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Teaching and Learning in Health Sciences in the Era of Educational Technologies: A Bibliometric Analysis

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Research Article

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Abstract

Background/purpose. The emergence of educational technologies has profoundly transformed teaching and learning methods in health sciences. This bibliometric study aims to identify the most widely used educational practices in this field between 2014 and 2024, exploring their applications within a constantly evolving technological context.

Materials/methods. Data were collected from the Scopus database using a specific query incorporating terms related to educational technology, resulting in a final corpus of 2460 articles written in English. A quantitative analysis was conducted using the R programming language within the RStudio development environment, utilizing the Bibliometrix package and its Shiny App interface. This analysis included a keyword co-occurrence analysis to identify the most cited publications, leading journals, and the most frequently associated keywords.

Results. The findings reveal a strong predominance of terms related to education, learning, and teaching, reflecting a significant focus on pedagogical approaches tailored to health sciences. Constructivist and cognitive theories emerged as the most commonly used conceptual frameworks. The integration of advanced technologies, such as artificial intelligence (AI) and online learning environments, was also highlighted. The COVID-19 pandemic served as a catalyst to accelerate these pedagogical transformations.

Conclusion. This study underscores the importance of transitioning toward educational practices that integrate digital innovations and highlights the need to develop pedagogical strategies tailored to the profile of health sciences students.

1. Introduction

Education is a fundamental pillar of the development of modern societies. Over the years, pedagogical approaches have evolved to meet the needs of diverse groups of learners, with particular attention given to adapting teaching methods in line with technological advancements. This evolution is especially evident in the health sciences field, where educational technology and information and communication technologies for education (ICTE) have become an essential component of pedagogical practices.

ICT have redefined how students access information and interact with educational content. They enable the creation of dynamic, adaptive, and interactive learning environments, fostering knowledge acquisition that goes beyond traditional methods (Lafraxo et al., 2021, 2024). However, the integration of these technologies comes with a growing need to rethink pedagogical approaches and identify the most appropriate learning theories to support this transformation.

Learning theories provide essential conceptual frameworks for understanding and optimizing knowledge acquisition processes. Among the most influential are behaviorism, cognitivism, constructivism, and socioconstructivism. Behaviorism (Watson, 1913; Pavlov, 1927; Skinner, 1938), developed by researchers such as Watson, Pavlov, and Skinner, emphasizes observable behaviors in response to external stimuli, highlighting the role of reinforcement and repetition in learning. Cognitivism (Piaget, 1950; Neisser, 1967), promoted by researchers like Piaget and Neisser, offers a different perspective by focusing on internal mental processes, such as memory, attention, and problem-solving. This theory is particularly relevant in digital environments that seek to stimulate learners' cognitive engagement through interactive activities and personalized content. Constructivism (Piaget, 1952), largely influenced by Piaget's work, emphasizes learners' active construction of knowledge through interaction with their environment. This approach encourages project-based and exploratory learning methods, often integrated into virtual environments and collaborative platforms. Finally, socioconstructivism, developed by Vygotsky (Vygotsky, 1978), highlights the importance of social and cultural interactions in the learning process. This theory finds direct application in online discussion forums, collaborative projects, and virtual learning communities.

In addition to these theories, learning styles represent a fundamental aspect of pedagogical design. They describe students' individual preferences for acquiring and processing information, ranging from visual learners who prefer graphical representations to kinesthetic learners who learn through manipulation and experimentation. Understanding these preferences allows for the design of tailored learning environments, maximizing the effectiveness of teaching methods.

Teaching strategies and methods also play a prominent role in integrating educational technologies. Traditional lecture-based approaches are gradually being complemented by active methods such as problem-based learning, flipped classrooms, and interactive simulations. These new approaches leverage ICTs to offer personalized, collaborative, and immersive learning experiences.

Despite the opportunities offered by educational technology, there remains an urgent need to evaluate pedagogical practices and identify the most effective theories and methods for health sciences students. These learners often have specific needs due to the complexity and practical nature of their field of study. A better understanding of theoretical frameworks suited to their profile would help optimize learning outcomes and foster a better integration of the competencies required for their future professional practice.

This bibliometric study aims to address this need by identifying and analyzing teaching and learning practices in health sciences in the era of educational technology. Through a rigorous analysis of a corpus of 2460 articles written in English between 2014 and 2024, this research will provide

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valuable insights into emerging educational practices and contribute to guiding future pedagogical developments. The objectives of this study are as follows:

- Examine the increasing trend in the publication of articles over the last decade.
- Identify patterns, including the most prolific scientific journals and the most cited articles in the studied field.
- Analyze the dominant keywords in analyzing teaching and learning practices in health sciences in the era of educational technology by conducting a keyword co-occurrence analysis.

The rest of the document is structured as follows: the second section presents the literature review. The third section details the methodology employed. The fourth section provides a comprehensive descriptive analysis and an analysis of keyword co-occurrence. Finally, the last section engages with a comprehensive discussion.

2. Literature Review

The rise of educational technologies has profoundly transformed teaching and learning methods, particularly in the field of health sciences. Digital tools now offer unprecedented opportunities to enhance the learning experience by promoting a more interactive, personalized, and immersive approach (Llorca, 2020b). Among these innovations, online learning platforms, medical simulation, virtual reality (VR), and augmented reality (AR) are increasingly used to improve the acquisition of both clinical and theoretical skills (Llorca, 2020a).

Online learning platforms, whether MOOCs (Massive Open Online Courses), Learning Management Systems (LMS), or interactive modules, enhance accessibility to educational content while facilitating self-directed learning. These tools are accompanied by new pedagogical approaches, such as adaptive learning, which automatically adjusts content and learning pace based on students' performance and individual needs. This personalization of the educational pathway is particularly relevant for health sciences students, who must assimilate a vast amount of information while developing complex practical skills. The integration of active learning methodologies in distance education could serve as a valuable complement to traditional teaching (Mancin et al., 2025).

Moreover, immersive technologies such as VR and AR are increasingly integrated into medical and nursing education (Quah et al., 2025). These technologies enable learners to practice in realistic simulated environments, replicating clinical situations without risk to patients while enhancing the precision of technical procedures (Lin et al., 2024). These tools promote experiential learning by reinforcing memory retention and decision-making in various contexts. Additionally, artificial intelligence (AI) is playing a growing role in health sciences education. With machine learning algorithms, it is now possible to analyze students' learning pathways and provide adaptive support. Educational chatbots and virtual assistants offer personalized assistance by answering students' questions and facilitating access to educational resources. Similarly, AI-driven recommendation systems help guide learners toward relevant content based on their knowledge gaps and areas of interest, serving as intelligent pedagogical assistants (Gökay Özgür & Bekiroğlu, 2025).

One of the major shifts in health sciences education is the transition from knowledge-based teaching to a competency-based approach (Le Goff, 2022). This approach emphasizes the development of specific, measurable skills aligned with professional requirements and patient needs. Unlike traditional models, where learning is based on the accumulation of theoretical knowledge, competency-based education focuses on the progressive mastery of essential abilities for clinical practice. It promotes the integration of knowledge, technical skills, and professional behaviors in authentic contexts, preparing learners for complex and unpredictable professional situations.

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Educational technologies play a key role in implementing the competency-based approach by facilitating teaching, assessment, and student monitoring. Virtual learning environments provide interactive platforms that allow students to access educational resources tailored to their pace and level of progress. These systems integrate performance analysis tools, enabling real-time tracking and continuous formative assessment. Digital simulations are also powerful tools for developing clinical skills, immersing learners in realistic scenarios through representations and concept maps. Concept maps play a fundamental role in knowledge construction by providing a graphical representation of relationships between different notions and key concepts (Lăcrămioara, 2015). These tools help students organize, structure, and visually connect their knowledge, fostering a deeper understanding of educational content. In the context of competency-based learning, concept maps assist in identifying links between various competencies to be acquired and integrating theoretical knowledge with practical applications. They are particularly useful for mapping out interconnections among numerous and complex concepts, such as in pathophysiology, pharmacology, or psychology. By reinforcing critical thinking and problem-solving skills, concept maps enhance students' ability to apply their knowledge effectively in professional settings.

3. Methodology

Data collection was conducted by querying the Scopus database, recognized for its extensive coverage of international scientific publications. A precise Boolean query was designed to target documents addressing pedagogical approaches, learning theories, and educational technology in the context of health sciences. The query syntax was as follows:

(TITLE-ABS-KEY (pedagogical AND approaches) OR TITLE-ABS-KEY (teaching AND strategies) OR TITLE-ABS-KEY (learning AND theories) OR TITLE-ABS-KEY (learning AND styles) OR TITLE-ABS-KEY (educational AND technology) AND TITLE-ABS-KEY (health AND sciences)) AND PUBYEAR > 2014 AND PUBYEAR < 2025

This query identified an initial total of 4174 documents published between 2014 and 2024. Several filters were applied to ensure the corpus's quality and relevance. First, only documents written in English were retained, reducing the corpus to 3836 documents. Additionally, to focus on original research with substantial scientific value, only research articles were selected. This process resulted in a final selection of 2460 articles.

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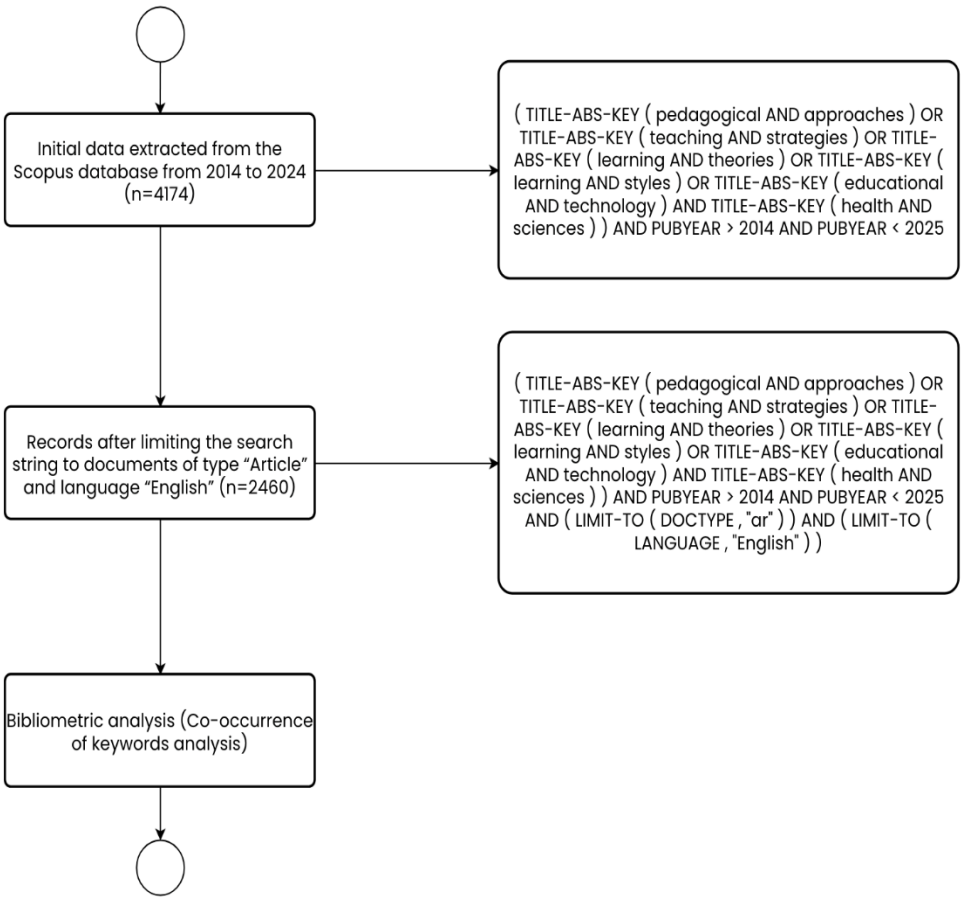

Figure 1. PRISMA flowchart of research methodology: Process for identifying and selecting studies for bibliometric analysis

The bibliometric analysis of this corpus relied on multiple approaches to explore research trends in health sciences education in the era of educational technologies. The local impact of sources was assessed by analyzing the h-index, total number of citations, and publication volume of each journal to identify the most influential sources. Additionally, an analysis of the most globally cited documents was conducted to determine the publications with the greatest impact on the scientific literature. The most frequent words analysis identified dominant terms in article titles, abstracts, and keywords by applying text mining techniques to the corpus metadata. Keyword co-occurrence analysis was used to examine relationships between recurring concepts by generating a co-occurrence network, highlighting dominant themes and their structure. Finally, thematic mapping classified themes based on their centrality and density into four categories: driving themes, basic themes, emerging or declining themes, and specialized themes. These analyses were conducted using the R programming language and the RStudio environment, a leading platform for statistical analysis and data visualization. The Bibliometrix library, specifically designed for bibliometric studies, was employed for the extraction, manipulation, and analysis of bibliographic data. Additionally, the Biblioshiny graphical interface, included within Bibliometrix, facilitated result visualization and the generation of relevant graphical representations.

Metadata from the 2460 articles were imported in CSV format into RStudio. An initial statistical exploration revealed the temporal distribution of publications and identified the most prolific journals. Subsequently, keyword co-occurrence analyses were performed to understand emerging themes in the fields of education and health sciences. The choice of R-Studio and Bibliometrix was motivated by their capability to efficiently and flexibly handle large bibliographic datasets. The integration with Biblioshiny provided a user-friendly interface to explore the data and produce high-quality, publication-ready visualizations.

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4. Results

4.1. Publication Output

The temporal distribution of scientific production over a decade (2014–2024) on education and educational technologies in health sciences is presented in the figure below (see Fig. 2). A clear upward trend is observed, reflecting a significant increase in interest in this topic within the scientific community. Between 2014 and 2019, scientific production remained relatively stable, with slight variations around 200 to 300 publications per year. This period likely corresponds to a phase of research consolidation regarding the early integration of educational technologies in health sciences education. A marked increase is visible from 2020 onward. This rise can be attributed to several factors, including the impact of the COVID-19 pandemic, which necessitated a rapid shift to distance learning formats, thereby stimulating interest in digital pedagogical approaches and learning theories adapted to virtual environments. Furthermore, the emergence of sophisticated digital learning platforms and new adaptive teaching methods also contributed to this growth. The year 2024 marks a significant peak in scientific production, with over 400 publications. This reflects not only the consolidation of academic interest in these themes but also a growing recognition of the importance of pedagogical strategies based on robust theoretical approaches such as cognitivism and socio-constructivism in a rapidly evolving digital context. This temporal evolution highlights the vitality of research in this field and the progressive adaptation of health sciences education methods to a rapidly changing digital world.

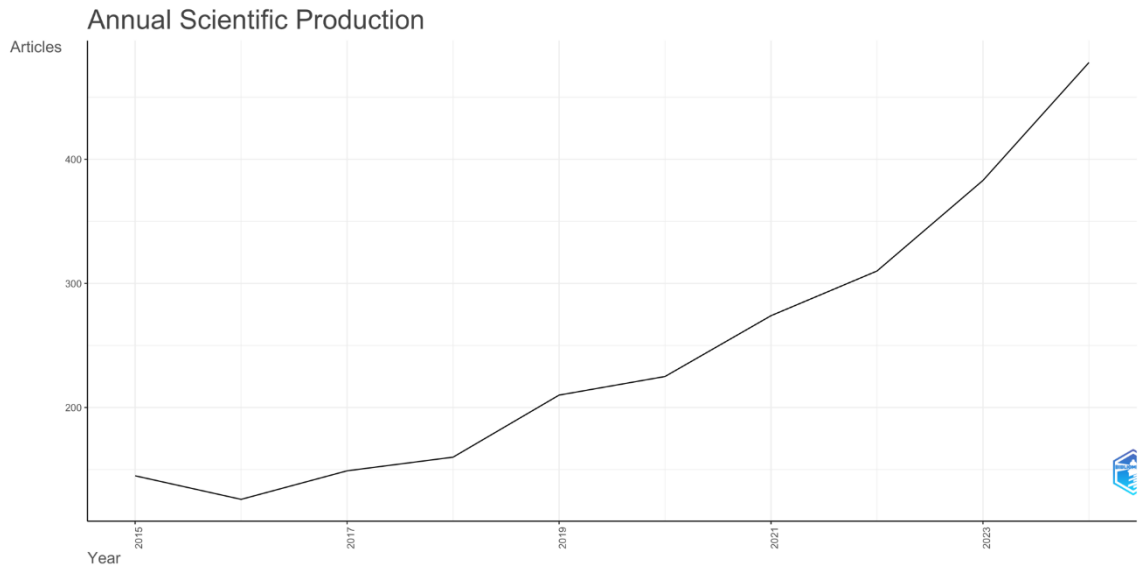

Figure 2. Annual Scientific Production

4.2. Sources' Local Impact

The following table presents the main sources that had a significant impact on the fields of education and educational technologies in health sciences between 2014 and 2024. BMC Medical Education stands out as the dominant source, with an h-index of 20, a total of 1,363 citations, and 84 published articles, reflecting its central role in health education research. The International Journal of Environmental Research and Public Health follows with an h-index of 14 and 706 citations for 40 publications, illustrating an expansion of educational research in the field of public health. Specialized journals such as Nurse Education Today (h-index of 12) and Medical Teacher (h-index of 11) are essential references for pedagogical methods in nursing sciences and medical training. Journals focused on teaching fundamental sciences, such as Anatomical Sciences Education and Advances in Physiology Education, reinforce the importance of targeted disciplinary approaches. Additionally, generalist journals such as BMJ Open and PLOS ONE demonstrate a broad dissemination of

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educational research within the wider scientific community. The h-index indicator confirms the prominence of specialized journals, although some, like Implementation Science, exhibit notable influence through innovative pedagogical approaches. This analysis reveals a diversification of sources, highlighting the growing importance of educational strategies and technology in health sciences teaching, supported by a multidisciplinary approach. The indicators used to assess the influence of sources are:

- h_index: An indicator measuring the productivity and scientific impact of the journal.
- TC: The total number of citations received.
- NP: The number of publications in the journal.
- PY_start: The year of the first publication corresponding to the analyzed corpus.

Table 1. Top sources' local impact

Source	h_index	TC	NP	PY_start
BMC MEDICAL EDUCATION	20	1363	84	2015
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	14	706	40	2017
NURSE EDUCATION TODAY	12	335	26	2015
IMPLEMENTATION SCIENCE	11	433	13	2015
MEDICAL TEACHER	11	303	18	2015
ANATOMICAL SCIENCES EDUCATION	10	229	16	2015
ADVANCES IN HEALTH SCIENCES EDUCATION	9	316	14	2016
BMJ OPEN	9	245	31	2016
ADVANCES IN PHYSIOLOGY EDUCATION	8	388	28	2016
PLOS ONE	8	167	32	2016

The most cited documents in the field of education and educational technologies in health sciences between 2014 and 2024 (Bauer et al., 2015; Aristovnik et al., 2020; Kelly & Barker, 2016; Gilboy et al., 2015; Huang et al., 2019; Estai & Bunt, 2016; Khan et al., 2019; Greenhalgh & Papoutsi, 2019; Gao et al., 2015; Stoumpos et al., 2023) are illustrated in the following figure (see Fig. 3). The document by Bauer (2015), published in BMC Psychology, ranks first with a total of 1,242 citations, reflecting a major influence in this research field and emphasizing implementation science and its application in public health and education. Aristovnik (2020) in Sustainability follows closely with 1,188 citations, highlighting a focus on sustainability in educational approaches. His work examined the impact of the COVID-19 pandemic on the lives of higher education students and the transition to online learning. Kelly (2016) in Public Health is also among the key contributions, with 682 citations. Gilboy MB (2015), in the Journal of Nutrition Education and Behavior (604 citations), considered the flipped classroom as an innovative pedagogical approach emphasizing learner-centered teaching. Other notable works include those by Estai (2016), with 516 citations, and Khan (2019), with 283 citations, demonstrating diversification towards human-machine interaction and the importance of integrating new information and communication technologies into health sciences education.

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Examples include interactive programs based on 3D visualization and the impact of mobile learning on increasing student motivation. Finally, more recent studies, such as Stoumpos (2023) in the International Journal of Environmental Research and Public Health, while having fewer citations (20), reflect a continuing publication trend on digital transformation in healthcare. This analysis highlights the strong scientific visibility of certain articles, which serve as essential references for the evolution of educational practices in the field of health sciences.

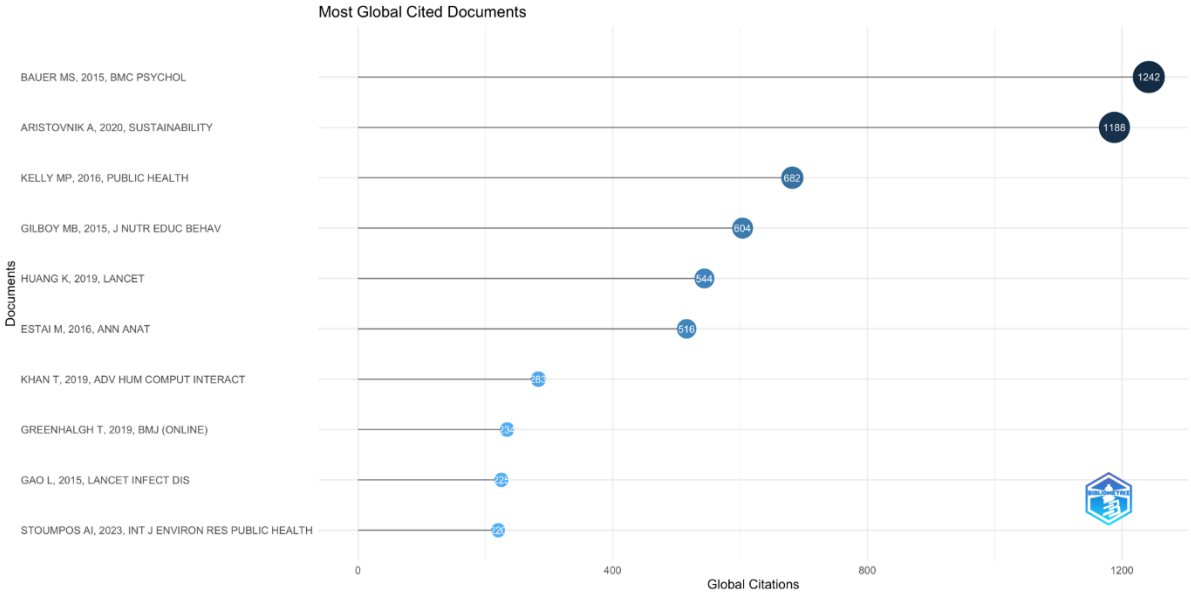

Figure 3. Most Global Cited Documents

4.3. Most Frequent Words

The word cloud presented in figure 4 highlights the key terms most frequently associated with publications on teaching and learning practices in health sciences in the era of educational technology. The most frequently used terms, such as “education”, “learning”, and “teaching”, demonstrate a strong focus on pedagogical aspects related to knowledge acquisition and skill transfer. These fundamental concepts underscore a continuous concern for training healthcare professionals in an evolving educational context. The emphasis on terms like “medical education” and “clinical competence” indicates a strong orientation toward clinical training, with particular attention to preparing health sciences students for practical situations in a complex medical environment. The presence of “medical student”, “health education”, and “student” confirms this interest in target audiences, particularly medical, nursing, and other healthcare students. Research methodologies are also well represented, as shown by the frequent occurrence of terms such as “qualitative research”, “cross-sectional study”, and “surveys and questionnaires.” This highlights a preference for diverse methodological approaches, ranging from in-depth qualitative studies to quantitative analyses based on surveys. The word cloud also reflects the impact of digital transformation and recent crises on educational practices. The emergence of terms like “artificial intelligence” demonstrates the growing integration of digital technologies and AI into health sciences education. Similarly, the presence of “COVID-19” highlights the pandemic’s catalytic effect on the evolution of teaching strategies, particularly through the widespread adoption of digital solutions to ensure educational continuity. Furthermore, cross-cutting themes such as “psychology”, “motivation”, and “leadership” reveal an increasing interest in the psychosocial dimensions of learning, suggesting a growing consideration of students’ and educators’ psychological dynamics in the development of pedagogical strategies. The mention of “implementation science” reflects a

commitment to translating research findings into effective educational practices. Finally, the focus on “health care delivery”, “patient care”, and “clinical article” suggests that student training is not limited to acquiring technical skills but also incorporates a holistic perspective that includes healthcare management and the quality of patient care.

Figure 4. Keywords frequency analysis

This word cloud thus illustrates the diversity and complexity of research in health sciences education, where technological innovations, research methodologies, and human and clinical dimensions intersect. These findings highlight the rapid evolution of the educational landscape in health sciences while suggesting a shift toward a more integrated, technologically advanced, and learner-centered pedagogy.

4.4. Co-occurrence of keywords analysis

Figure 5 represents a co-occurrence network of keywords extracted from our corpus of 2,460 articles published between 2014 and 2024, focusing on pedagogical practices and learning theories in health sciences. This visualization highlights three main thematic clusters, reflecting the dominant research directions in this field.

The first cluster, represented in red, encompasses concepts related to medical education and pedagogical strategies used in the context of health sciences. Terms such as learning, education, medical education, teaching, and medical student occupy a central position in this cluster, indicating their significance in scientific discussions on pedagogical approaches. This cluster highlights researchers’ strong focus on developing educational competencies and adapting teaching methods to meet the needs of health sciences students. The second cluster, in blue, is centered on clinical studies, public health, and survey-based research methodologies. Predominant terms include major clinical study, surveys and questionnaires, health education, and motivation. This cluster underscores the relationship between pedagogical practices and broader themes, such as health promotion, mental health education, and the assessment of learners’ knowledge and motivation. The third cluster, in green, is associated with the impact of the COVID-19 pandemic on health sciences education. Keywords such as COVID-19, pandemic, and coronavirus disease 2019 characterize this group. This cluster reflects researchers’ efforts to document and analyze adaptations in pedagogical practices in response to the unprecedented challenges posed by the pandemic, particularly the increased reliance on educational technologies and distance learning.

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The size of the nodes, particularly for education, learning, and medical education, indicates their high frequency and centrality within the studied corpus. The links connecting these nodes highlight the strong interconnections between concepts, especially between pedagogical strategies and the increasing use of educational technologies such as artificial intelligence. Additionally, the relationships between the clusters demonstrate the evolution of educational practices, influenced both by technological advancements and the specific needs of learners in a rapidly changing context, such as the pandemic.

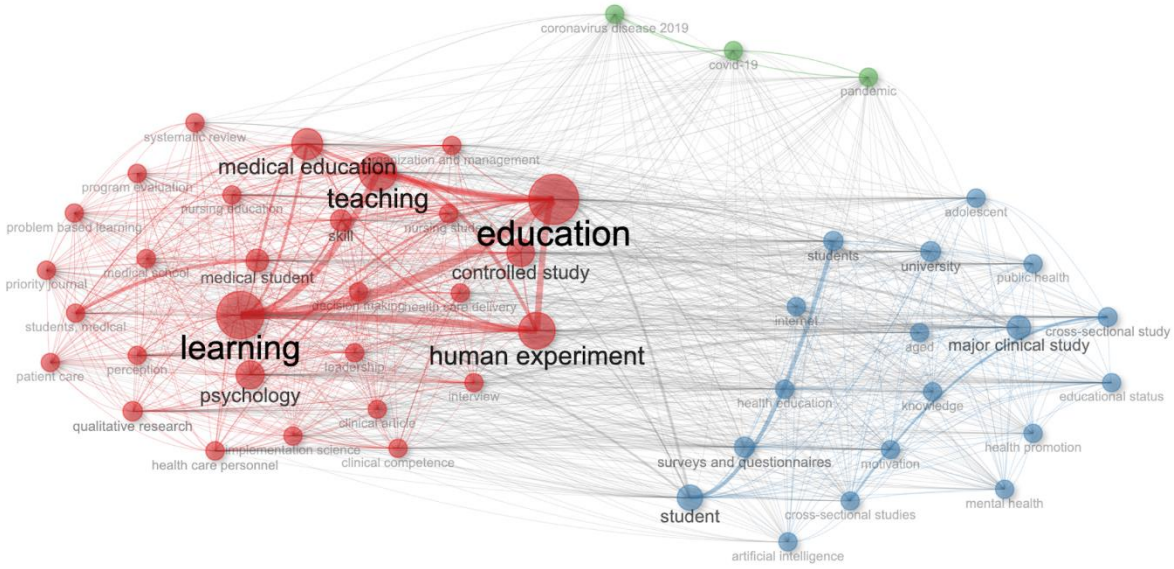

Figure 5. Co-occurrence of keywords analysis

The thematic map presents a multidimensional analysis of the main themes identified in this corpus, evaluating their centrality (representing their relevance in the broader field) and density (reflecting the degree of internal development of the theme) (see Fig. 6). The motor themes, located in the upper right quadrant, include concepts such as education, learning, and teaching. These themes, both highly developed and highly central, are structural pillars of health sciences research. They reflect the importance placed on pedagogical strategies and learning approaches, particularly in the context of health sciences, where the integration of new educational technologies is essential. These themes are at the heart of academic discussions and reflect their transversal impact across multiple subdomains. The basic themes, grouped in the lower right quadrant, such as controlled study and major clinical study, are fundamental concepts that play a structuring role in pedagogical practices but appear underexplored in terms of in-depth research. Their centrality shows that they are closely linked to the overall body of scientific work in the field, but their low density indicates significant potential for development to enrich existing knowledge and deepen their application in various pedagogical contexts. In the upper left quadrant, niche themes such as healthcare personnel, implementation science, and healthcare delivery are very developed but not central. Finally, the emerging or declining themes in the lower left quadrant include educational status, adolescent, and COVID-19. The presence of COVID-19 in this group can be explained by the intensity of research on educational practices during the pandemic, followed by a saturation or shift in scientific priorities to other issues. Nonetheless, these themes remain relevant for analyzing short-term impacts or recent developments in pedagogical approaches.

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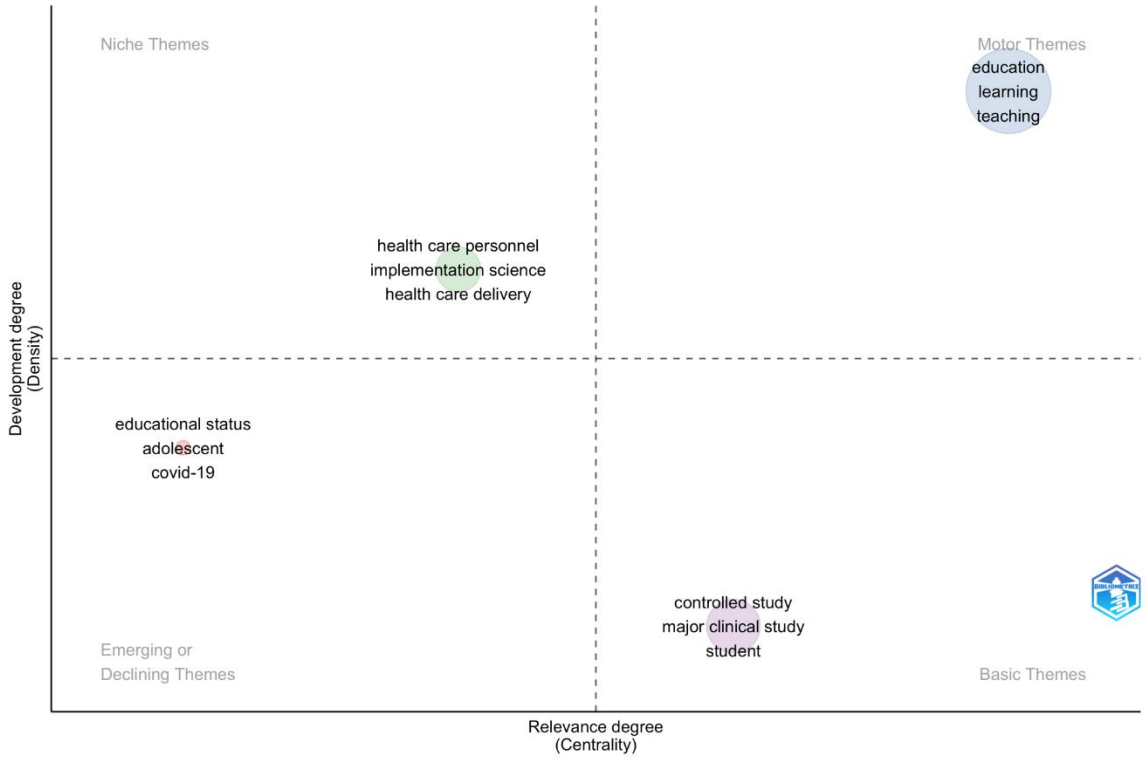

Figure 6. Thematic Map

4.5. Limitations

This study has certain limitations related to the tools and methods used in the bibliometric analysis. First, the use of the Scopus database as the sole data source may introduce a selection bias, potentially excluding relevant publications indexed in other databases such as Web of Science or PubMed. Additionally, the analysis period, limited to the 2014-2024 interval, may restrict the understanding of long-term trends in health sciences education in the era of educational Technologies, as it does not account for earlier works that may have laid the foundation for the observed trends. Regarding the assessment of source and publication impact, the use of the h-index and the total number of citations may introduce a temporal bias: older articles have had more time to accumulate citations, while recent and potentially influential contributions may be underrepresented.

Despite these limitations, the adopted methods provide a comprehensive overview of research trends and help identify major contributions in the field of health sciences education in the era of educational technologies.

5. Discussion

Information and Communication Technologies (ICT) have initiated a profound transformation in pedagogical approaches, facilitating the transition to online education. This paradigm shift has leveraged digital tools to offer more flexible and accessible education, particularly relevant in a global context marked by disruptions such as the COVID-19 pandemic (Uzun et al., 2024). Among the pedagogical innovations supported by ICT, the flipped classroom stands out as a promising model (Martin, 2023; Flamant et al., 2018; Seizeur et al., 2017). Unlike traditional teaching focused on in-person lectures, the flipped classroom invites learners to explore educational content at their own pace before class sessions. This pre-class preparation, often conducted through educational videos, digital readings, or interactive online activities, frees up in-person time for collaborative activities and practical applications. The flipped classroom is particularly suited to health sciences, where learning

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relies on a combination of theoretical knowledge and practical skills. By allowing students to master the theoretical foundations remotely, this approach maximizes class time for clinical simulations, case studies, or in-depth discussions. However, this transition to digital practices also presents challenges, including accessibility to digital tools and the training of educators to fully leverage these new methods.

In response to challenges related to the accessibility of digital tools, Learning Management Systems (LMS) play a crucial role in facilitating the transition to online education and overcoming technological barriers (Chen et al., 2023; Awang & Darus, 2012; Kalayci & Humiston, 2015). Platforms such as Moodle, Claroline Connect, and Chamilo provide centralized, intuitive environments that consolidate all educational resources, organize learning pathways, and track student progress. Their interactive design and user-friendly interfaces make them accessible even to users with limited digital tool proficiency, addressing one of the main challenges of online education: inclusivity and ease of use. Additionally, LMS integrate a variety of interactive features, such as video conferencing tools, online quizzes, and collaborative spaces, which enhance learner engagement and enrich their experience. These platforms not only provide equitable access to educational content but also strengthen the participatory and collaborative aspects of learning. For example, in health sciences, LMS can host clinical simulations, interactive case studies, and formative assessments, contributing to a progressive and practical acquisition of skills. Constructivism and socioconstructivism are fully integrated into modern teaching approaches, especially through the flipped classroom and the use of LMS. Constructivism, which values active and autonomous learning, is particularly suited to the flipped classroom, where students explore educational content at their own pace via digital platforms. This model encourages individual preparation and better assimilation of knowledge before in-person sessions. Furthermore, socioconstructivism, focused on collaborative and social learning, is reflected in the interactive tools of LMS, such as forums, group activities, and co-creation tools. These tools promote exchanges between students and facilitate the co-construction of knowledge while developing essential transversal skills such as communication and collaboration. In modern education, the synergy between LMS and the flipped classroom maximizes pedagogical effectiveness. LMS offers easy and personalized access to content, while in-person sessions are optimized for collaborative activities based on socio-constructivist approaches, such as debates, problem-solving, or simulations. This combination makes learning more interactive, relevant, and tailored to the needs of learners.

6. Conclusion

This bibliometric study analyzed pedagogical practices and learning theories in health sciences in the era of educational technology, over a decade marked by technological advancements and major societal transformations. The results highlight the emergence of several key themes, including medical education, innovative learning methods, and the impact of the COVID-19 pandemic on pedagogical practices. The findings emphasize the increasing integration of digital innovations into health sciences education, underscoring the need to develop pedagogical strategies tailored to the evolving needs of students in this field. Beyond mapping research trends, this study sheds light on the growing importance of adaptive learning environments, competency-based education, and the use of artificial intelligence in personalized learning experiences. The shift from traditional didactic methods toward more interactive, student-centered approaches aligns with the broader objective of enhancing learning outcomes, improving clinical reasoning, and fostering lifelong learning skills among future healthcare professionals. Additionally, the analysis highlights the role of digital platforms, virtual simulations, and collaborative online tools in reshaping pedagogical frameworks, offering opportunities for more flexible, scalable, and accessible education. However, several challenges remain. The integration of technology in education must be accompanied by critical reflections on its pedagogical effectiveness and digital equity. The disparities in access to educational

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technology, differences in digital literacy among faculty and students, and the need for robust institutional support are critical factors that require further investigation. Moreover, while this study provides valuable insights into research trends, its reliance on bibliometric analysis has inherent limitations, such as database selection bias and the challenges of capturing qualitative dimensions of pedagogical effectiveness.

7. Suggestion

Future research should explore the long-term impact of digital innovations on student performance, engagement, and professional competencies. Additionally, interdisciplinary collaborations between educational researchers, technology developers, and healthcare practitioners could further enhance the design and implementation of evidence-based educational technologies. By fostering a continuous dialogue between pedagogy and technological innovation, health sciences education can evolve to meet the demands of an increasingly complex and digitalized healthcare landscape.

Declarations

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Ethical Approval. No approval from the ethics committee was required.
Data Availability Statement. The database is available from the corresponding author.

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