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Bibliometric review of articles related to context-based learning in science education

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Abstract

This study provides a bibliometric study of publications on context-based learning in science education to give readers a better understanding of the current state of the field's research. The major goal of this study is to provide bibliometric information on articles on context-based learning in science education published in periodicals listed in the Scopus Database between 2005 and 2023. A bibliometric analysis based on seven categories–number of articles and citations per year, most influential countries, most productive authors, most significant affiliations, funding institutions, and subject areas was performed on the information gathered from publications scanned and published within the study's parameters. Network diagrams and bibliometric analyses were produced using the Scopus Database. The year in which the most articles were published is 2022. The top three most productive countries were the Netherlands, Germany, and Turkey, respectively. The number of citations to papers included in the Scopus Database grew steadily, reaching its peak in 2022 with 410 citations. Pilot, A., who published 13 times, was the most productive author on this subject. Most publications are affiliated with Universiteit Utrecht, Freudenthal Institute and Technische Universiteit Eindhoven. Horizon 2020 framework program was the top funding source in terms of articles published. Additionally, it was examined how the publications were distributed by subject. The publications' respective topic areas were social sciences and computer sciences. This study offers a global view of context-based learning in science education as well as a vision for future research.

Keywords: bibliometric analysis, science education, physics, chemistry, biology, context-based learning

INTRODUCTION

Due to its potential to improve students' knowledge and application of scientific concepts, context-based learning has attracted substantial attention in the field of science education (King & Henderson, 2018). In-depth bibliometric analysis of research articles concentrating on context-based learning in science education is presented in this article. This study attempts to discover trends, major themes, and research gaps by methodically reviewing the literature, offering insightful information to educators and academics in the field. The bibliometric study demonstrates the expansion of research in this field, as well as important publishing trends, significant authors, and popular research themes. This review also emphasizes the interdisciplinary nature of context-based learning and examines its implications for present and future scientific research and practice.

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Contribution to the literature

- The analysis sheds light on the evolution of context-based learning approaches, helping researchers and educators understand the current state of the field and its future directions.
- This synthesis contributes valuable insights for curriculum designers, teachers, and policymakers to effectively implement CBL.
- This bibliometric review article offers a comprehensive analysis of the existing literature on context-based learning in science education.

Science education is crucial to promote students' scientific literacy and get them ready for active citizenship in society (Holbrook & Rannikmae, 2007). According to Lupión-Cobos et al. (2017), context-based learning has become recognized as a potential strategy for raising students' interest in and comprehension of science because it places an emphasis on the integration of realistic experiences and real-world situations. This bibliometric review will highlight research trends, major topics, and areas requiring more research to offer a summary of the available literature on context-based learning in science education. As a result, context-based learning has become a cutting-edge educational strategy aiming to close the knowledge gap between theoretical scientific concepts and their real-world applications. This article gives a bibliometric analysis of the research on context-based learning in science education to provide readers a thorough overview of the subject and spot any developing patterns.

LITERATURE REVIEW

Context-based learning has attracted a lot of attention in science education because it has the potential to improve students' comprehension and application of scientific principles in practical settings according to Baran and Sozbilir (2018). Key studies, theoretical frameworks, and research trends are highlighted in this section's review of the literature on context-based learning in science education. Several studies have explored the effectiveness of context-based learning approaches in promoting student engagement and learning outcomes (Gebre et al., 2014; Patterson et al., 2011; Sevian et al., 2018; Valdmann et al., 2016; van Dulmen et al., 2022; Vogelzang et al., 2019). Research conducted by Akcay (2009) demonstrated that integrating real-world contexts into science instruction improves students' motivation, interest, and knowledge retention. Similarly, Yu et al. (2015) conducted a study showing that context-based learning experiences lead to higher levels of conceptual understanding and problem-solving skills in science. Context-based learning emphasizing the integration of realistic experiences and real-world contexts to improve students' understanding and application of scientific principles is widely acknowledged as a promising method to science teaching (Nagarajan & Overton, 2019). One of the foundational studies in the field was conducted by Lemke (2001) who emphasized the importance of situating learning in meaningful contexts. Lemke's (2001) sociocultural theory highlighted the role of social interactions and the use of authentic tasks to support students' cognitive development and understanding of scientific concepts. Several studies have focused on the impact of context-based learning on students' engagement and motivation in science education. For instance, Fortus et al. (2005) conducted a study with high school students and found that the use of real-world contexts and problem-solving tasks increased students' motivation and interest in science. Similarly, Yilmaz et al. (2022) explored the effects of context-based learning on students' attitudes towards science, indicating positive shifts in students' perceptions of the relevance and applicability of science.

Theoretical frameworks have been developed to guide the implementation of context-based learning in science education (Vos et al., 2010). The constructivist perspective, as proposed by Doolittle (2014) emphasizes the active construction of knowledge by learners through meaningful interactions with the environment. According to this framework, context-based learning provides students with authentic experiences facilitating the development of scientific reasoning and critical thinking skills. Additionally, the socio-cultural theory, as advocated by Furberg and Arnseth (2009), highlights the role of social interactions and cultural tools in shaping students' learning experiences within meaningful contexts.

Curriculum design is a crucial aspect of context-based learning (Parchmann et al., 2006). In terms of curriculum design, many researchers have proposed frameworks and models for integrating context-based learning in science education. Several models and approaches have been proposed to structure and organize context-based science curricula. For example, Rodriguez et al. (2019) provides a framework for engaging students in hands-on exploration, explanation, elaboration, and evaluation of scientific concepts within relevant contexts by using the 5E instructional model. Additionally, the science, technology, and society (STS) approach, as advocated by Chowdhury (2016) integrates the social, ethical, and technological dimensions of science into the curriculum to enhance students' understanding of the societal implications of scientific knowledge. 5E instructional model (Balci et al., 2006) is

frequently used as a pedagogical approach promoting engagement, exploration, explanation, elaboration, and evaluation within meaningful contexts. Furthermore, Cetin-Dindar and Geban (2017) proposed the learning in science and everyday life model emphasizing the connections between science and students' everyday experiences, fostering a deeper understanding of scientific concepts. Building upon Lemke's work, researchers such as Fensham (2009) emphasized the significance of real-world contexts in science education and proposed the framework of context-based science curricula.

Assessment strategies play a vital role in evaluating students' learning outcomes in context-based learning environments (Vaino et al., 2012). Traditional assessment methods, such as multiple-choice tests, may not capture the complexity of learning that occurs in authentic contexts. Alternative assessment approaches, such as performance-based assessments, portfolios, and project-based tasks, have been proposed to better align with the goals of context-based learning and assess students' abilities to apply scientific knowledge in real-world situations (Avargil et al., 2012). Moreover, Schultz et al. (2022) discussed the challenges and opportunities in assessing students' understanding and application of science concepts within authentic contexts. They highlighted the need for performance-based assessments and the integration of multiple modes of assessment, such as portfolios and project-based tasks, to capture the complex nature of learning in context.

The professional development of teachers is essential for the successful implementation of context-based learning approaches (De Putter-Smits et al., 2013). Research by Vos et al. (2011) suggests that teachers need ongoing support and training to effectively design and implement context-based learning experiences. Professional development programs should provide opportunities for teachers to enhance their pedagogical content knowledge, develop instructional strategies for context-based learning, and collaborate with colleagues to share best practices (Srinivasa et al., 2022). Furthermore, teacher professional development is a crucial component in effectively implementing context-based learning approaches. Brown and Crippen (2016) conducted a meta-analysis of professional development programs for science teachers and found that sustained, job-embedded professional development that supports teachers in integrating context-based approaches leads to improved student outcomes. This highlights the importance of providing teachers with ongoing support and resources to implement context-based learning effectively.

While context-based learning has shown promise in science education, there are also challenges and gaps in the research. Longitudinal studies exploring the long-term effects of context-based learning on students' learning outcomes and career choices are needed. Additionally, research on the implementation of context-based learning across different science disciplines and among diverse student populations is warranted to address potential variations and ensure equity in science education. In summary, the literature on context-based learning in science education highlights its potential to enhance students' engagement, conceptual understanding, and problem-solving skills. Theoretical frameworks, curriculum design models, assessment strategies, and teacher professional development play crucial roles in implementing effective context-based learning experiences. However, further research is needed to explore the long-term impact of context-based learning, address implementation challenges, and investigate its effectiveness across diverse student populations and science disciplines.

METHOD

Data Collection Process

The Scopus Database was used to locate research publications on context-based learning in science education published between 2005 and 2023. This study offers an overview of the literature on the topic. Context-based learning, science education, physics, chemistry, and biology education were utilized as search terms. In the initial scan, 169 publications were discovered. After choosing a setting for education and a few periodicals, 127 publications were still available. After narrowing the search to peer-reviewed English-language articles, 125 articles were found. These publications were then examined using bibliometric approaches. The article selection process followed the PRISMA (preferred reporting items for systematic reviews and meta-analyses) standards (Moher et al., 2015) (**Figure 1**).

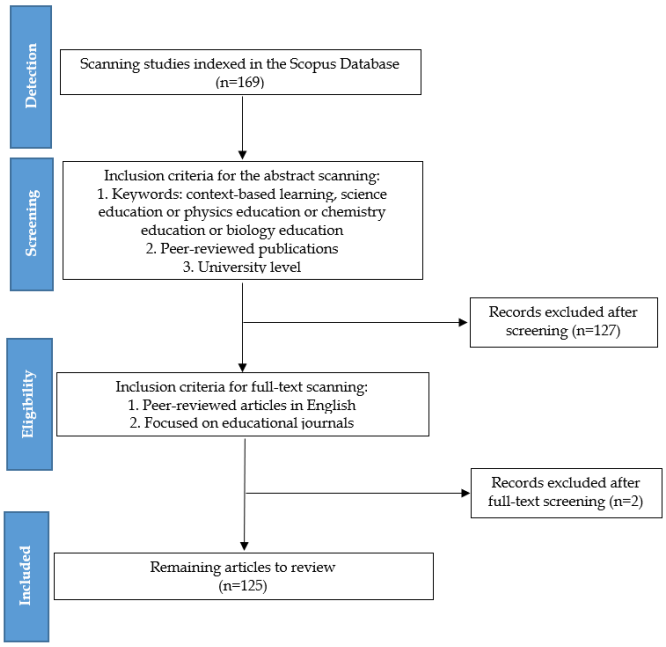

Figure 1. PRISMA flow diagram showing article selection process (Source: Authors' own elaboration)

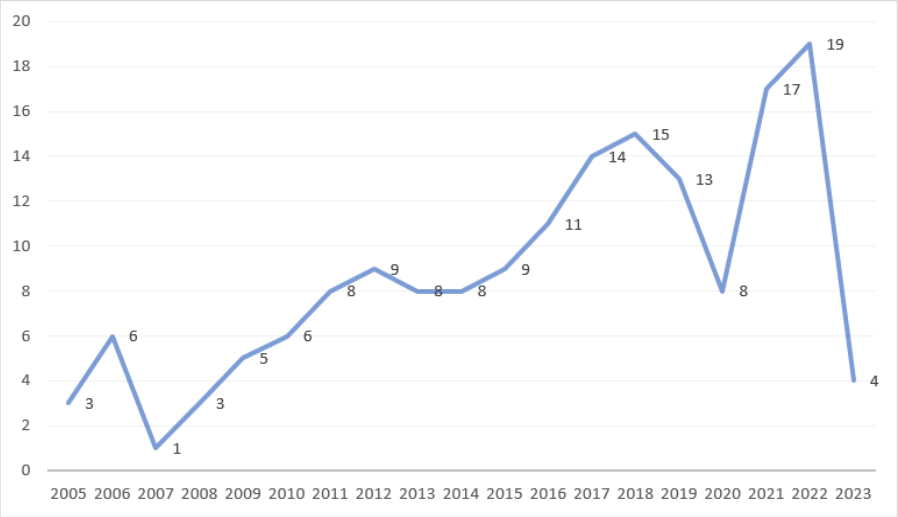

Figure 2. Articles by year distribution from 2005 to 2023 (Source: Authors' own elaboration)

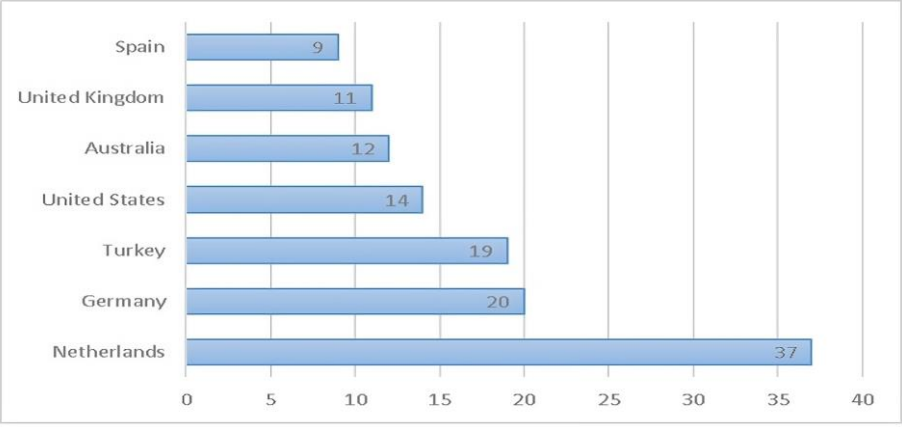

Figure 3. Distribution of articles by country (Source: Authors' own elaboration)

Data Analysis

Excel and Scopus Analyzer were two of the bibliometric tools used to analyze the data and create maps of important factors. In the study, statistical analysis was also done to look for trends and patterns in the data. Descriptive statistics were used to analyze the distribution of publishing output among yearly accounts, nations, publications, and publication years.

The search's parameters, which only incorporated articles listed in the Scopus Database, placed restrictions on the study. The study was further constrained by the lack of data on citation counts and other bibliometric indicators. Despite these drawbacks, the research offered insightful information on trends and patterns in research linked to context-based learning in science education.

RESULTS

Distribution of Articles by Years

The study began with an analysis of the distribution of articles published in the journals listed in the Scopus Database by year. **Figure 2** displays the study's findings.

Analysis according to **Figure 2** showed that although there were fewer articles between 2005 and 2015, there was a rise in those numbers in the subsequent years. However, most of all articles are found in journals that were published after 2015. The two years with the highest number of articles were 2021 (f=17) and 2022 (f=19).

Distribution of Articles by Country

The distribution of the discipline's articles by countries was also examined. Top-10 countries by number of articles are shown in **Figure 3**.

According to **Figure 3** (f=37), most of the articles were completed in the Netherlands. Germany (f=20), Turkey (f=19), United States of America (f=14), Australia (f=12), United Kingdom (f=11), Spain (f=9), and other countries were listed respectively.

Number of Citations by Years

Figure 4 shows steady rise in citations for works on the use of throughout time. It is projected that fewer citations will be made in 2023 than in 2022 because the

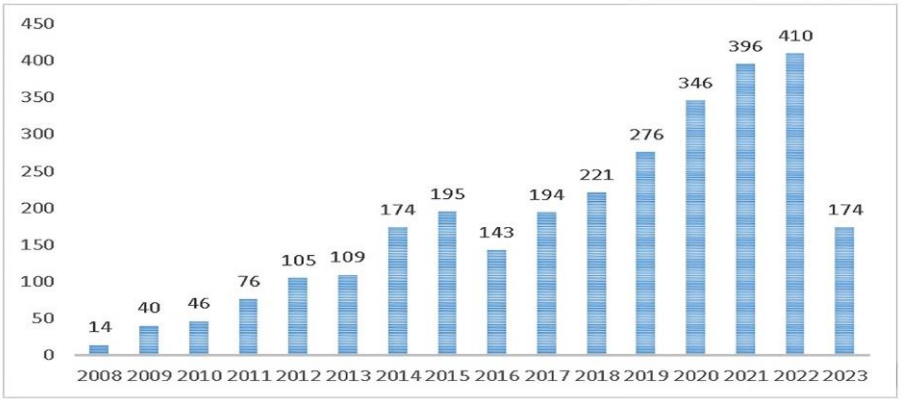

Figure 4. Number of citations by years (Source: Authors' own elaboration)

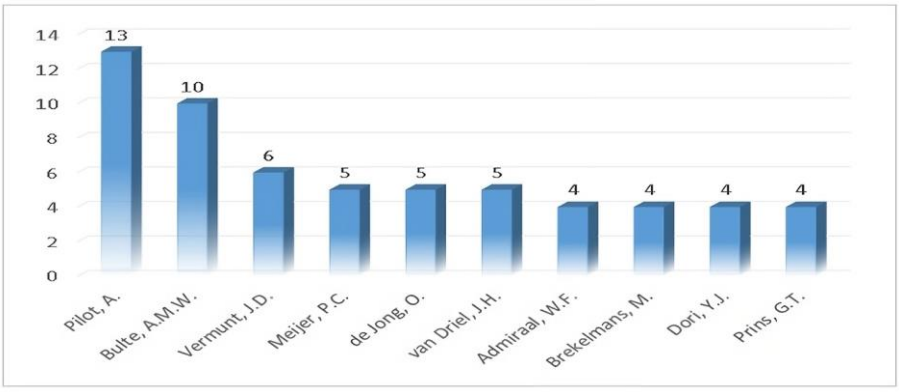

Figure 5. Number of articles by author (Source: Authors' own elaboration)

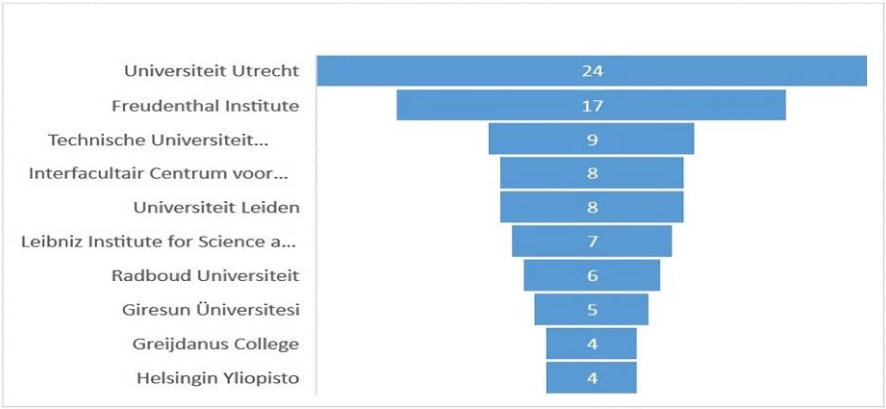

Figure 6. Number of articles by affiliation (Source: Authors' own elaboration)

year has not yet ended. Also, it can be shown that in 2022, number of citations for studies on use of context-based learning in science education reached its high.

Distribution of Number of Articles by Author

When the authors of the articles on context-based learning in science education are investigated, it is discovered that Pilot, A. has produced 13 of the most articles on this topic. Following this with Bulte, A. M. W. (10 publications), Vermunt, J. D. (six publications), Meijer, P. C., de Jong, O., and van Driel, J. H. each are five publications and Admiraal, W. F., Brekelmans, M., Dori, Y. J., and Prins, G. T. are the authors each having four publications (**Figure 5**).

Distribution of Number of Articles by Affiliation

Universiteit Utrecht (24 publications), Freudenthal Institute (17 publications) and Technische Universiteit Eindhoven (nine publications) are the top three universities in terms of the number of publications by affiliates.

Also, Interfacultair Centrum voor Lerarenopleiding, Onderwijsontwikkeling en Nascholing produced eight publications each. As seen in **Figure 6**, Leibniz Institute for Science and Mathematics Education (seven publications), Radboud Universiteit (six publications), Giresun University (five publications), Greijdanus College and Helsingin Yliopisto (four publications each) are the other educational institutions in order.

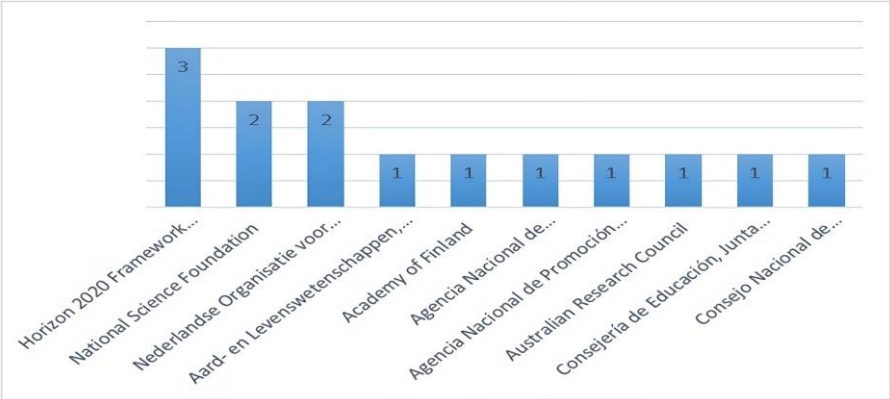

Figure 7. Number of articles by funding sponsors (Source: Authors' own elaboration)

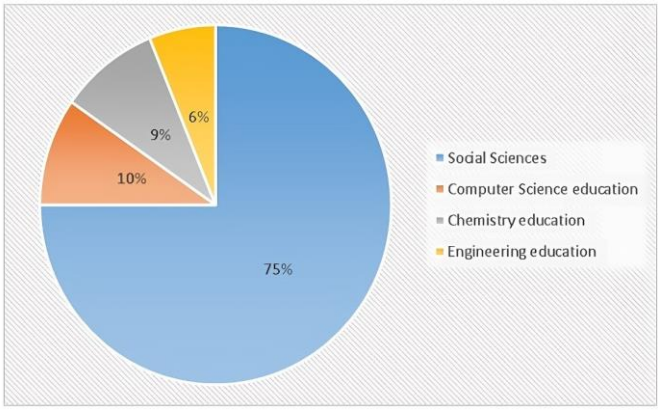

Figure 8. Distribution of articles by subject area (Source: Authors' own elaboration)

Distribution of Number of Publications by Funding Sponsor

Horizon 2020 framework program demonstrates leadership by supporting three publications related to context-based learning in science education. With their support for three two publications, National Science Foundation and Nederlandse Organisatie voor Wetenschappelijk Onderzoek are the second- and third-ranked sponsors, respectively. Following that, there are seven distinct sponsoring organizations with one publication each (**Figure 7**).

Distribution of Publications by Subject Area

Figure 8 shows that when the topic areas of the studied publications are considered, most of the studies (75%) are in the social sciences, 10% of the studies is in the computer sciences education and 9% in the chemistry education, 6% in engineering education subject area.

DISCUSSION

The Scopus Database yielded 125 articles on context-based learning in science education. Most of the articles were published between 2015 and 2022, with a noticeable increase in publishing beginning in 2005. This outcome is generally in line with the findings of the investigations carried out in the past (Karakus et al., 2019; Zhang et al., 2022). The Netherlands, Germany, and Turkey were the top three most productive countries with the Netherlands creating the most articles. The number of citations to articles included in the Scopus Database grew steadily, reaching its peak in 2022 with 410 citations.

The bibliometric review of the research on context-based learning in science education in this paper offers a thorough examination of the research literature. By synthesizing the findings, it was obtained important insights into the current state of the subject, spot trends, and talk about implications for future research and practice. Firstly, the growth of research publications in context-based learning in science education indicates increasing interest in and recognition of its potential benefits. The steady increase in the number of publications over time suggests that context-based learning has gained traction as a significant area of research in science education. This growth indicates the importance of considering real-world contexts and authentic experiences in science classrooms to enhance students' learning outcomes.

The interdisciplinary nature of context-based learning is evident from the distribution of research across various disciplines, including science education. This interdisciplinary focus highlights the recognition that context-based learning is not solely a pedagogical approach but also involves exploring cognitive and affective dimensions of learning. The integration of different perspectives and methodologies from multiple disciplines enriches the understanding of context-based learning and promotes comprehensive investigations. Another important finding is the identification of influential authors and publication outlets in the field of context-based learning in science education. These individuals and outlets have played a pivotal role in shaping the research agenda and disseminating knowledge in the field. Their contributions have advanced our understanding of the theoretical foundations, curriculum design, assessment practices, and teacher professional development in the context-

based learning domain. Context-based learning's complex nature is better understood through the analysis of major themes and concepts. It demonstrates that a variety of topics, including curriculum design, pedagogical techniques, assessment strategies, teacher professional development, and the impact on student learning outcomes, have been covered in the study literature. This range of topics demonstrates how sophisticated and intricate context-based learning is as a teaching strategy. Whereas the existing literature has given significant evidence of the positive impacts of context-based learning, a few gaps and challenges still need to be addressed. Longitudinal studies that explore the long-term effects of context-based learning on students' learning results and career choices are required to maintain its impact. Furthermore, more inquiry is required to investigate the usage of context-based learning across different science disciplines and among diverse student populations to guarantee equitable access and results. Moreover, the successful implementation of context-based learning relies on effective teacher professional development. Ongoing support and resources should be provided to teachers to enhance their pedagogical content knowledge, instructional strategies, and collaboration opportunities. Professional development programs should be designed to meet the specific needs of teachers and provide a platform for sharing best practices and experiences. Additionally, the evaluation has highlighted major contributors to the area by identifying influential authors and publishing trends.

The results highlight the value of context-based learning in raising student motivation, engagement, and conceptual knowledge in scientific instruction. Students are better able to understand the relevance and applicability of science in their daily lives when scientific concepts are linked to settings in the real world. This strategy encourages critical thinking, problem-solving abilities, and scientific literacy, all of which are necessary for students to take an active role in a society that is becoming more and more science driven.

The various theoretical frameworks, curriculum design models, and assessment strategies identified in the literature provide valuable guidance for educators seeking to implement context-based learning in their classrooms. 5E instructional model, for instance, offers a structured framework for engaging students in inquiry-based learning within meaningful contexts. Similarly, the integration of social, ethical, and technological dimensions of science through STS approach allows students to develop a deeper understanding of the societal implications of scientific knowledge.

The discussion also emphasizes how crucial continual professional development for teachers to successfully adopt context-based learning. To improve their pedagogical material understanding, teaching tactics, and cooperation with colleagues, teachers require assistance and tools. Giving teachers the right resources and instruction will enable them to design engaging lessons that support student achievement and the concepts of context-based learning.

The bibliometric review concludes by showing the development and importance of context-based learning in scientific education. The findings highlight gaps and issues while offering insightful information about the condition of the subject today. They also identify major trends. Researchers and practitioners may expand the use of context-based learning to support meaningful and successful scientific education by addressing these gaps and utilizing the new insights.

CONCLUSIONS AND IMPLICATIONS

Despite the progress made in context-based learning research, several gaps and challenges remain. This section discusses the limitations and areas requiring further investigation, such as the need for more longitudinal studies, the exploration of diverse student populations, and the assessment of the effectiveness of context-based learning across different science disciplines. Furthermore, the review addresses the challenges associated with implementing context-based learning in classrooms and the professional development needs of teachers.

Context-based learning represents a promising approach to promote meaningful and authentic learning experiences in science education. This bibliometric review provides a comprehensive overview of the existing research, highlighting its growth, key themes, and gaps. By synthesizing knowledge and identifying research trends, this review contributes to the advancement of context-based learning in science education, ultimately improving the quality of science education practices and fostering students' scientific literacy.

This review has implications for researchers and practitioners. Identified gaps and challenges can guide future investigations, such as exploring innovative instructional approaches and examining contextual factors. Experts can use context-based learning approaches in teaching and training to improve outcomes, with guidance from this review. It offers an analysis of the research on context-based learning in science education. The study shows growth and interdisciplinary themes in the field. This section offers useful recommendations for educators and decision-makers interested in integrating context-based learning into science education based on the results of the bibliometric analysis. It also provides academics with insights into potential multidisciplinary research collaborations, cutting-edge research methodologies, the incorporation of technologically improved learning approaches, and future perspectives for exploring context-based learning.

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