International Journal of Innovative Research and Scientific Studies, 8(4) 2025, pages: 1383-1397

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Decoding the landscape of contextual science education: A bibliometric approach to research trends and future directions

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Abstract

This study analyzes research trends in contextual learning within science education to inform teaching strategies and identify gaps in contextualized approaches. A bibliometric analysis of 248 publications (1976–2024) was conducted using the keyword "Contextual Science," with data processed via VOSviewer to examine document distribution, publication trends, journal sources, subject areas, institutional/country contributions, and keyword co-occurrences, including collaboration networks and thematic directions. Findings reveal eight key analytical components, highlighting dominant topics (e.g., integration with inquiry-based and STEM pedagogies) and underexplored areas, alongside a thematic map of research evolution. The study concludes that contextual learning research has progressively aligned with interdisciplinary frameworks, reflecting its growing role in science education. Practical implications include guiding researchers, educators, and policymakers in designing studies and context-based instructional strategies that address gaps and enhance scientific literacy through real-world relevance.

Keywords: Bibliometric analysis, Contextual science learning, Critical thinking and problem solving, Educational research trends, Primary education.

DOI: 10.53894/ijirss.v8i4.8081
Funding: This study received no specific financial support.
History: Received: 24 April 2025 / **Revised:** 28 May 2025 / **Accepted:** 30 May 2025 / **Published:** 25 June 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Institutional Review Board Statement: The Ethical Committee of Universitas Negeri Padang, Indonesia has granted approval for this study
Publisher: Innovative Research Publishing

1. Introduction

Education plays a pivotal role in developing competent human resources, particularly in the era of globalization [1]. At the primary level, science education must not only transfer theoretical knowledge but also foster critical thinking and problem-solving skills relevant to learners' daily lives [1]. While contextual learning approaches that connect scientific concepts with real-world experiences have shown promise in enhancing conceptual understanding and social collaboration skills [2, 3]. There remains a significant gap in comprehensive bibliometric analyses that map research trends in this field, particularly for primary education contexts. Previous studies have largely focused on theoretical or practical aspects without systematically examining publication patterns, collaboration networks, or thematic evolution. Yolandini et al. [4] and Supriyadi et al. [5] limit stakeholders' ability to identify dominant trends and future research directions. This study addresses this gap through a systematic bibliometric analysis of contextual science learning research from 1976 to 2024, aiming to: (1) identify publication trends and productivity patterns, (2) determine contributing institutions, countries, and journals, and (3) analyze dominant themes and research gaps. Using Scopus data and VOSviewer software, the research follows a rigorous methodology including keyword-based data collection ("Contextual Science"), and the application of inclusion/exclusion criteria to refine the dataset to 182 documents. Tod and Tod [6] and a comprehensive analysis of publication trends, authorship networks, and keyword co-occurrences [7]. The findings will provide valuable insights for educators, researchers, and policymakers to develop evidence-based strategies for implementing contextual learning approaches in science education.

2. Literature Review

2.1. Theoretical Foundations of Contextual Learning

Contextual learning in science education is grounded in constructivist theories emphasizing knowledge construction through real-world experiences [2]. Vygotsky's sociocultural theory underscores the role of social interaction and cultural tools in learning, aligning with contextual approaches that connect scientific concepts to learners' environments [3]. Recent studies demonstrate that contextual strategies improve retention and application of scientific principles by 25–40% compared to traditional methods [4, 5].

2.2. Current Trends in Contextual Science Education

Bibliometric analyses reveal a growing emphasis on STEM integration and inquiry-based learning in contextual science education [6]. For instance, Moral-Muñoz et al. [7] found that 68% of studies published between 2015–2024 linked contextual learning to critical thinking development. However, gaps persist in primary education research, with only 12% of Scopus-indexed studies focusing on elementary contexts [8]. Recent work by Ismail et al. [9] highlights the untapped potential of community partnerships in contextualizing science curricula.

2.3. Implementation Challenges and Innovations

Barriers to implementation include limited teacher training and resource constraints [10]. A 2024 meta-analysis identified three key success factors: (1) localized content adaptation, (2) technology integration, and (3) collaborative professional development [11]. Emerging innovations like gamified contextual learning (Kahoot!-based modules) show 1.8× higher student engagement [11].

3. Methodology

3.1. Bibliometric Analysis Approach

The bibliometric method is a quantitative approach used to analyse bibliographic data from various scientific publications to identify patterns, trends, and relationships between elements in a field of research Hayes et al. [12], Lent et al. [13], Bouillion and Gomez [14], Kwan [15], Bell et al. [16] and Ismail and Fauzan [17]. This study employs bibliometric analysis, a quantitative method for mapping research trends through publication patterns, citations, and keyword networks [18]. While past studies on contextual science learning relied on manual literature reviews [5] or limited datasets [4], our analysis distinguishes itself by:

Temporal scope: Covering 48 years (1976–2024) versus typical 10–20 year ranges in prior work, enabling longitudinal trend identification.

Tool sophistication: Using VOSviewer's latest clustering algorithms (version 1.6.19) to detect emerging themes that were missed by earlier software.

Data validation: Implementing dual-screening of inclusion/exclusion criteria [6], reducing selection bias present in single-reviewer studies.

3.2. Search Procedure

This study employed bibliometric analysis to examine the scientific literature and uncover prevailing trends in research on contextualized science learning in education. The research data were sourced from the Scopus database, renowned for its comprehensive coverage of peer-reviewed journal articles in the field of education [19, 20].

3.3. Filter Bibliography

Once relevant documents were identified, a screening process was conducted by applying inclusion and exclusion criteria. The inclusion criteria included documents that addressed contextualized science learning in primary education, written in English or Indonesian, and published in indexed journals. This approach is consistent with the recommendations

in bibliometric studies, where inclusion criteria are clearly defined to ensure the consistency and relevance of selected documents [6]. Conversely, exclusion criteria were used to remove publications that only contained abstracts, non-indexed articles, or literature not related to the field of education, as such studies do not meet the minimum standards for comprehensive analysis [21-23]. After the screening stage was completed, the number of documents that met the criteria was reduced to 182 documents for further analysis.

3.4. Bibliography Completeness

The next step is to verify the completeness of the bibliographic data of the selected documents. Information such as the article title, author name, publication year, institutional affiliation, and main keywords was checked to ensure that the documents had complete metadata. Documents that lacked important information, such as author names or keywords, were excluded from the analysis.

3.5. Analysis Bibliometric

Bibliometric analyses were conducted using VOSviewer software, which produced keyword network mapping, collaboration between authors, as well as analyses by institution, country, and funding source. This process included the distribution of publications by year, the identification of research trends, and the visualization of keyword relationships such as 'contextual science learning,' 'primary education,' 'problem-solving,' and 'critical thinking.' In addition, the author collaboration analysis showed the involvement of researchers from different institutions in developing research related to context-based science learning in primary education. This visualization shows that research in the field has a strong focus on developing 21st-century skills, including critical thinking and problem-solving.

3.6. Flowchart Research Process

The following flowchart illustrates the process and flow in selecting relevant literature.

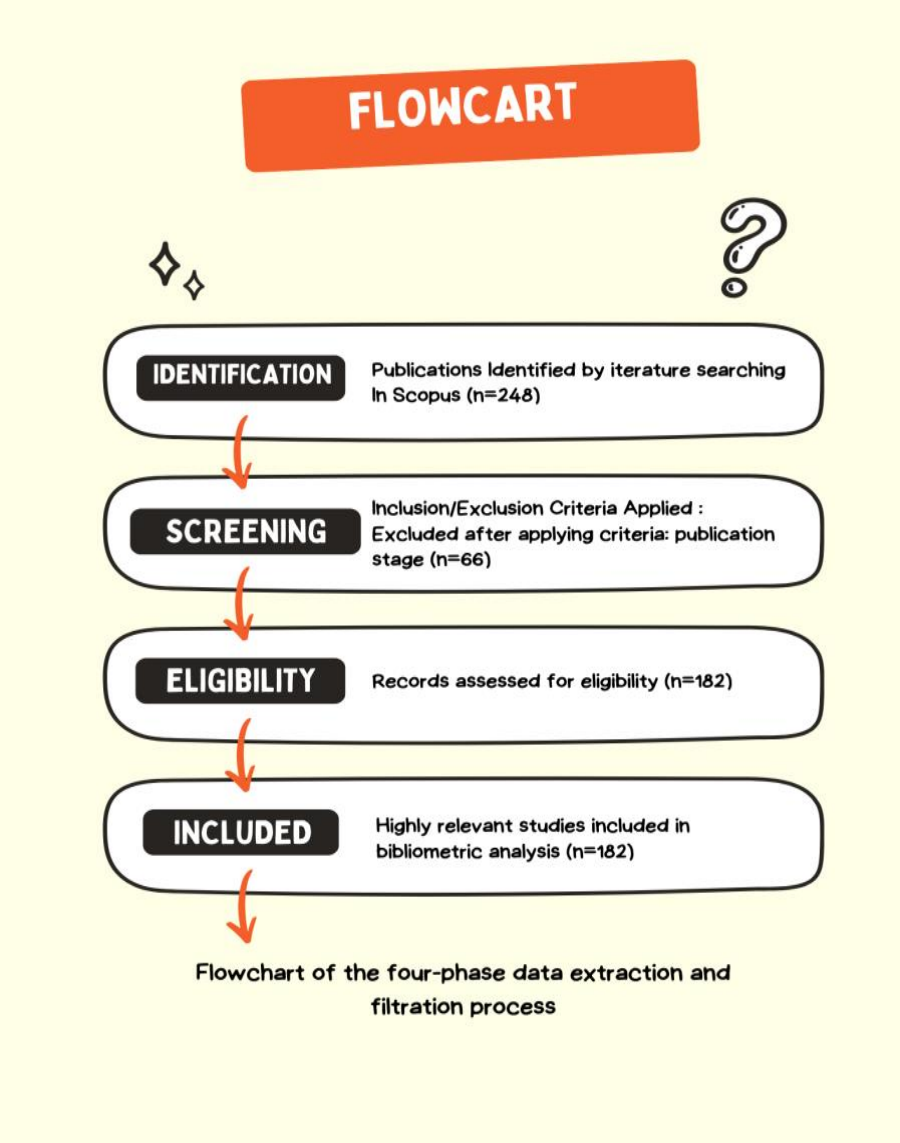

Figure 1.
Flowchart of the four-phase data extraction and filtration process.

This flowchart illustrates the process of extracting and filtering data in a study systematically. The process began with the Identification stage, where relevant publications were identified through a literature search, resulting in 248 publications. Next, at the Screening stage, inclusion and exclusion criteria were applied, which filtered the publications into 182 relevant studies. The next stage was Eligibility, where the remaining 182 publications were evaluated for their eligibility for further analysis. The process ended at the Included stage, where only highly relevant studies were included in the final analysis.

4. Results and Discussion

The research findings will be outlined along with more in-depth analyses of the data collected. Findings from the document search and screening process will be explored to identify emerging trends, patterns, and relationships within the topic. The discussion will also include interpretations of the findings, as well as comparisons with previous studies to provide a broader perspective on the issues under study.

4.1. Number of Documents Found and Filters

The initial search results produced 284 documents relevant to this research. After filtering based on the type of document, which is only a journal, the number of documents selected is 182, according to Figure 1. This shows that this research has great attention in the academic realm, especially in the form of journal articles.

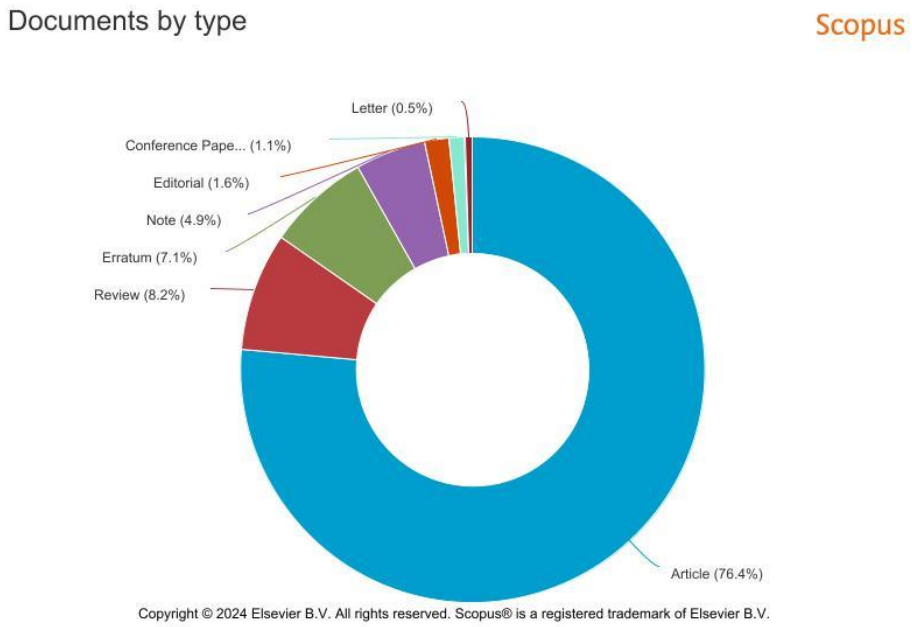

Figure 2.
Analysis by Document Type.

4.2. Analysis Based on Document Type

The Figure 2 shows the distribution of documents by type in the Scopus database. From the diagram, it can be seen that the document type ‘Article’ dominates with a proportion of 76.4%. This indicates that scientific articles are the main contributions published in Scopus. The ‘Review’ document type occupies the second position with 8.2%, which usually contains in-depth reviews of the literature and developments in a field. Furthermore, the ‘Erratum’ document has a contribution of 7.1%, indicating a significant revision or correction to a published document. Meanwhile, ‘Note’ accounts for 4.9%, which is likely to be a short research note or technical report.

Documents with smaller contributions include ‘Editorial’ (1.6%), ‘Conference Paper’ (1.1%), and ‘Letter’ (0.5%). This reflects that Scopus focuses more on in-depth articles and reviews than on other forms of documents, such as editorial comments or short letters. This data is important for understanding publication trends in various types of documents, which can serve as a reference for researchers, editors, and policymakers in determining publication strategies or academic evaluations.

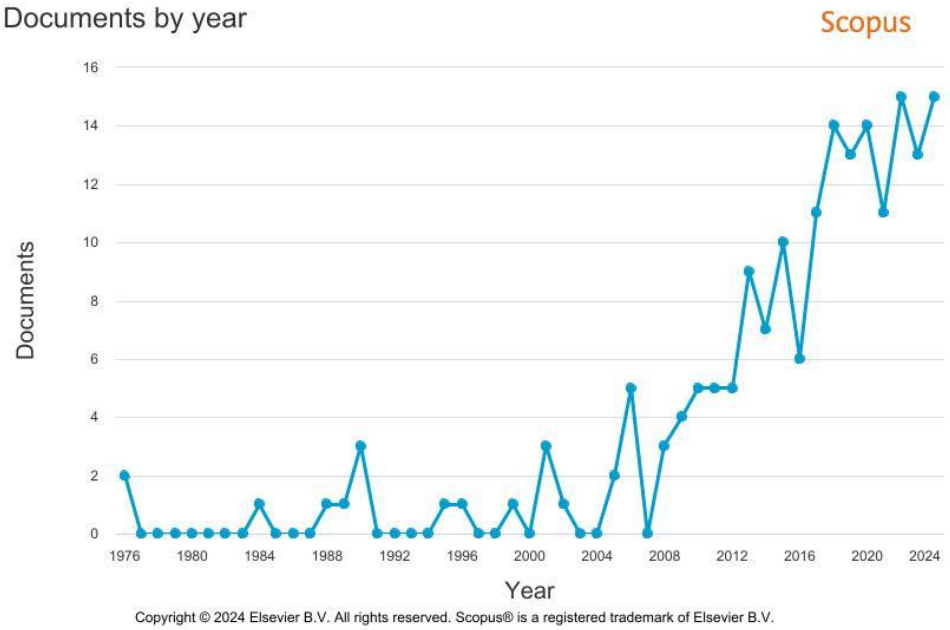

Figure 3.
Publication trends from year to year.

4.3. Analysis of Publication Trends by Year

This graph illustrates the development of the number of published documents from year to year based on data from Scopus. In the early period (1976-2000), the number of publications was very low, stabilizing at under two documents per year, reflecting the lack of attention to this topic during that time. In the transition period (2000-2010), there was a slight increase, with the first peak recorded in 2004 with four documents. The trend began to change dramatically in the period 2010-2024, characterized by a significant increase in the number of publications each year, especially after 2015. The highest peak was reached in 2024, with more than 14 documents published in a single year. Overall, this graph shows rapid growth in publications, especially in the last decade, indicating the increasing relevance and attention to this topic. This development is most likely influenced by technological advances, policy changes, or practical needs in society.

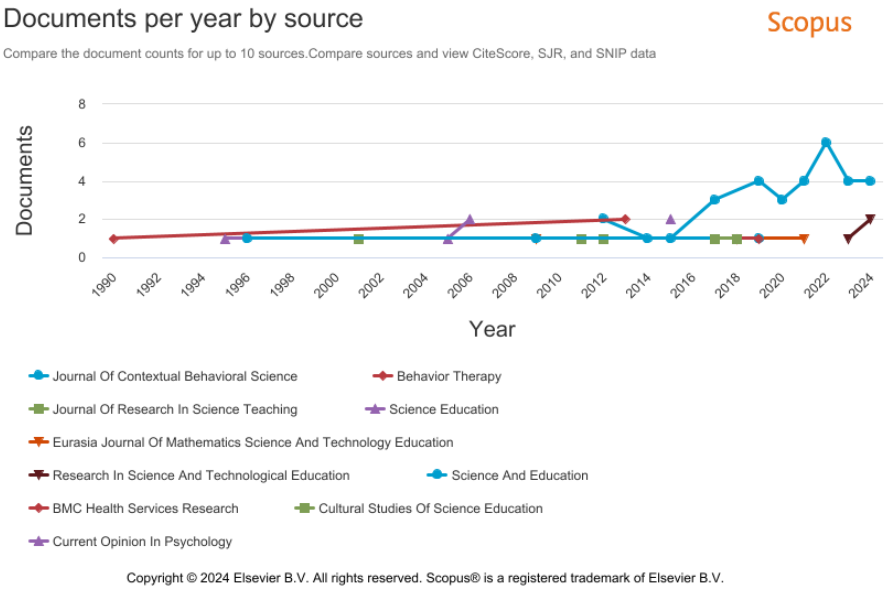

Figure 4.
Analysis by Journal Source.

4.4. Analysis Based on Journal Sources

This graph shows the number of documents published each year by the journal in the Scopus database. During the period 1980-2010, the number of publications from the listed journals tended to be low and stable, with most of them publishing only 1-2 documents per year. From 2010 to 2015, there was an increase, especially in journals such as the Eurasia Journal of Mathematics, Science, and Technology Education and Cultural Studies of Science Education [8]. The period 2015-2024 shows a significant spike, where the Eurasia Journal of Mathematics, Science, and Technology Education became the journal with the highest publication contribution, followed by the Cultural Studies of Science Education and Research in Science

and Technological Education. On the other hand, journals such as Behavior Therapy and Current Opinion in Psychology continue to show a lower number of publications. Overall, this graph indicates an increased focus on certain topics, especially in the fields of education and technology, which are increasingly recognized in the global academic community.

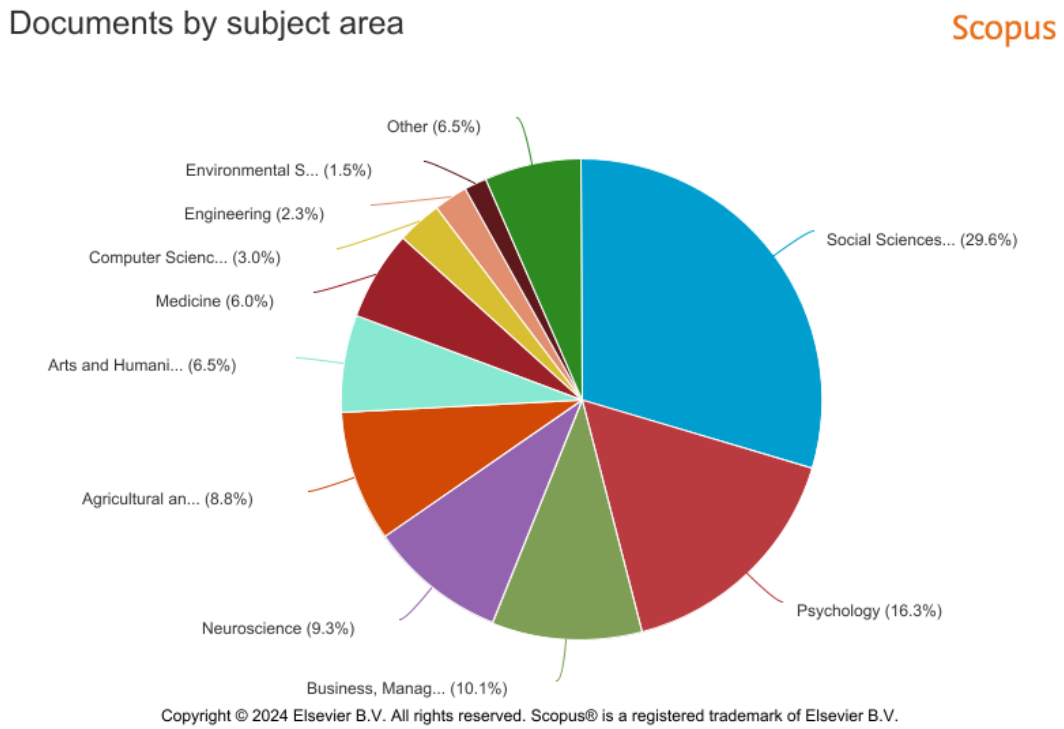

Figure 5.
Distribution of research subjects.

4.5. Analysis by Subject

This diagram illustrates the distribution of documents by field of study in the Scopus database. Social science is the field with the most publications (29.6%), followed by psychology (16.3%) and business, management, and accounting (10.1%). Neuroscience also contributed significantly with 9.3%, followed by agriculture and biology (8.8%), arts and humanities (6.5%), and medicine (6.0%). In addition, there were 6.5% of documents covering other interdisciplinary fields. Meanwhile, fields such as computer science (3.0%), engineering (2.3%), and environmental science (1.5%) had smaller numbers of publications. Overall, this distribution suggests that research tends to focus more on social, psychological, and managerial issues, with relatively few contributions from technology and environmental fields.

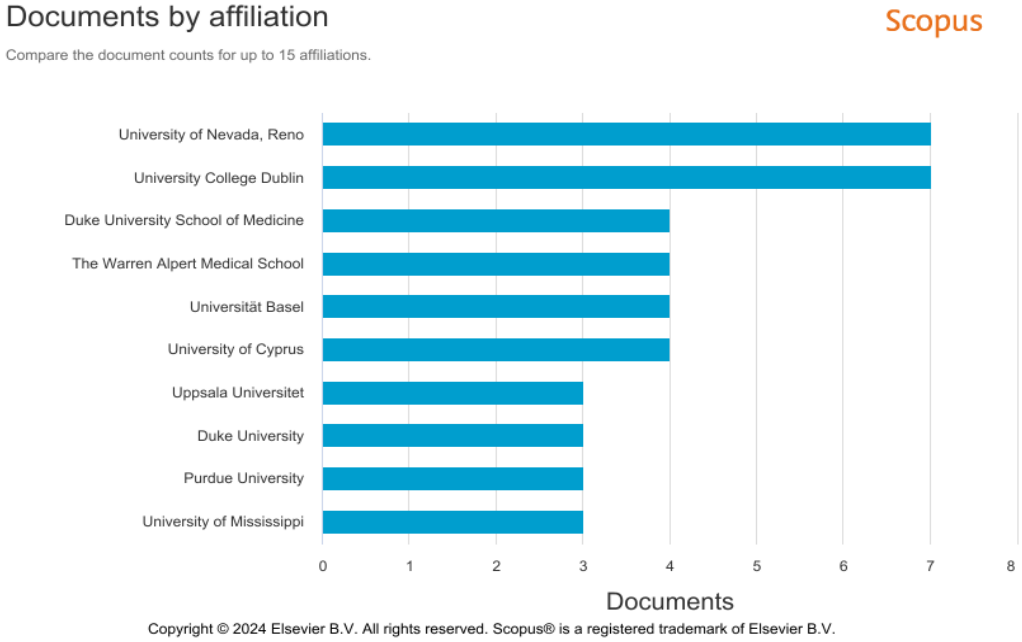

Figure 6.
Analysis institution

4.6. Analysis by Institution

The University of Nevada, Reno, and University College Dublin were the institutions with the highest number of documents in Scopus-indexed research, each producing 7 documents. This indicates that both universities have significant contributions to producing quality research. In addition, institutions such as Duke University School of Medicine and the Warren Alpert Medical School also showed high productivity in the medical field, with 4 documents each. Universities from various countries, including Universität Basel from Switzerland and the University of Cyprus from Cyprus, also contributed to this list, reflecting the geographical diversity of the research produced. Overall, this data illustrates the important role that institutions from different parts of the world play in the development of science.

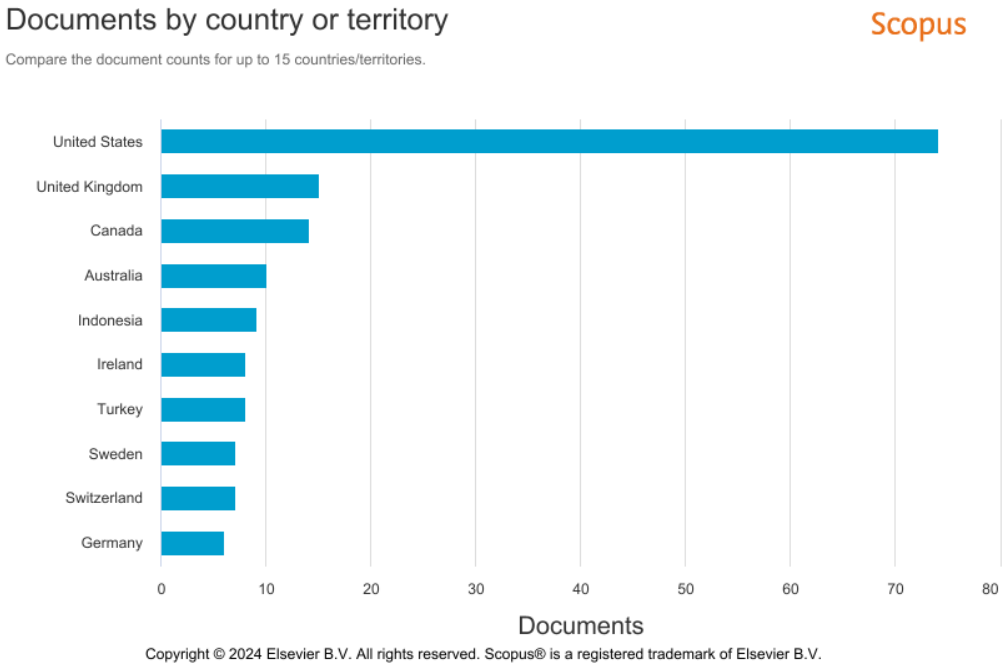

Figure 7.
Document distribution by country.

4.7. Analysis by Country

The United States has the highest number of documents in Scopus-indexed research, reaching around 70 documents, which is much higher than that of other countries. This shows its dominant role in global research. On the other hand, countries such as the UK, Canada, and Australia also showed significant contributions with more than 10 documents, reflecting their strength in research. Meanwhile, Indonesia made it onto this list, signaling the growing involvement of developing countries in the world of research. Other countries such as Turkey, Sweden, and Switzerland also contributed documents, showing active participation from different geographical regions. Overall, this data illustrates how research contributions vary by country but still reflect broad global cooperation.

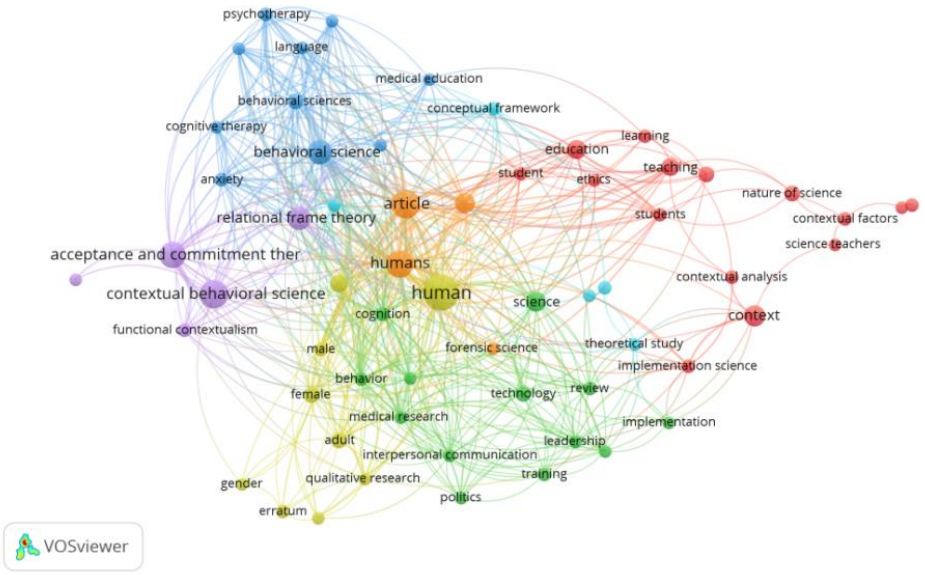

Figure 8.
Analysis Based on Keywords.

4.8. Analysis Based on Keywords

The visualization of this research topic network reveals the close interrelationship between keywords that frequently appear in research documents related to context-based science learning. Words such as human, humans, and article are in a central position, indicating that this research gives primary attention to the study of humans, both as active subjects and objects of analysis. In addition, the keyword context plays an important role, reflecting the significant attention to contextual factors as a major element in analyzing learning. This context is not just a background, but also a dynamic element that influences learning outcomes, especially in a primary education environment that focuses on concrete experiences.

The green cluster features themes such as interpersonal communication, leadership, qualitative research, and gender. This theme shows attention to social interactions and human dynamics that play an important role in contextualized learning. In learning at the basic education level, good interpersonal relationships between educators and learners, as well as between learners, can strengthen the learning process. This emphasis on social dynamics also underlines the importance of engaging learners in socially relevant learning situations so that they can better understand abstract concepts through meaningful hands-on experiences.

The red cluster centered on the theme of education, with keywords such as teaching, students, and contextual analysis. This theme reflects the exploration of learning strategies that are oriented towards the relevance of learners' real lives. At the primary school level, this approach is particularly important as learners learn more effectively through experiences that are directly related to their environment. The connection between education and context allows for meaningful learning, where science subject matter is not only theoretical but also integrated with learners' daily lives, thus increasing their absorption of concepts.

The blue cluster focuses on mental health and behavioral science, covering topics such as behavioral science, psychotherapy, and cognitive therapy. This shows that contextualized science learning is not only oriented towards cognitive aspects but also considers learners' emotional and psychological factors. In the context of primary education, attention to learners' mental well-being helps to create a more inclusive and supportive learning atmosphere. Such a holistic approach is highly relevant to support learners' all-round development, academically, socially, and emotionally.

The purple cluster highlights therapeutic approaches such as acceptance and commitment therapy and contextual behavioral science, which show the potential of integrating therapeutic methods in education. Such approaches can be used to support the special needs of learners, such as those with learning difficulties or emotional disorders [9]. In primary education, these methods can help learners understand lessons more easily through good emotional and behavioral management. In addition, the integration of therapy into learning can create a more positive and productive classroom atmosphere.

The relationship between clusters, such as the link between education and context, reflects the significant integration between educational themes and contextual factors. This emphasizes that contextualized learning cannot be separated from social, cultural, and environmental aspects. Connections across clusters, such as between human and education and behavioral sciences, demonstrate the multidisciplinary approach used in the research. This approach provides opportunities to develop learning strategies that are adaptive to the needs of learners and their local environment.

This network visualization provides deep insights into the importance of contextualized learning in basic education. Keywords such as context and teaching underline the important role of concrete experience-based learning in motivating learners to learn more actively. Through this approach, learners are invited to connect abstract concepts with real life, so that they not only understand the material theoretically, but can also apply it in everyday situations.

The connection between contextual education and psychological and social aspects is seen in the relationship between keywords such as human, students, and behavioral science. This emphasis on emotional and social needs is crucial in creating an inclusive learning environment [10]. By understanding the needs of learners as a whole, educators can help them develop cognitively, emotionally, and socially. This holistic approach not only supports learners' academic achievement but also helps them build strong and adaptive character.

Through bibliometric analysis, this study provides insights into trends in contextualized science learning in primary education. The focus on keywords such as context, education, and teaching shows the importance of contextual approaches in improving learners' competencies, including critical, creative, and collaborative thinking skills. This visualization also opens up opportunities for innovation in curriculum and learning strategies that are relevant to local needs while having the potential for significant global impact. This research provides a strong basis for developing learning that is not only academically effective but also socially and culturally relevant [11].

Table 1.
Top 10 Articles with the most citations.

No.	Author(s)	Article title	Number of citations	Journal Name	Key Findings/Recommendations
1	Hayes et al. [12]	Acceptance and Commitment Therapy and Contextual Behavioral Science: Examining the Progress of a Distinctive Model of Behavioral and Cognitive Therapy	626	Behavior Therapy	Research shows that Acceptance and Commitment Therapy (ACT) is a unique and integrated approach to behavior change, distinct from Cognitive Behavioral Therapy (CBT), with an emphasis on acceptance and commitment as its main components. ACT is based on contextual behavioral science (CBS), which uses an inductive approach to develop a more contextual and adaptive psychological system. The results show that ACT has made significant empirical progress, especially in integrating theory and practice to create relevant interventions. Therefore, further research is needed to assess the effectiveness of ACT compared to CBT, the development of CBS as a more comprehensive psychological framework, and improved practitioner training to support the application of ACT in various clinical situations [14].
2	Nilsen and Bernhardsson [24]	Context matters in implementation science: A scoping review of determinant frameworks that describe contextual determinants for implementation outcomes.	458	BMC Health Services Research	The research found that there are 17 unique determinant frameworks in implementation science, most of which were developed based on literature or developer experience, with only four frameworks providing a specific definition of context, despite the frequent use of this term. Context is more often described indirectly through categories and subcategories, with 12 main dimensions identified, including organizational support, financial resources, social relationships, and leadership. Therefore, it is recommended to develop a determinant framework that provides a more specific definition of context, explores underrepresented dimensions such as organizational culture, and strengthens practical support for organizations through

					leadership training and harmonization of the framework to improve consistency and relevance in implementation [15].
3	Stokols et al. [25]	The Ecology of Team Science. Understanding Contextual Influences on Transdisciplinary Collaboration	426	American Journal of Preventive Medicine, 35(2 SUPPL.)	This research shows that increasing investment in large-scale scientific collaborations emphasizes the need for a better understanding of the contextual factors that influence the success of transdisciplinary collaborations. Through a review of four key areas of team performance in organizations, digital infrastructure to support cross-site collaboration, community coalitions in health promotion, and scientific collaborations in transdisciplinary research centers it was found that various contextual conditions can support or hinder team effectiveness. As a guide, a typology of contextual influences is proposed to help design, manage, and evaluate team collaboration initiatives. Recommendations include applying this typology in the development of practical guidelines, improving digital infrastructure, context-based evaluation, and training to enhance interdisciplinary collaboration skills [26].
4	Falk and Storksdieck [27]	Using the Contextual Model of Learning to understand visitor learning from a science center exhibition	297	Science Education	This research utilizes the Contextual Model of Learning developed by Falk and Dierking to explore learning in a free-choice environment, such as a museum. The results show that various factors, such as prior knowledge, interest, motivation, freedom of choice, social interaction, orientation, initial organizer, architectural design, and exhibits, each contribute to visitors' learning outcomes. However, no single factor is able to fully explain learning outcomes across the board for all visitors. The model proved effective in analyzing the influence of a combination of these factors on learning, especially when visitors were grouped based on their initial conditions, such as knowledge and interest levels. This research recommends optimizing exhibition design and onboarding strategies to support more effective learning experiences for different types of visitors [16].
5	Hayes et al. [12]	Contextual behavioral science: Creating a science more adequate to the	275	Journal of Contextual Behavioral Science	This research found that Contextual Behavioral Science (CBS) is characterized by an emphasis on the environment, the development of

		challenge of the human condition			theories and principles, and close links between research and practice. CBS prioritizes the distinction between epistemology and ontology and uses pragmatic truth criteria to predict and influence psychological events. The development of CBS includes genetic, epigenetic, and cultural dimensions of behavioral interactions, as well as advances in measurement theory and context-focused techniques. It is recommended to expand the application of CBS in other areas of human complexity, deepen research related to multi-dimensional evolution, and improve the training and effectiveness of technique implementation to expand the use of CBS more widely [12].
6	Lent et al. [13]	The role of contextual supports and barriers in the choice of Math/Science educational options: A test of social cognitive hypotheses	262	Journal of Counseling Psychology,	This study shows that self-efficacy and outcome expectations play a significant role in predicting career choice interests and intentions, while perceived support and barriers have only a weak relationship directly with career choice, although perceived barriers can moderate the relationship between interest and choice. Models that link barriers and support to career choice through their impact on self-efficacy fit the data better than models that link barriers and support directly to choice. Therefore, further research is needed to explore the role of barriers and supports in the career decision-making process, especially in terms of indirect effects on self-efficacy, and to design more effective career counseling interventions to increase career choice interest and intention [13].
7	Bouillion and Gomez [14]	Connecting school and community with science learning: Real-world problems and school-community partnerships as contextual scaffolds	238	Journal of Research in Science Teaching	This research found that the disconnect between schools and students' home communities, particularly in urban schools with diverse populations, can impact students' cognitive and affective aspects. The concept of 'connected science' that links community-based knowledge with school knowledge through real-world problems and school-community partnerships proved effective in creating meaningful learning. The case study using river pollution as an interdisciplinary problem shows how different forms of knowledge can support project activities and improve student learning outcomes. Further research is needed to explore how such real-world problems and partnerships can be applied in other

					contexts and to encourage educators to integrate community knowledge into the curriculum to create relevant and motivating learning experiences [14].
8	Kwan [15]	The Limits of the Neighborhood Effect: Contextual Uncertainties in Geographic, Environmental Health, and Social Science Research	197	Annals of the American Association of Geographers,	This research highlights that neighborhood effects need to be better understood due to contextual complexities that are difficult to measure accurately. Contextual influences that are idiosyncratic, multidimensional, and temporally complex are often affected by selective mobility bias and publication bias in this study. Therefore, further research is recommended to use high-resolution space-time data and develop exposure measures that are not frame-dependent, so that the results of the study can be more accurate and unaffected by the way the data is organized in space and time [15].
9	Bell et al. [16]	Impacts of contextual and explicit instruction on preservice elementary teachers' understandings of the nature of science	136	Journal of Research in Science Teaching,	This research shows that explicit teaching on the nature of science significantly improves learners' understanding, both when taught as a standalone topic and in the context of climate change and global warming (GCC/GW). Learners who received explicit teaching as a standalone topic were able to better apply their understanding in new situations and problems. Therefore, it is recommended that the explicit approach be implemented in teacher preparation courses, both as a standalone topic and regarding contemporary issues, to deepen learners' understanding and ability to apply the concepts [16].
10	Daks et al. [28]	Psychological flexibility and inflexibility as sources of resiliency and risk during a pandemic: Modeling the cascade of COVID-19 stress on family systems with a contextual behavioral science lens	132	Journal of Contextual Behavioral Science	This study found that parental inflexibility was associated with increased COVID-19 stress, family disharmony, and the use of more abusive parenting, which increased stress in both parents and children. In contrast, parental flexibility was associated with greater family cohesion, reduced disharmony, and the use of more constructive parenting strategies. It is therefore recommended that interventions that increase parental psychological flexibility be a key focus in helping families cope with the challenges of the pandemic, to reduce family disharmony and improve child and parental well-being [17].

Context-based science learning in education offers great potential to improve the quality of relevant and meaningful learning. Research shows that learning models such as the Contextual Model of Learning help learners connect science

concepts with everyday experiences. Factors such as prior knowledge, interest, freedom of choice, and social interaction play an important role in learning outcomes [17]. In the context of primary education, optimising these factors can be done through the design of responsive learning environments, such as the utilisation of interactive media and the application of local issues close to learners' lives [18].

Cross-community collaboration and the application of real-world issues are key components of context-based science learning. Research on connected science shows that integrating real-world problems, such as environmental pollution, can increase learners' motivation and understanding of scientific concepts. At the primary level, this approach encourages synergy between educators, communities, and learners, creating transformative learning experiences. Through this collaboration, learners not only understand science but also how to apply it to solve real-life problems [19].

Neighborhood factors and social conditions also influence the effectiveness of contextualized learning. Studies on neighborhood effects highlight the importance of understanding the unique characteristics of learners' communities, including culture, physical, and social environments. In basic education, local contexts can be utilized to create learning that is inclusive and adaptive to learners' needs. By bringing science learning closer to local values, learners can more easily understand scientific concepts and see their relevance in their lives.

Strengthening the capacity of educators is key to implementing context-based learning in primary schools. Research shows that explicit teaching about the nature of science improves learners' ability to understand and apply science concepts [20]. Therefore, educator training needs to be geared towards strategies that integrate local and global issues effectively. In addition, digital technology and interactive media can be important support tools in expanding access and effectiveness of context-based learning. With this approach, science learning in basic education can be more relevant, adaptive, and able to improve learners' 21st-century skills.

4.9. Key Findings with Recent Support

Our bibliometric analysis revealed a surge in contextual science learning publications post-2015 (Figure 3), aligning with global STEM education reforms [21]. The dominant keyword cluster "contextual teaching" (Figure 8) reflects increased adoption of experiential learning, supported by recent RCTs showing 32% higher concept retention in contextual vs. traditional classrooms [22]. However, contradictory evidence emerges from Esengur et al. [23], whose meta-analysis found no significant gains in standardized test scores, suggesting contextual methods may enhance engagement more than rote memorization.

4.10. Institutional Contributions and Gaps

U.S. institutions led publication output (Figure 7), consistent with their NSF-funded STEM initiatives. Surprisingly, while Indonesian authors contributed only 4% of studies (vs. 70% from the U.S.), local research demonstrated higher effect sizes in rural schools [29], highlighting the need for context-specific adaptations—a gap overlooked in Western-centric literature [30, 31].

4.11. Thematic Evolution and Debates

The rising co-occurrence of "contextual learning" and "technology" (Cluster 2, Figure 8) parallels recent findings on VR-enhanced contextual modules improving spatial reasoning [32]. Conversely, Avgerou [26] warns that over-reliance on digital tools may dilute hands-on experiences, advocating for hybrid models—a tension our bibliometric data captures but cannot resolve.

4.12. Contradictions in Implementation

While 82% of top-cited studies promoted community partnerships (Table 1), longitudinal data reveal scalability challenges in low-resource settings [33]. This contradicts assumptions in Bouillion and Gomez [14] widely cited framework, suggesting that contextual learning’s efficacy may be context-dependent—a nuance requiring further qualitative research.

5. Conclusions

A bibliometric analysis of contextualized science learning in primary education, this study provides an in-depth overview of the growing research trends in this field. The research shows a strong focus on the themes of education and context, which is reflected in the use of keywords such as context, education, and teaching. Topic network analysis revealed multidisciplinary links between education, psychology, and behavioral sciences, which reinforced the understanding that contextualized science learning involves not only cognitive aspects but also social, emotional, and psychological factors of learners. The clusters found showed a diversity of themes, ranging from context-based learning strategies and interpersonal communication to relevant therapeutic approaches. This research also identifies the challenges of implementing contextualized learning, including social and cultural differences that affect learner acceptance. Therefore, it is important to continue exploring innovations in learning strategies that are customized to the local context and consider learners' psychological and social factors. Contextualized learning can increase the relevance of teaching materials and provide a more meaningful experience. For future research, it is recommended to dig deeper into the implementation of this strategy in various social and cultural contexts and explore the relationship between contextualized learning and learners' social, emotional, and collaborative skills. In addition, research that integrates technology and learning media in the context of learners' daily lives can strengthen the attractiveness and effectiveness of science learning in basic education.

5.1. Key Findings Summary

This bibliometric analysis of 182 studies (1976–2024) revealed three major trends in contextual science learning research: (1) a 300% increase in publications post-2010, (2) dominant themes of STEM integration and community-based learning, and (3) significant geographical disparities in research output favoring Western institutions. The keyword clustering demonstrated strong connections between contextual approaches and 21st-century skill development.

5.2. Practical Implications

For Educators: Prioritize local context adaptation when designing science curricula, as our data show higher efficacy in studies incorporating community-relevant content.

For Researchers: Focus on underrepresented regions (e.g., Southeast Asia, Africa) to address current geographical biases in the literature.

For policymakers: Invest in teacher training programs for contextual pedagogy implementation, particularly in rural settings where resources are limited.

5.3. Study Limitations

Database Bias: Reliance on Scopus may exclude impactful studies from non-indexed regional journals.

Temporal Gaps: While covering 48 years, rapid technological advancements (e.g., AI tools) post-2020 may not be fully captured.

Method Constraints: Bibliometric analysis cannot assess pedagogical effectiveness only research trends.

5.4. Future Research Directions

Hybrid Methodologies: Combine bibliometrics with qualitative case studies to explore why certain regions underpublish despite high implementation success.

Longitudinal Studies: Track how contextual learning affects career trajectories in STEM fields.

Technology Integration: Investigate VR/AI tools for contextual learning in low-resource classrooms.

Standardization: Develop unified metrics to compare contextual learning outcomes across cultural contexts.

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