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Innovative Teaching: A Bibliometric Analysis From 2013 to 2023

Raisa Esenovna Kussainova
L.N. Gumilyov Eurasian National University, KAZAKHSTAN

Gulsara Tundebayevna Urazbayeva*
L.N. Gumilyov Eurasian National University, KAZAKHSTAN

Assel Bolatovna Kaliyeva
L.N. Gumilyov Eurasian National University, KAZAKHSTAN

Edyta Denst-Garcia
Nazarbayev University, KAZAKHSTAN

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Abstract: This study sought to investigate the current state of innovative teaching research and identify emerging themes and trends in the field from 2013 to 2023. The Scopus database was searched for the term "innovative teaching," resulting in 1005 documents. After manual screening, 903 articles were exported in the BibTeX format for further processing in Bibliometrix using three bibliometric analysis types: network analysis, science mapping, and performance analysis. Performance analysis revealed bursts in publication output in 2015 and 2021, with a moderate boost in 2018. Ten top-cited journal papers were identified. The citation rates were low between 2019 and 2021, but there has been an upturn since 2022. The top keywords included simulation and nursing education, and there was a shift in research topics from broad educational concepts to more specific approaches, such as e-learning. Innovative teaching has been predominantly investigated in higher education, particularly in nursing education, with themes like "teaching/learning strategies" suggesting an emphasis on enhancing teaching practices not just through technology infusion. This study can aid educators and researchers in staying current with innovative teaching developments and inform their teaching practices.

Keywords: *Bibliometrics, Bibliometrix, innovative teaching, research trends, topic evolution.*

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Introduction

In recent years, teaching has undergone a vast transformation due to advancements in technology and changes in student expectations. As a result, there has been an increased interest in innovative teaching methods, which has led to numerous studies and analyses conducted to understand the impact of such methods on student learning outcomes. Innovative teaching means educators utilizing new approaches and technologies to tackle educational issues in unconventional manners and encourage learners to engage in deep learning and foster their creativity, as opposed to the standard strategies of knowledge-transfer and teacher-centered instruction (Tan et al., 2022). Innovative teaching has become a buzzword in education, as educators and institutions strive to keep pace with the changing needs and expectations of students. The term 'innovative teaching' encompasses a wide range of approaches, from incorporating technology into the classroom to project-based learning, active learning, and other learner-centered strategies. Encouraging students' academic engagement, promoting their self-efficacy beliefs, and sustaining their interest are among the benefits of innovative teaching approaches (Cao et al., 2020). The concept of innovative teaching has gained traction in response to the growing recognition that traditional lecture-based teaching methods may no longer be effective in meeting the miscellaneous learning needs of students in the 21st century (Fung et al., 2022; Nadeem et al., 2022; Zarestky et al., 2022).

Moreover, with the rise of digital technologies and the availability of new educational tools, the need for innovative teaching practices has become increasingly important. As a result, there has been a growing interest in the study of innovative teaching across various disciplines. On top of that, the COVID-19 pandemic has accelerated the adoption of innovative teaching practices, as schools and universities were forced to rapidly shift to online learning modalities. This has led to an increased interest in exploring the effectiveness of various innovative teaching approaches in both online and traditional classroom settings. For instance, Brown et al. (2023) conducted an eight-week-long VR course that supplemented online instruction in human anatomy. Each of the 55 students was provided with a VR-capable laptop and a head-mounted display. They remotely participated in weekly synchronous group laboratory sessions in a shared synthetic space, where they worked with a computer-generated representation of a cadaver. They had the ability to scale the cadaver infinitely and explore anatomical structures from various angles. The researchers claimed that VR was on a

* **Corresponding author:**
Gulsara Tundebayevna Urazbayeva, L. N. Gumilyov Eurasian National University, Kazakhstan. ✉ gsrzb@aol.com

par with the routine 2D approach in terms of students' knowledge acquisition and retention of anatomical spatial relationships. However, learners could visit the virtual laboratory 24/7, which likely instigated their engagement and offered more opportunities for interaction with instructors, peers, and content.

In another recent study (Guo et al., 2023), a new task design called chatbot-assisted in-class debates was introduced as a means to enhance students' critical thinking and argument construction skills. Forty-four undergraduate students took part in debates with their classmates after interacting with a chatbot named Argumate, which was programmed to assist students in generating ideas to advocate their position and anticipate opposing viewpoints. Ultimately, this novel approach enabled participants to generate more organized, substantial, and detailed arguments, incorporating a greater number of claims, supporting data, and warrants.

Studies like these make us believe that innovative teaching research has the potential to provide evidence-based insights into the effectiveness of different teaching strategies and technologies, which can in turn shape educational practice and policy. Teaching in the today society with its rapid developments in ideas of knowledge needs educators who can keep up-to-date and exploit all the possibilities in their teaching that new knowledge and technologies offer in order to translate novelties into better learning outcomes for their students (Gilbert et al., 2021; Vermeulen et al., 2022). Innovative teaching approaches should empower students to become active participants in their learning (Rahmawati et al., 2022), develop essential skills for the future such as the effective utilization of artificial intelligence (Carayannis & Morawska-Jancelewicz, 2022), and cultivate learning enthusiasm (Hu et al., 2021). Therefore, staying up-to-date with the latest findings in innovative teaching research is crucial in informing educational practice and policy in light of the ever-evolving nature of the field of education. Given the rapid pace of change in the field of education, it is essential to continuously monitor and analyze the trends and patterns in innovative teaching research. This will help educators and institutions keep abreast of the latest developments in teaching and learning, thereby making informed decisions on the adoption of innovative teaching strategies in their classrooms. One possible method for obtaining a comprehensive understanding of the research landscape is to conduct a bibliometric analysis, which provides an overview of the state of the field. The bibliometric analysis provides an objective method for exploring the research output in a specific domain in the extant literature, identifying key themes, and tracking their evolution over time (Xiao et al., 2022). The assiduous analysis of large volumes of unstructured data through bibliometric studies can enable scholars to pinpoint gaps in knowledge and generate fresh ideas for investigation. This tool can help researchers decode and visualize the accumulated knowledge and evolutionary trends of well-established fields by analyzing large amounts of unorganized data in a rigorous manner. Hence, a bibliometric study can lay a solid groundwork for pushing a field forward in new and meaningful ways (Donthu et al., 2021).

Problem Statement

The fundamental assumption underlying the use of bibliometric indicators to study research activity in a specific field is that scientific publication is the primary outcome of such activity. Despite the growing interest in innovative teaching, there has been a lack of quantitative analysis of the themes and trends in this specific area. However, after years of implementing contemporary concepts in education, pedagogues and researchers need to amass teaching experiences and practices to formulate age-appropriate and universally accepted curricula. Prior bibliometric analyses have only covered discrete facets of the educational realm, such as smart learning (Agbo et al., 2021; X. Chen et al., 2021) or concentrated on education research as a whole, without delving into innovative teaching practices (C. Huang et al., 2020). As such, there is a need for a bibliometric investigation that could provide a comprehensive overview of the state of research on recent innovative teaching literature, identify the most commonly studied themes, and track changes in research focus over time. Such an analysis might help researchers and practitioners in the field gain a better understanding of the current state of knowledge on innovative teaching, and identify areas for future research and practice.

In the recent decade, learning theories have undergone transformations, with the widespread adoption of new technologies and methods in education (Valtonen et al., 2022). Particularly, papers on the use of artificial intelligence in school contexts became available (Su et al., 2022). We therefore decided to focus our research on the timeframe from 2013 to 2023. The findings of this study could bridge the aforementioned evidence gap and inform future research and practice, contributing to the development of effective and uncommon teaching approaches that meet the needs of diverse learners in a rapidly changing world.

Aim and Research Questions

The purpose of this study was to quantitatively explore the current state of innovative teaching research and to identify the major themes and trends that have emerged over the last decade. Specifically, we aimed to answer the following research questions:

Research question 1. What has been the trend in publications on innovative teaching over the past decade (2013-2023)?

Research question 2. Which years and papers had the highest citation rates in innovative teaching research over the past decade?

Research question 3. What have been the major topics in innovative teaching research over the past decade and what are the most common associations between them?

Research question 4. How have the dominant topics in innovative teaching research evolved over the past decade?

Research question 5. What are the motor (the most important and well-explored), basic, declining, and niche (peripheral) themes of innovative teaching research?

Methodology

We needed to estimate scientific output in the textual data on innovative pedagogy. To that end, the present study adopted a quantitative methodology involving a computer-assisted review technique known as a bibliometric analysis.

Data Collection

The term "innovative teaching" was searched in the Scopus database on March 10, 2023, with a publication timespan from 2013 to 2023 using the following search query string: "DOCTYPE (article) AND PUBYEAR > 2013 AND PUBYEAR < 2023 AND (LIMIT-TO (LANGUAGE, 'English'))." In total, 1005 documents were returned. Titles were manually screened, and any publications that were written in languages other than English or had document types other than the articles were eliminated. The remaining collection of publications consisted of 903 articles, which were then exported in BibTeX format for further processing.

Data Analysis

In order to address the research questions, our study exploits three bibliometric analysis types, namely, network analysis, science mapping, and performance analysis. The prevalence of a research topic over time was determined through performance analysis, which involved counting citations and publications. The science mapping technique was applied to identify the most frequent research topics in the dataset using a tree map and to trace their temporal trends through plots depicting trend topics and thematic evolution. Regarding network analysis, a keyword co-occurrence network was constructed to explore the relationship between keywords within the same document; the keywords shape clusters used to pinpoint core topics in the research field. Additionally, a strategic diagram was utilized as a science mapping technique to unearth basic, declining, niche, and motor themes based on measures of centrality (the intensity of links between a keyword cluster and other clusters) and density (the internal strength of the keyword cluster) (Yu et al., 2021). All the analyses were conducted in the Bibliometrix R package (Aria & Cuccurullo, 2017).

Findings

Research Question 1: "What has been the trend in publications on innovative teaching over the past decade (2013-2023)?"

According to the Scopus database, the spikes in publication output regarding innovative teaching during the decade occurred in 2015 and 2021. Also, there was a slight uptick in 2018 (Figure 1).

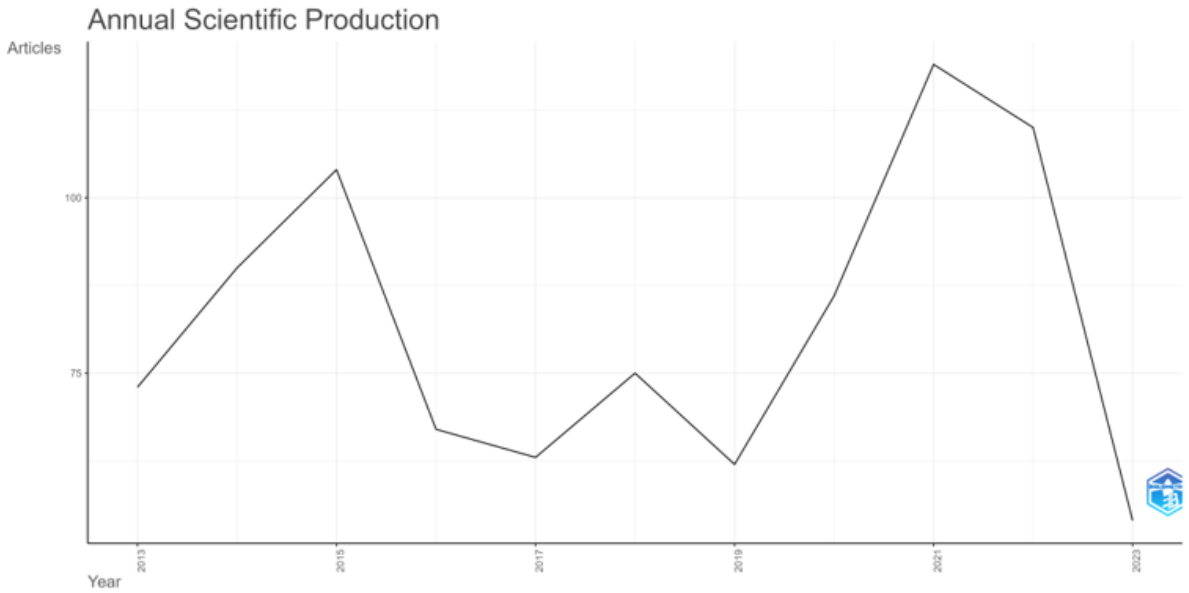

Figure 1. Annual Scientific Production Regarding Innovative Teaching

Research Question 2: "Which years and papers had the highest citation rates in innovative teaching research over the past decade?"

The Scopus search detected that in the period between 2019 and 2021, there were extremely few citations for articles on innovative teaching (.30 to .95) (Figure 2). Only in 2022, the number of cited articles increased to 9.31 per year, and finally, in 2023 it burst to 37.44 per year.

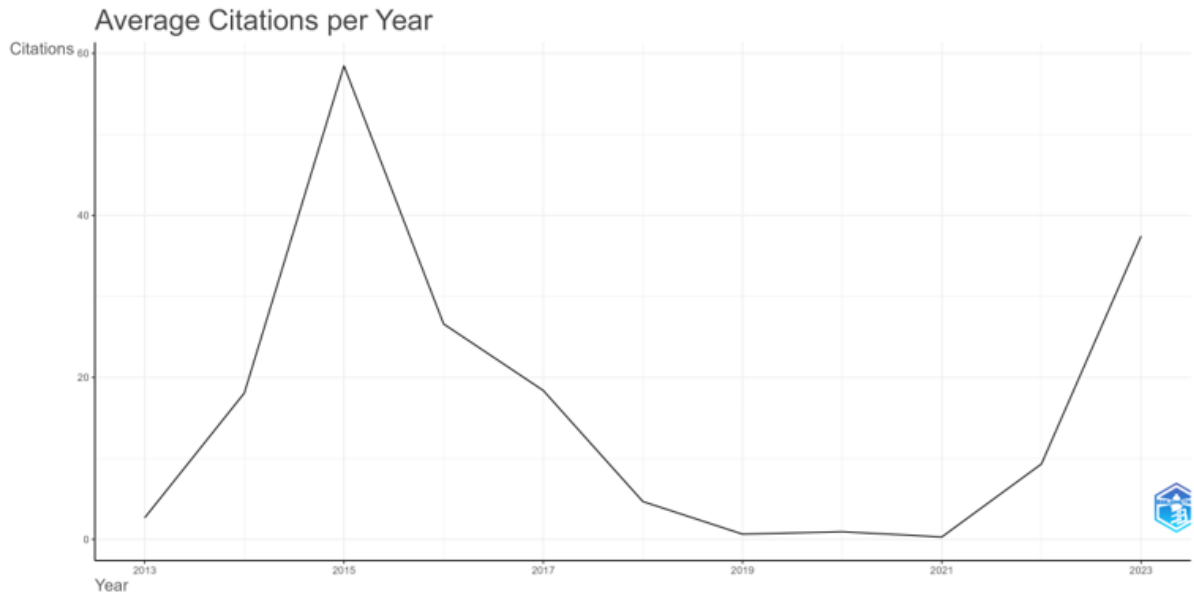

Figure 2. Average Article Citation to Papers on Innovative Teaching per Year

The 10 most cited articles on the topic (Table 1) were ranked by citation number. The total of citations for the papers was 4,043. The most cited publication, with a total of 751 citations (83.44 per year), was that by McLaughlin et al. (2014) describing how they flipped a pharmaceutics course at a university by replacing traditional lectures with self-paced online videos so that class time was dedicated to active learning activities.

Table 1. The 10 Most Cited Papers on Innovative Teaching by Total Citation Number (2013-2023)

Rank	Title	Authors (Year)	Journal Title	Citations
1	A course redesign to foster learning and engagement in a health professions school	McLaughlin et al. (2014)	Academic Medicine	751
2	Using technology to maintain the education of residents during the COVID-19 pandemic	Chick et al. (2020)	Journal of Surgical Education	554
3	Simulation in healthcare education: A best evidence practical guide. AMEE Guide No. 82	Motola et al. (2013)		528
4	A social gamification framework for a K-6 learning platform	Simoes et al. (2013)	Computers in Human Behavior	498
5	Flipping the classroom to improve student performance and satisfaction	Missildine et al. (2013)	Journal of Nursing Education	412
6	The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities	Abreu and Grinevich (2013)	Research Policy	280
7	The effect of games and simulations on higher education: A systematic literature review	Vlachopoulos and Makri (2017)	International Journal of Educational Technology in Higher Education	278
8	Student learning and perceptions in a flipped linear algebra course	Love et al. (2014)	International Journal of Mathematical Education in Science and Technology	266
9	Challenges to learning and schooling in the digital networked world of the 21st century	Voogt et al. (2013)	Journal of Computer Assisted Learning	263
10	Young students using iPads: App design and content influences on their learning pathways	Falloon (2013)	Computers and Education	213

Research Question 3: "What have been the major topics in innovative teaching research over the past decade and what are the most common associations between them?"

A tree map of the top 50 keywords derived from the dataset (Figure 3) exhibited that the terms "education," "nursing education," "simulation," "nursing," "teaching," "innovation," "higher education" and "medical education" were most frequent in the total pool of keywords. Besides, categories like "blended learning," "creativity," and "virtual learning" were noticeable, indicating that these topics have received considerable attention in the literature. On the other hand, such topics as "flipped classroom," "mobile learning," "artificial intelligence," and "social media" were minor.

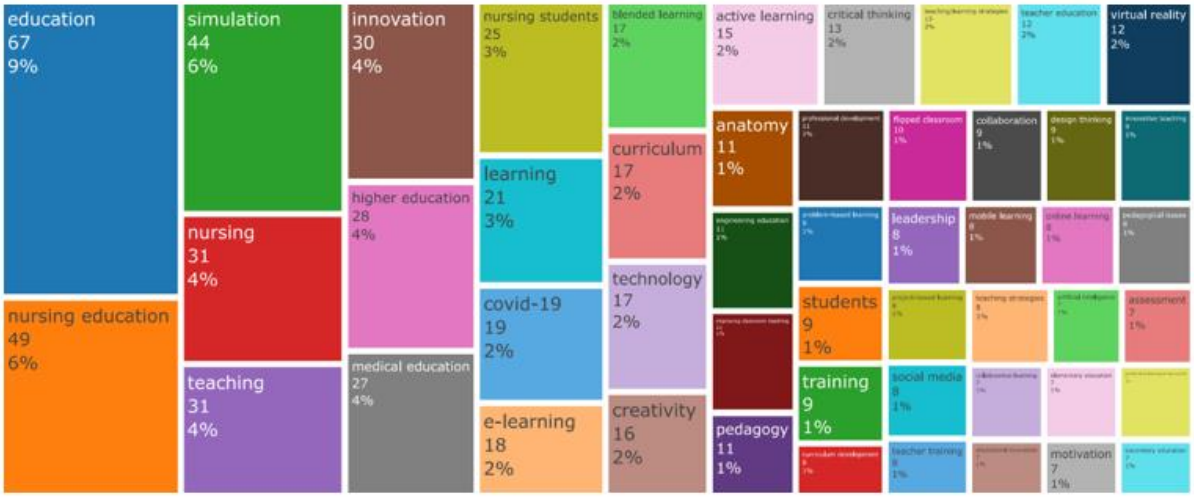

Figure 3. A Keyword-Based Tree Map Derived From Scopus-Covered Articles Related to Innovative Teaching

Word co-occurrence denotes the statistical association between keywords that appear within the same text. A network map of keyword co-occurrence demonstrates the correlation between these terms, where the proximity of certain keywords indicates their relevance. This closeness of keywords also forms clusters, which represent central topics in the literature (C. Huang et al., 2020). This can provide insights into the key themes in the field, as well as the relationships between them. Figure 4 shows the distribution of the keywords with at least five occurrences between 2013 and 2023. The network map displays that there were four major topic clusters during the period from 2013 to 2023: (a) Education cluster, which touches on terms simulation, training, teaching, learning, covid-19, curriculum, pedagogy, anatomy, and artificial intelligence; (b) nursing cluster that encompasses terms virtual reality, students, technology, leadership, and blended learning; (c) nursing education cluster, which strongly relates to the nursing one and includes terms nursing students, teaching strategies, and online learning; and (d) innovation cluster that contains collaboration, e-learning, creativity, and design thinking.

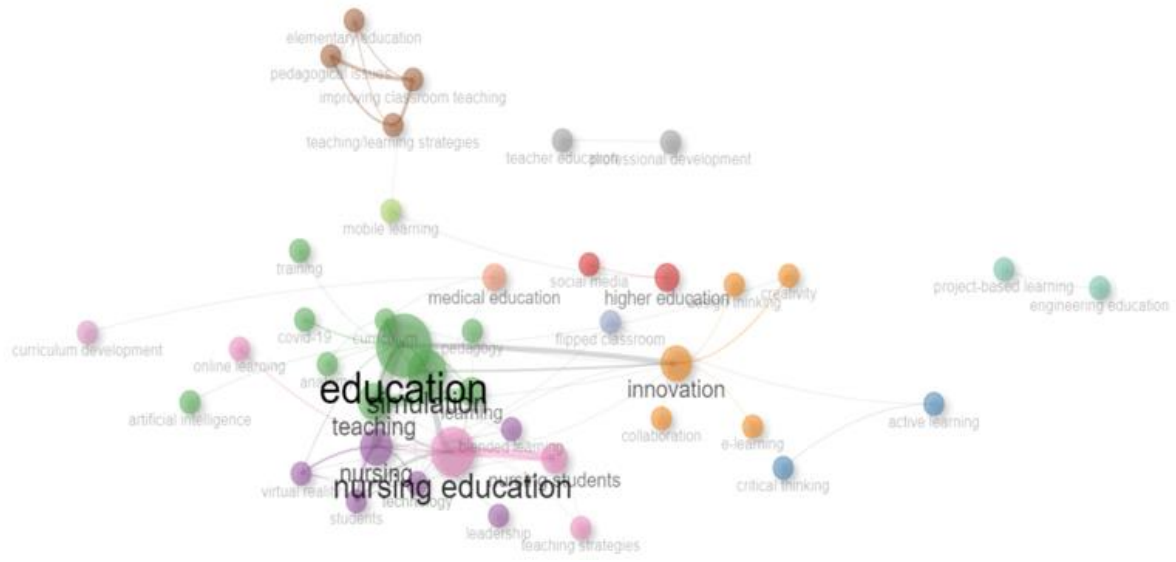

Figure 4. Keyword Co-Occurrence Network Derived From Scopus-Covered Articles Related to Innovative Teaching

Research Question 4: "How have the dominant topics in innovative teaching research evolved over the past decade?"

To answer this question, we resorted to statistical analysis of the prevailing terms in articles, which can help pinpoint the research trends and provide valuable insights into the progress of scientific outputs (Mahi et al., 2021). The transformation of the focal themes was analyzed by dividing the observed time interval into two parts, namely 2013-2019 and 2020-2023, to see how the study focus changed over time. The results are depicted in Figure 5. While from 2013 to 2019 the research in innovative teaching focused on rather generalized conceptual domains of education, in the last four years it has been portrayed by quite a number of distinct educational directions and approaches like the flipped classroom or e-learning. When it comes to dominant themes, in 2013-2019 they were "higher education" and "nursing students." The latter subsequently transitioned into several separate semantically adjacent items like "nurse education" and "medical students," with "nursing education" becoming the top research term around innovations in teaching during 2020-2023. Whereas the research topic "higher education" has dispersed into some narrow branches such as "critical thinking" and "science education." On the whole, judging by the terminology in the publications, it is fair to indicate that over the past 10 years, the trend in innovative teaching has been towards technologization and diversification of the field

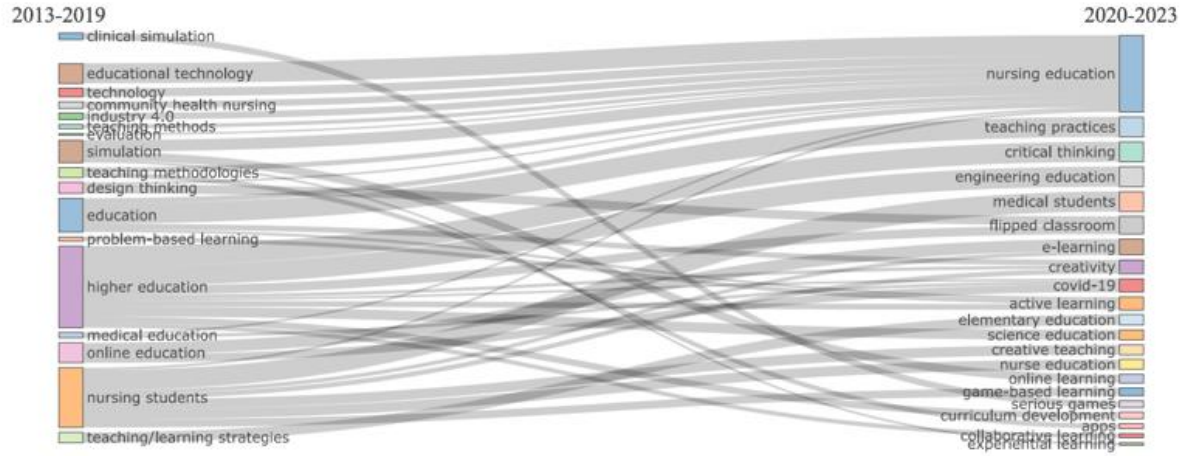

Figure 5. Thematic Evolution of Innovative Teaching Research From 2013 to 2023

As a further step, we computed a plot displaying the trend topics in the searched literature segment (Figure 6). As indicated by the size of the blue nodes in Figure 6, the most frequent keywords in our dataset were "education" and "nursing education." In general, however, the obtained picture largely coincides with the thematic evolution.

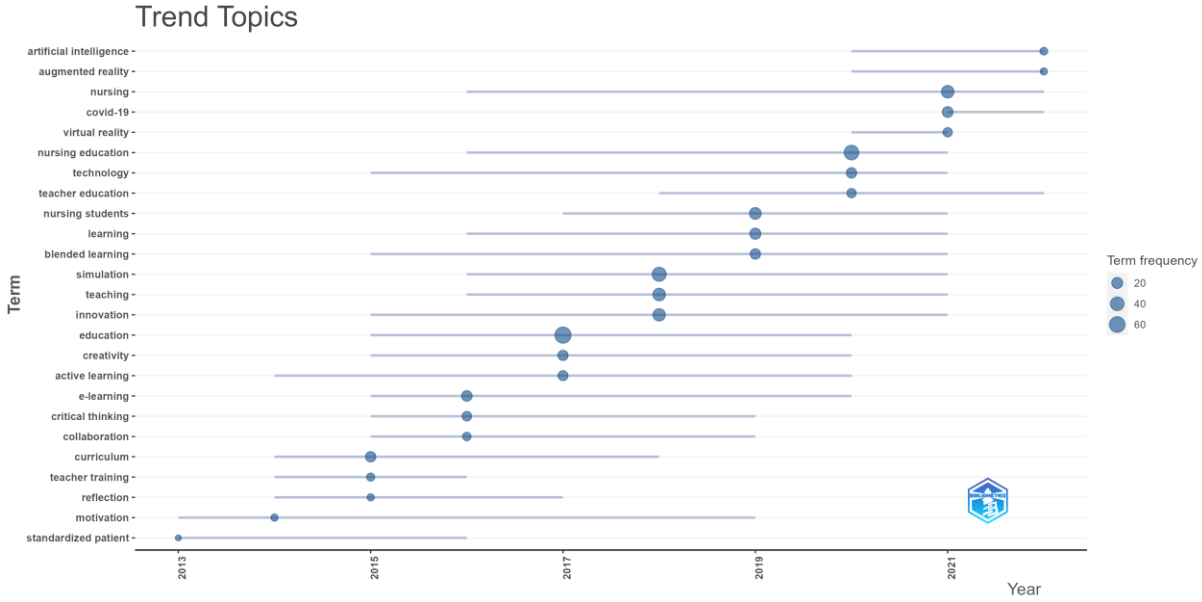

Figure 6. Topic Trends in Innovative Teaching Research From 2013 to 2023

Research Question 5: "What are the motor (the most important and well-explored), basic, declining, and niche (peripheral) themes of innovative teaching research?"

Figure 7 offers the state of topic groups in innovative teaching research over the observed time interval. The groups are distributed between four quadrants according to centrality degree and density, with keyword clusters diversified by

color (Y. Zhang & Wang, 2021). The bottom right quadrant denotes a high centrality but a low density and comprises terms fundamental to the subdomain of innovative teaching. These terms have formed three independent groups, and we can see that innovative teaching is investigated mainly in higher education, particularly in nursing education, and is directed not only at students but also at teachers; the pivotal methods in these publications are the flipped classroom, simulation, and active learning; the core characteristics here are critical thinking and creativity. The bottom-left portion contains "engineering education," "project-based learning", and "mobile learning", hence, both the density and centrality of these items are marginalized and they are highly likely declining themes. The upper-left quadrant signifies niche themes that are in a favorable stage of development but have a limited impact on the overall research field. The upper-right quadrant shows the motor themes which are characterized by high centrality and high density, they are both well-developed and are important for structuring a research field.

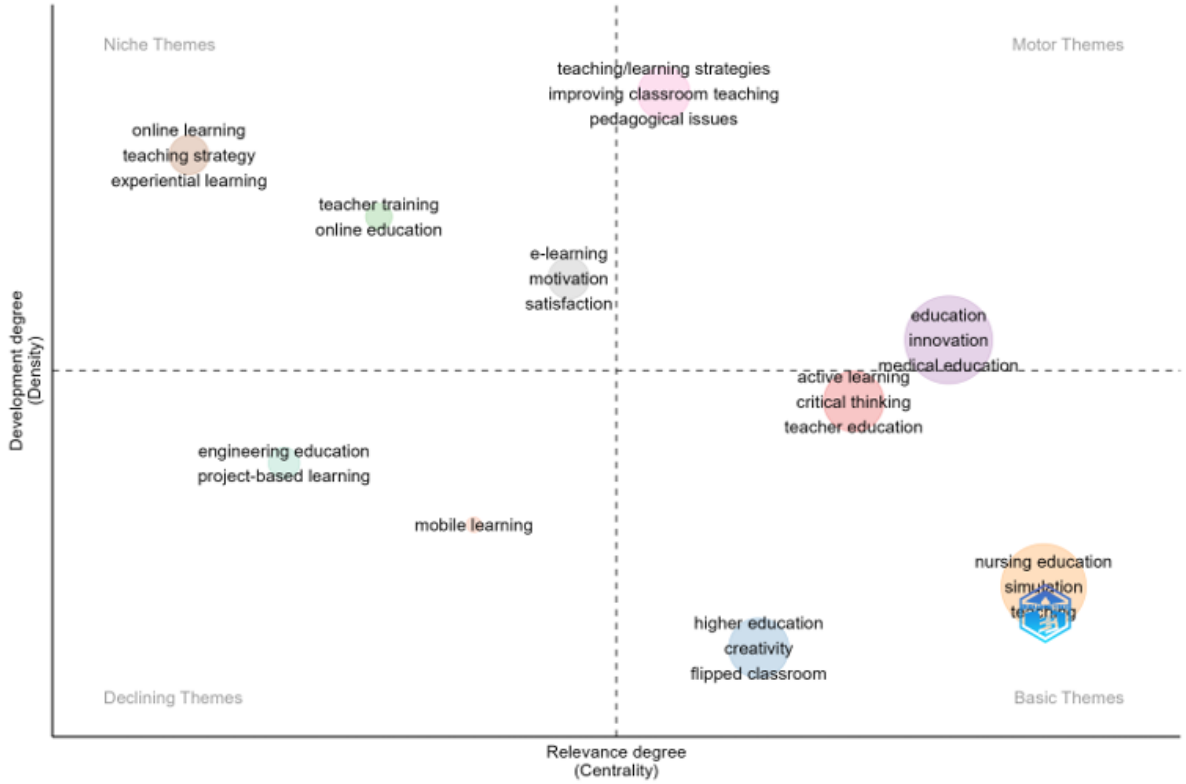

Figure 7. Thematic Map of Innovative Teaching Research from 2013 to 2023 Based on Density and Centrality With Niche Themes, Motor Themes, Basic Themes, and Declining Themes

Discussion

This research sought to identify the major trends and topics in the literature on innovative teaching between 2013 and 2023. The upsurges in publication productivity in innovative teaching in 2015 and 2021 can be explained by the fact that in the mid-2010s, K-12 and higher education reportedly experienced an upsurge in the popularity of flipped learning (Jong, 2023), which is a relatively novel instructional approach in which the teacher provides resources to the learners in advance for review and then reinforces the topic and answers students' questions in the classroom (Cueva & Inga, 2022). Put another way, this approach involves students watching video lectures or completing other activities outside of class, and then using class time to work on assignments, projects, or other hands-on activities. The subsequent peak in publications is probably due to the global outbreak of coronavirus disease in 2020, which is the time point where we observe an upward trend culminating in 2021 as a cumulative effect of solutions for the unprecedented educational challenges posed by the COVID-19 pandemic. Perhaps the rapid shift to hybrid and online learning models in 2020 forced educators to develop new strategies for engaging students in new learning models and environments, which likely laid the groundwork for more sustained and focused efforts in 2021.

Regarding the decline in publications between 2019 and 2021, this is somewhat in line with the findings from a bibliometric analysis of e-learning papers over 2015-2020 retrieved from the Web of Science database (Djeki et al., 2022), which infers that the number of publications dedicated to e-learning decreased over time so that fewer articles were published in 2020 as compared to 2015-2019, while the authors anticipated an increase in the number of articles on e-learning in the year due to its potential as a solution to maintain learning continuity during the COVID-19 pandemic.

While the COVID-19 pandemic led to a boom in online and blended learning experiences in 2020 and 2021, there may have been a delay in the publication of articles on innovative teaching in response to these developments. Consequently, the increase in citations of articles on innovative teaching may not have been reflected until later periods, i.e., 2022 and 2023. However, it is also plausible that competing priorities among educators and researchers during the pandemic may have contributed to a lack of attention to academic publications on innovative teaching, despite an increase in the number of corresponding papers during this time. As such, it is possible that a combination of factors contributed to the delayed rise in citation rates for those documents.

The findings from the keyword-based tree map suggest that innovative teaching practices are being explored and implemented in various domains of education, with a particular focus on nursing and medical education. Surprisingly, the topics like flipped learning and artificial intelligence turned out to be at the periphery of the keyword corpus although they would seem forefront in the education research domain. For instance, a bibliometric analysis of educational artificial intelligence research development covering the interval between 2000 and 2019 (P. Song & Wang, 2020) identified that research on the topic had mounted worldwide over the timespan. Jimenez et al. (2019) conducted a bibliometric analysis of 1689 scientific documents pertaining to educational technology and higher education within the Web of Science database, with a total of 1689 publications for the period from 1972 through 2018. The study found that there has been an increment in the number of publications on educational technology since the onset of the twenty-first century, and it multiplied more than tenfold by the end of the 2010s. A bibliometric analysis of the research landscape under technology-enhanced learning in higher education contexts from 1990 to July 2018 using the Web of Science database (Shen & Cha, 2020) approximately mimics the findings from Jimenez et al. (2019). However, the low prominence of those tech-related topics in our study could be because they are relatively new approaches to teaching and learning, and there may not yet be as much research on their effectiveness or implementation as there is for other topics.

The data yielded from the keyword co-occurrence network may be seen in the way that aside from autochthonous concepts like teaching approaches, the documented attempts to introduce innovations in the education field over the last decade have been centered around emerging technologies such as synthetic reality environments, which echoes the shift towards a more digital and immersive learning approach in today's learning environment worldwide (Bernardo & Duarte, 2022). Moreover, it can be deduced that a substantial portion of the research efforts have been especially devoted to innovations in medical education, which is clearly due to the high priority of this industry, in which progress is taking giant steps and much faster than in most other areas, so updating the methodology and content of education here is imperative (Alsharif et al., 2022).

Topic trends analysis unearthed that publication productivity on one of the most cutting-edge, appealing, and promising educational innovations, virtual reality, became noticeable as late as in 2021 (unless we count the term's synonym "simulation," which thrived in 2018), although it may seem that the effects of virtual reality technology on learning outcomes has been widely investigated, and its potential as a game-changer for education is acknowledged by researchers worldwide.

The explanation for this result, nonetheless, presumably lies in the fact that the term "innovative teaching" is not often used in studies using virtual reality in education. For, in fact, there is an upward trend in the publication of studies on virtual reality, as evidenced by the many high-quality papers devoted to the effectiveness of virtual reality in enhancing student engagement (Li et al., 2022; Riner et al., 2022; Y. Song et al., 2023), motivation (H.-L. Chen & Liao, 2022; Liu et al., 2022; Ozdemir & Ozturk, 2022), and learning outcomes (Banjo-Ogunnowo & Chisholm, 2022; C.-H. Chen et al., 2021; Yamaguchi et al., 2022) recently published in credible journals. This is also supported by quite a number of emerging systematic studies on the use of virtual environments for enhancing the learning experience of students across different education levels and subjects (Coban et al., 2022; Ding & Li, 2022; Long et al., 2023; Luo et al., 2021; Putranto et al., 2023; Villena-Taranilla et al., 2022). Hence, this technology appears to us a propitious direction for future educational research. The same is true for the two keywords whose citations gained momentum in 2022, namely "augmented reality" and "artificial intelligence," especially the latter phenomenon, whose popularity became incredibly high at the arrival of 2023 (King, 2023), new artificial intelligence products are being released every day now, they are permeating more and more spheres of life, and it is already clear that artificial intelligence will become a root topic in an array of research domains, including education, in the coming years.

As for thematic groups in the innovative teaching research, all of the variables in the basic theme group occupy a solid place in research on innovative pedagogy but have not yet become leading themes. Critical thinking is understood as the capacity to analyze information effectively and form a judgment based on that analysis (Y.-M. Huang et al., 2022; Plummer et al., 2022; Weng et al., 2022). In education, critical thinking is important for developing decision-making and problem-solving skills and can be developed by instructors at the university level (Shakurnia et al., 2022). Critical thinking is recognized as a crucial component of innovative education. It is mentioned among key transversal competencies deemed elemental for Education 4.0 (Miranda et al., 2021). Critical thinking and innovative education are two closely related concepts. Learners with strong critical thinking skills are better able to analyze information and make informed decisions, which is essential for their academic success and future careers (Hart et al., 2021; M. Lin et al., 2023). Innovative education, on the other hand, seeks to promote learning by using creative teaching methods and new technologies to engage students and promote a deeper understanding of the subject matter. Likewise, the significance of

creativity in education lies in the fact that a creative individual is one equipped to make weighted decisions, observe things from various angles, and create fresh opportunities and alternatives (Chacon-Lopez & Maeso-Broncano, 2023). All in all, creativity and critical thinking in innovative education should be acknowledged as important area of focus for educators and researchers.

Mobile learning in the declining themes category is quite surprising, as several recent bibliometric studies (Fan et al., 2023; Goksu, 2021; Khodabandelou et al., 2021) unanimously indicate that the academic output of the mobile learning topic in the early 2020s is about double that of the early 2010s. The fact that online learning and e-learning were in niche themes can be due to the fact that both concepts are quite broad and can embrace the sea of novel educational technologies, such as networked collaborative learning (Shahzad et al., 2023), Blockchain-based learning systems (Haque et al., 2023), artificial intelligence chatbots (Y. Lin & Yu, 2023), and so forth. Regardless, the authors of the studies employing these technologies might simply not have used such omnibus keywords. It could also indicate that there is still much to be explored in this cluster.

As can be discerned from the content of the motor themes segment, systematic instruction issues represent a hot thread in innovative teaching over the past decade, which suggests that the innovative teaching practices used in the studies that were within the scope of this bibliometric analysis go beyond technological advancements. In particular, "teaching/learning strategies" allows one to assume that educators are interested in exploring new ways to engage students in the learning process, such as collaborative learning and problem-based learning. This finding highlights the fact that educators are looking for ways to improve teaching practices beyond simply integrating technology into the classroom. Moreover, "pedagogical issues" suggests that educators are interested in understanding the underlying principles of effective teaching and learning. This theme could encompass a range of topics, such as curriculum development, assessment, and classroom management. These topics are fundamental to the teaching profession and are not necessarily related to technology. This is in harmony with the remark by L. Zhang et al. (2022), namely "With technology often conceptualized as the solution to support online learning, it is imperative to put innovative pedagogy at the forefront of the design of online teaching and learning." Finally, "medical education" raises the suggestion that there is an increasing interest in exploring innovative teaching practices in specialized areas, such as healthcare education. Therefore, there is a need for innovation in teaching practices across a range of disciplines. On the whole, this thematic map underlines the importance of considering a variety of factors when developing innovative teaching strategies, such as student engagement, pedagogical principles, and specialized disciplines. The motor themes explored herein should be developed further considering their significance for future research.

Our study can contribute to education research and practice by providing a comprehensive overview of the major topics and trends in innovative teaching research over the last decade, which can be helpful for educators and researchers looking to stay up-to-date with the latest developments in this field. Practitioners can use these findings to inform their teaching practices and to devise new strategies for engaging students in new learning models and environments. Overall, this bibliometric research has identified four major topic clusters related to innovative teaching that can enrich education research and practice. The Education cluster encompassed terms such as simulation, COVID-19, and artificial intelligence, reflecting the evolving field of education. The presence of COVID-19 implies the pandemic's impact on teaching methodologies. The Nursing cluster incorporated terms like virtual reality and blended learning, signifying advancements specific to the field. The Nursing Education cluster included nursing students, teaching strategies, and online learning, which may highlight the efforts to apply various pedagogical approaches in nursing education to improve learning outcomes. Lastly, the Innovation cluster comprised collaboration, e-learning, creativity, and design thinking, demonstrating the exploration of novel approaches in teaching and learning.

Conclusion

This bibliometric study aimed to investigate trends and topics in innovative teaching research over the past decade (2013-2023). The study found bursts in publication output in 2015 and 2021, with a slight increase in 2018. The citation rates for articles on innovative teaching were low between 2019 and 2021 but increased in 2022 and 2023. Analysis of the top 50 keywords revealed that topics such as simulation and nursing education have received considerable attention in the literature on innovative teaching. The dominant topics in innovative teaching research have shifted from general educational concepts to more specific approaches like e-learning. While there has been a trend towards the technologization and diversification of the field, relatively new research areas such as flipped learning and artificial intelligence have not received as much attention. Theme mapping suggests that innovative teaching has mainly been investigated in higher education, particularly in nursing education, with the flipped classroom, simulation, active learning, critical thinking, and creativity being key concepts. This finding might be attributed to the fact that higher education institutions strive to enhance teaching methodologies to meet the needs of current customers and services (De Wit & Altbach, 2021; Garcia-Morales et al., 2021; Jokhan et al., 2022). As a result, there is a growing emphasis on innovative instructional approaches in these settings. Innovative practices, such as flipped classroom model, simulation-based learning, and active learning techniques, have proliferated and gained attention in education due to their potential to facilitate students' core competencies (Ke et al., 2023; Patino et al., 2023; Wu et al., 2023). As regards nursing education, health care is reportedly one of the most burgeoning industries worldwide (Abdullah et al., 2021) and higher

education plays a vital role in equipping nurses with the competencies required for professional practice (Lee et al., 2021), so researchers and educators accommodating nursing at the tertiary level are more likely to explore and publish on state-of-the-art pedagogy topics. In the nursing profession, the quality of education directly affects patient care. Consequently, there is a strong motivation within the nursing education community to investigate innovative teaching methods that would further translate into positive effects on patient outcomes.

Motor (that is well-researched and crucial for the field) themes like "teaching/learning strategies" allow us to assume that innovative teaching practices have focused on systematic instruction issues. These themes indicate that educators are seeking new ways to engage students and improve their teaching practices beyond technology. Our study findings can be interpreted as suggesting the need to strike a balance between utilizing emerging technologies and maintaining expertise in pedagogical approaches when designing teaching strategies, so that technology and pedagogy can be integrated to optimize learning outcomes. This equilibrium implies exploiting today's technologies to hone instructional delivery, promote active learning, and catalyze student engagement, while also masterfully applying instructional approaches that facilitate critical thinking, effective communication, and deep understanding of the subject matter. Researchers and educators should stay updated with the latest developments in the field, consider the relevance of topics covered in the literature to their own contexts and teaching needs, and focus on the connections between these topics to better understand the field and to design new pedagogical solutions. Our study provides a quantitative perspective on the state of the art in the advancements that have shaped the educational landscape over the past decade. The publications which had influenced the field were established. Future researchers can rely on this paper as a jumping-off point.

Recommendations

As a future line of research, incorporating other databases such as pre-prints available in the Google Scholar or Dimensions databases could provide additional insights not yielded herein. This is currently problematic due to the lack of software that recognizes data exported from Google Scholar, whereas metadata from Dimensions lacks keywords (Galeano-Barrera et al., 2022). To gain a more comprehensive understanding of innovations in teaching, future research could expand on our study by conducting qualitative data analysis in order to unearth more specific issues in the subject.

The trend in innovative teaching over the past decade has been towards technologization and diversification of the field. Educators should continue to stay up-to-date with emerging technologies and their potential applications in teaching and learning. Given that the prominence of such cutting-edge concepts as artificial intelligence and flipped learning has been accelerating in education, and research on these topics is likely to escalate in the coming years, it would be interesting to continue tracking the corresponding keywords in future literature searches to see if their occurrence in the literature on innovative teaching increases over time.

Limitations

The present study has some limitations that should be acknowledged, one of which is that the study relies exclusively on the articles that were indexed in the Scopus database. Although Scopus is a valuable resource, it may not cover the entire range of literature on the subject as some journals are not indexed there. Secondly, our bibliometric analysis only takes into account the metadata and keywords of the papers, without delving into the full text, which might skew the scope of the analysis. Thirdly, the search criteria of "innovative teaching" might not encompass all the innovative approaches to education, which could potentially exclude some relevant publications from our sample.

Ethics Statements

This research does not need ethical approval.

Conflict of Interest

The authors report no actual or potential conflicts of interest.

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Authorship Contribution Statement

Kussainova: Conceptualization, data collection, statistical analysis and interpretation, and writing. Urazbayeva: Conceptualization, supervision, critical revision, and editing. Kaliyeva: Reviewing and editing. Denst-Garcia: Interpretation and critical revision.

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