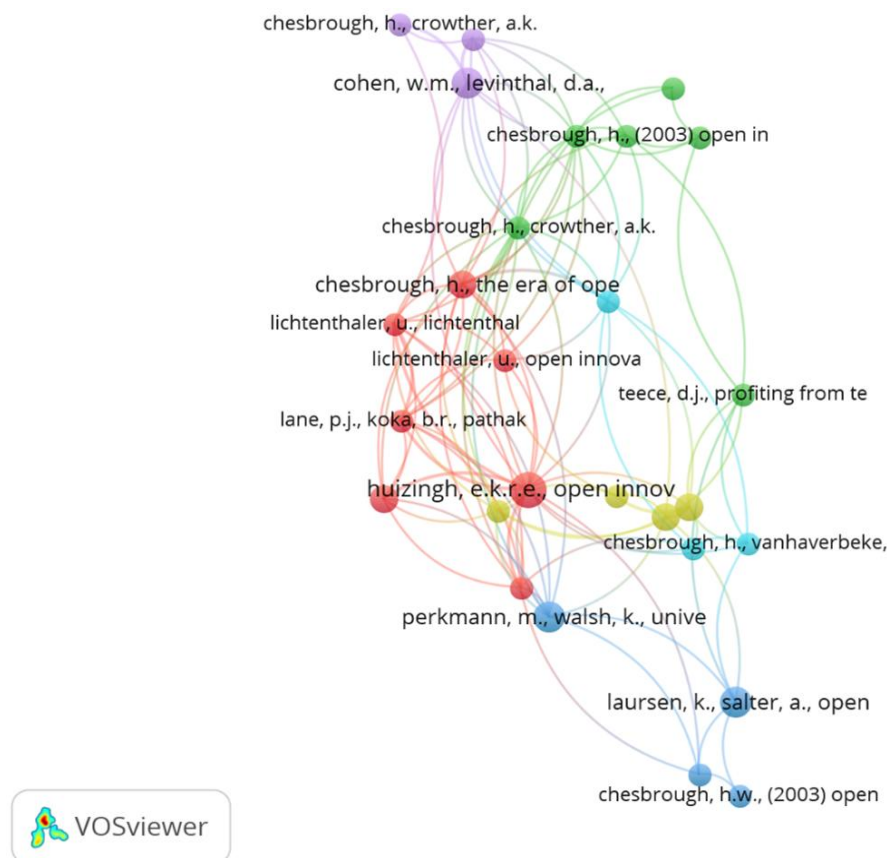


Fig. 4. The Co-citation Map.

4. Discussion and Implications

After providing an overview of the topic and defining key concepts, including crowdsourcing and its types, the article concentrated on the potential application of crowdsourcing in educational institutions. The work was carried out using bibliometric techniques, providing statistical and relevant information, while exploring the impact of existing research on this field. Our research revealed a lack of bibliometric studies on this topic, which motivated this work to explore the adoption of crowdsourcing in educational institutions through bibliometric analysis and visualization of mapping data. The conducted analysis underscored the importance of crowdsourcing in educational settings, along with key growth trends and developmental paths in the field. Llorente and Morant [12] note that crowdsourcing enhances personalized support for students in their learning and development. As a result, students will be able to successfully complete their course and meet their pedagogical needs. In this sense, Ainoutdinova and Blagoveshchenskaya [37], show that, although crowdsourcing goes beyond this satisfaction and meeting students' expectations, it helps create open communities, foreign language learning spaces, massively open online courses (MOOC) and virtual network platforms for sharing material, ideas or links.

The study also identified major contributions through leading articles and influential sources. Additionally, key bibliometric data were examined to track the development of the subject. However, the research revealed a lack of conceptual and methodological work, as well as a wide dispersion of the literature, while pointing out underexplored areas and opportunities for future research.

The scope of the study is limited to the bibliometric examination of biographical information. Metrics relating to articles on crowdsourcing in educational establishments provide us with key elements. The period studied elucidates that our subject is relatively recent but growing. Our findings align with those of recent studies [11], which highlight the significant growth of crowdsourcing analysis in academia in recent years, including its application in the field of language teaching and learning. The number of sources identified indicates substantial academic and interdisciplinary interest. The average annual growth rate of 21.7% and the multiplier coefficient demonstrate a proportional increase in publications in this field. The average citation count of 26.33 underlines the considerable academic impact of the literature in this field. Furthermore, the relatively low number of 64 single-authored papers indicates a trend toward collaboration among researchers, highlighting the importance of cooperation and synergy. Consequently, the variety of institutions actively involved in publishing work on crowdsourcing in educational institutions yield an institutional diversity index (top 10) of 0.401360, reflecting a reasonable diversity that could enrich research with varied perspectives and foster interdisciplinary collaborations. In this context, collaboration could be fostered by modern ICT technologies through crowdsourcing. Moreover, our findings are consistent with recent research indicating that technologies can create new opportunities for teacher collaboration [38,39].

The evolution of problem-solving approaches and how Web 2.0 technologies, the wisdom of crowds and collective intelligence facilitate more collaborative and innovative decision-making were discussed. Web 2.0 tools such as platforms, online forums, wikis and social networks can transform the way decisions are made in educational institutions, promote crowdsourcing and facilitate interaction and learning. Previous research by Van Bommel et al. [40] suggests that teachers can both share and acquire knowledge within social media spaces.

Extensive research has been carried out into crowdsourcing and education, as evidenced by the gradual increase in publications between 2005 and 2015, followed by a variable trend and fluctuations between 2016 and 2023. The significant peak period is recorded between 2020 and 2022, with maximum growth in 2022. Given that few articles were published before 2009, this pivotal year marks the start of a more substantial significant output in the field. These results are supported by Garrigos and Narangajavana [11], who state that crowdsourcing and education research began in 2009. Our results suggest that the adoption of crowdsourcing in educational institutions is periodic or event-driven. The significant fluctuations recorded show that it is influenced by major global events and specific trends. The COVID-19 pandemic likely prompted the education ecosystem, and teachers in particular, to strengthen collaborations and move towards cutting-edge technologies and distance learning solutions. The way in which teachers can collaborate through technology should continue to generate interest [41]. The gradual increase recorded between 2009 and 2015 underlines the growing adoption of crowdsourcing techniques in various sectors, including education. The rise of popular crowdfunding and crowdsourcing platforms like Mechanical Turk and Kickstarter has facilitated greater exploration of these methods in educational settings. Crowdfunding has proved essential in fostering crowdsourcing through small online donations to large investors to fund educational projects. Interest in crowdfunding increased after the financial crisis of 2007-2008, when tighter lending restrictions dried up start-up capital [42]. The stability observed between 2016 and 2019 is perhaps explained by the stability in crowdsourcing methodologies and applications having reached a certain level of emergence. It should be emphasized that this stability is not in itself a proof of maturity or effectiveness, but mainly reflects the growing interest of the scientific community in this field. It also reflects a period of optimization and consolidation of the technologies put in place. The evolution of publications in 2020 and 2022 is due to the emergence of new technological innovations, the development of artificial intelligence tools and crowdsourcing platforms.

This study also highlighted the place occupied by new technological innovations focused on crowdsourcing, given their significant impact and in particular the influence of ICT, as well as the revolutionary development of generative

artificial intelligence, particularly in the field of foreign language teaching [43]. Educational institutions can harness collective intelligence through crowdsourcing to improve the quality and relevance of education. To achieve this, local authorities need to put in place all the appropriate mechanisms that can stimulate open innovation with a view to harnessing collective intelligence [44]. Artificial intelligence, meanwhile, reinforces these efforts by offering sophisticated tools for analysis and personalization. Machine learning has become one of the branches of AI, and its capacity lies in the automation of complex tasks and the analysis of big data. In this context, Rong et al. [45] assert that crowdsourcing is a cutting-edge research area that can facilitate machine learning.

Based on the literature, some researchers, including Alenezi and Faisal [46], suggest that crowdsourcing and machine learning can enhance various educational activities, such as research, student interactions in massive open online courses, homework grading, exams, and more. Crowdsourcing has also proven to be a collaborative practice between teachers. Although designed for academic conversation and the exchange of ideas, it has proved more effective in changing teachers' beliefs as well [47,48].

In fact, crowdsourcing applications have proved indispensable in educational institutions, due to their identified benefits and advantages. It could offer academic actors (teachers, students...) immense opportunities to improve teaching and learning processes, with benefits for local development. Following Bouachri and Zerrad [44], if agreements between actors in different sectors (including education) can foster sustainable development, the question is whether they are beneficial or not. In this context, Lenart-Gansiniec et al. [14] and Gómez-Prado et al. [49] point out that such crowdsourcing facilitates the exchange of educational material, knowledge, and skills; it optimizes costs and time, promotes research, and supports student projects. In addition, the aspect of motivation and incentive has taken its place among others. According to Abdi et al. [50] crowdsourcing helps to reinforce learning (internal and external) and can contribute to improving motivation and incentive to learn. In addition, it makes students feel more engaged, relaxed, independent and motivated [37]. Donlon et al. [51] in their study point out that crowdsourcing builds trust between participants and increases their desire to collaborate.

These productions have been confirmed not only by their fluctuations over time, but also by their considerable number of frequently cited citations. The article by Poetz and Schreier [29] is the leading publication, with over 906 citations. The concept of crowdsourcing in generating new ideas, through comparing professionals and users, is evident. It is followed by Boimabeau's [30] paper, with a figure of over 374 citations.

Analysis of the co-citation map shows relationships between researchers based on citation frequency. The nodes representing the authors indicate a higher frequency of Huizingh [52] in the different clusters. The Move cluster is led by Cohen and Levinthal [35], and their paper represents a significant frequency, ranking second among all co-cited papers. Their studies [32,33] show stronger relationships and form the most cited nodes at the cluster level, represented in blue. Existing thematic and conceptual connections between scientific works reveal trends, research dimensions and networks of influence of crowdsourcing in educational institutions.

The prevalence of crowdsourcing techniques in this sector is demonstrated by an analysis of the co-occurrence of all keywords. Based on the major themes analysis figure and the co-occurrence map, the term innovation ranks first, with 271 occurrences, followed by study with an occurrence of 218. Although crowdsourcing is a specific, relevant, and emerging topic in the field of education, it may not have reached the same frequency level as broader concepts such as innovation, which is used generally in various contexts and thus appears as a larger node in the co-occurrence analysis. Given that crowdsourcing is strongly present in other fields (technology, sociology, management), it appears less frequently present in the educational context. The four groups presented indicate interconnected themes of interest that may guide future research and practice in education, particularly as regards the use of crowdsourcing to optimize learning and teaching methods. The clusters illustrate the multiple aspects of crowdsourcing in educational settings, and provide a detailed view of the key and intriguing factors for the successful implementation of crowdsourcing in educational settings. Although it is still in the launch phase, its adoption is becoming essential, as it provides a practical, feasible and effective method for enriching education by harnessing collective intelligence and integrating technological innovations. Our results align with research indicating that crowdsourcing may be an effective approach for developing collective educational resources in medical education [53] and higher education [51,54].

The multidisciplinary nature of the sources indicates that crowdsourcing in education has proved to be a topic of multidisciplinary interest, touching on technology management, innovation, sustainability and even ethics. Moreover, it has also become very relevant in recent years in the academic world, which was supported by Estell és-Arolas et al. [55] by showing that its use is present in many academic fields. However, innovation and technology consistently remain as the central axes. Research Technology Management and Journal of Open Innovation Technology Market and Complexity are clearly distinguished and proved to be the main sources of publications. This explains why these journals have become channels for disseminating knowledge about our subject. On the basis of the Percentage of Publication per Journal JPR calculated, both sources devote more than 5% of their publications to the field of crowdsourcing in education with a rate of 7.21% and 5.9% respectively. In contrast, the AMA Journal of Ethics ranks tenth, with a rate of 0.66. This is to be expected, given that it is well respected in the field of medical ethics and the social sciences of health.

The various clusters revealed by co-citation analysis highlight the different theoretical and practical dimensions of crowdsourcing research explored by researchers. In addition, the search for gaps in the grey literature highlighted areas

requiring further attention and exploration, including the projection of crowdsourcing into the future and the exploration of new crowdsourcing technologies to be implemented in response to challenges encountered in the educational context, as well as to adapt research to technological developments. In addition, 2020 was marked by the global crisis of COVID-19. These major world events provided an opportunity to propel nations to seek cutting-edge technologies and innovative solutions to ensure the stability and survival of territorial development of the educational sector in particular. As already mentioned, this link remains hypothetical in the context of the present bibliometric analysis and cannot be established as a direct explanatory factor for the observed evolutions. Although the study mainly uses descriptive bibliometric indicators to characterize the general structure of the field, it also integrates network and thematic analyses, notably through the co-quotation of references and the co-occurrence of keywords. These analyses were voluntarily conducted in a synthetic way in order to preserve the overall coherence of the study, whose main objective is to propose a structuring mapping of crowdsourcing in educational institutions. Further longitudinal comparative analyses or advanced network modeling could be relevant extensions for future research. This study points out that the uneven distribution of literature, with a scarcity of high-quality studies specifically addressing this topic, may have biased, limited or even distorted the results of the analysis. Future emerging research could resolve and fill this gap. Although bibliometric methodology offers considerable advantages, it also has certain limitations that can influence the accuracy of analyses. Results depend heavily on the quality of the studies, the analysis indicators chosen, and the selection criteria such as linguistic limitation can lead to an under-representation of some enriching contributions, which is a limit of the study and opens up prospects for future research integrating multilingual corpora. Moreover, the use of the Scopus database may introduce coverage bias and lead to the exclusion of relevant works indexed in other databases such as Web of Science, ERIC or Google Scholar. Furthermore, future research could mobilize a multi-base approach to broaden the analytical scope and strengthen the comparative robustness of results; thus, a more comprehensive analysis is becoming more imperative. The identified gaps call for more targeted research directions. Empirical studies, including qualitative and quantitative studies, are needed to analyse the conditions for crowdsourcing adoption in educational institutions and its effects on pedagogical practices and governance. The development of integrative conceptual frameworks linking crowdsourcing to educational innovation remains insufficiently explored. Comparative analyses between educational contexts could finally shed light on the mechanisms of dissemination and institutionalization of these practices. Case studies could be integrated to deepen understanding of specific situations, providing possible models for crowdsourcing in education. The specific educational context and criteria used in this study mean that, while the results offer valuable insights, they cannot be generalized to other contexts. Bibliometric results indicate that crowdsourcing in an educational context is an emerging field, marked by growth, but still poorly structured theoretically, as evidenced by the dispersion of sources, the diversity of keywords and the centrality of open innovation frameworks. This situation calls for the development of conceptual frameworks linking crowdsourcing to theories of educational innovation, collective intelligence and organizational capacity. At the institutional and practical level, the predominance of multi-author collaborations and institutional diversity suggest the need for coordinated strategies favoring inter-institutional networks, inter-institutional partnerships, the co-creation of teaching resources and the use of collaborative platforms. Finally, the rise of themes related to innovation, ICT and AI underlines the importance for educational institutions to invest in digital infrastructure and training, in order to translate scientific advances into concrete pedagogical practices.

By addressing the gaps and applying the research insights identified in our study, we support the continuous updating of methods and promote the ongoing advancement of crowdsourcing practices in the educational sector, which could encourage the stakeholders involved and decision-makers to adapt these practices in educational institutions. In short, the avenues of research presented here have the potential to greatly enrich previous literature, which could fill important gaps.

5. Conclusions

By applying a variety of bibliometric methods and tools, this study has identified the importance of two concepts, crowdsourcing and educational institutions, for the sustainable development of the education sector. This importance was identified through the analyses carried out in section 3. Subsequently, we thoroughly examined the various aspects of crowdsourcing in educational institutions in this bibliometric study.

The bibliometric approach proved valid for achieving our objectives and contributed significantly to the existing body of knowledge. Complex bibliometric analyses were carried out by adopting a rigorous method for identifying and analyzing relevant articles, using ScientoPy and VOSviewer software. These tools were effective in helping us to map co-occurrences and co-citations, thus providing a clear overview of trends, interactions and connections in crowdsourcing research in education.

In this study, the average annual growth rate identified in the key bibliometric data indicates a growing interest in this field of research. This aligns with recent research by Garrigos and Narangajavana [11], who highlight significant growth in the analysis of crowdsourcing within academia in recent years, including its application in language teaching and learning. Furthermore, the lasting impact of previous studies and their relevance were also manifested by the average citations per paper, suggesting that they have significant academic impact, impressive visibility and reputation,

and research quality in the field of crowdsourcing in education. Furthermore, the average age of the papers, the variety of authors and the institutional partnership and collaboration testify to an interconnected and more dynamic research field.

Our article has highlighted the works that have had an impact on the field studied, through an analysis of the most influential studies. The close connections between different key concepts were illustrated using the co-occurrence map. Innovation, study, research institutes, platform and crowdsourcing were the five most frequently used keywords before and after 2022, maintaining their positions as the most prominent terms. The domains of innovation (e.g., platform, crowdsourcing, open innovation, network) and education (e.g., study, research institutes, e-learning, student) always remained at the heart of researchers' concerns because of their impact and capacity to respond to socio-economic challenges and foster an educational climate based on crowdsourcing practices. Our results suggest a convergence on innovation and collaborative educational practices, with a progressive increase in empirical research in this area, which mainly reflects the growing interest of the scientific community in this field.

Distinct clusters were identified through the authors' co-citation analysis, revealing the various dimensions of crowdsourcing research in the educational context. In addition, the review of gaps in the existing literature highlighted multiple areas of research calling for further exploration, such as the ongoing evaluation of crowdsourcing tools and the exploration of new applications and innovative techniques in the educational sector in particular.

Ultimately, this bibliometric study provides a comprehensive overview of the key factors for the effective and successful adoption of crowdsourcing in educational institutions. It underlines the importance of innovation through crowdsourcing and collaborative working in education. In sum, to answer our research questions and achieve our objectives, our analysis highlighted the advances in crowdsourcing research in educational institutions by exploring trends, major themes, and collaborations through co-citation analysis, while also identifying gaps and unexplored aspects of the field that require further research. The results obtained could enrich our understanding of the subject, paving the way for new research perspectives on the one hand, and guide future research, adopting innovative techniques to perfect learning and teaching processes on the other.

All the Declarations and Statements

Author Contributions Statement

The authors contributed equally to this research.

All authors have read and agreed to the published version of the manuscript.

Conflict of Interest Statement

The authors declare no conflicts of interest.

Funding Declaration

None.

Data Availability Statement

The datasets generated and analyzed during the current study can be obtained from the corresponding author.

Ethical Declarations

None. This study did not involve human participants or animals.

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Declaration of Generative AI in Scholarly Writing

The authors declare that generative AI and AI-assisted technologies were only used to improve language clarity and readability.

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