

## Research Trends in Contextual Teaching And Learning in Basic Science Education: Bibliometric Analysis (2021–2025)

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### ABSTRACT

Contextual Teaching and Learning (CTL) has been widely implemented in elementary science education, with previous studies primarily examining its effectiveness in improving students' learning outcomes. However, existing literature reviews and bibliometric studies have mainly emphasized learning effectiveness rather than providing a comprehensive bibliometric mapping of CTL research in elementary science education. Therefore, this study aimed to analyze publication trends, journal characteristics, author collaboration, keyword networks, methodological approaches, and citation impact to identify research developments and gaps in CTL research published between 2021 and 2025. Following the PRISMA 2020 guidelines, relevant literature was retrieved from the Google Scholar and Scopus databases using Publish or Perish, managed with Covidence AI, and analyzed using Microsoft Excel and VOSviewer. Of the 353 records initially identified, 39 articles met the inclusion criteria. The findings revealed a steady increase in publication output, rising from five articles in 2021 to fourteen articles in 2025. All included studies were published in SINTA-indexed journals, whereas no Scopus-indexed articles met the inclusion criteria. The dominant keywords were *Contextual Teaching and Learning*, *learning outcomes*, *learning*, and *science education*, while author collaboration remained fragmented into small research clusters. Quantitative and Research and Development (R&D) approaches were the predominant methodologies, indicating that CTL research continues to focus primarily on learning effectiveness. Citation analysis further showed that the most highly cited studies mainly investigated learning outcomes, scientific literacy, learning motivation, and cognitive skills. These findings highlight the need to strengthen international collaboration, improve publication quality, diversify research methodologies, and expand CTL research beyond learning outcomes. Future bibliometric studies should broaden database coverage and incorporate advanced citation-based analyses to provide a more comprehensive understanding of CTL research development.

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### Introduction

The development of 21st-century education requires learning processes that are oriented not only toward mastering concepts but also toward fostering critical thinking, creativity, communication, collaboration, and problem-solving skills to address the challenges of a rapidly changing global environment (Yusuf, 2023). These demands have positioned scientific literacy as a fundamental competency that enables students to understand scientific phenomena, evaluate scientific evidence, and make informed decisions (Romli et al., 2024). The development of scientific literacy is closely linked to

science education, which encourages students to construct knowledge through inquiry, scientific reasoning, and the application of scientific concepts to real-world contexts (Oktasari et al., 2025). Consequently, science instruction should adopt student-centered learning approaches that actively engage students in constructing knowledge through meaningful learning experiences (Sayadi & Pangandaman, 2025). In this context, instructional approaches that connect learning materials with students' real-life experiences are essential for creating meaningful learning and fostering the development of scientific literacy.

In this context, Contextual Teaching and Learning (CTL) is considered an appropriate instructional approach to address these educational needs. CTL is a learning approach that enables teachers to connect instructional content with students' real-life contexts while encouraging them to relate newly acquired knowledge to their everyday experiences. Grounded in constructivist theory, CTL views students as active participants in constructing knowledge through prior experiences, social interaction, and direct engagement with their environment. Through activities such as observing, exploring, discussing, solving problems, and reflecting, CTL promotes active student engagement while fostering critical thinking, creativity, and collaboration skills (Wijayati, 2026). In science education, CTL enables students to participate in observation, investigation, experimentation, and problem-solving activities related to real-world phenomena, making learning more meaningful and relevant. These characteristics make CTL particularly suitable for elementary science education, which emphasizes scientific processes such as observation, experimentation, investigation, and concept construction based on authentic phenomena. By connecting science concepts with real-life contexts, CTL helps students develop a deeper understanding of scientific concepts, enhance scientific literacy, and strengthen essential 21st-century competencies, including critical thinking, problem-solving, collaboration, and the application of knowledge in authentic situations (Saputri et al., 2025).

Various empirical studies have shown that the application of Contextual Teaching and Learning (CTL) in elementary science education has a positive impact on multiple aspects of student learning. CTL has been shown to improve learning outcomes and students' understanding of science concepts by connecting instructional content with their real-life experiences, thereby making learning more meaningful. Furthermore, CTL contributes to the development of scientific literacy, science process skills, and critical thinking by actively engaging students in observation, investigation, discussion, and contextual problem-solving activities. Previous studies have also reported that CTL enhances students' learning motivation, classroom engagement, and active participation throughout the learning process, thereby fostering a more active and student-centered learning environment (Aliyyah et al., 2020; Fitriani et al., 2023; J. Ratnasari et al., 2024; Suryawati & Osman, 2018).

Although the effectiveness of Contextual Teaching and Learning (CTL) in improving learning outcomes, learning motivation, critical thinking, and science process skills has been widely demonstrated, research on CTL remains dispersed across different subjects, educational levels, and learning contexts, limiting a comprehensive understanding of its development as a research field (Marshall, 2025). Most previous studies have focused on evaluating the effectiveness of CTL using experimental designs, Classroom Action Research (CAR), and Research and Development (R&D) approaches, whereas studies examining publication trends, author collaboration, keyword development, and research themes remain relatively limited (Aliyyah et al., 2020; Fitriani et al., 2023). Consequently, publication trends, collaboration patterns, thematic development, methodological characteristics, and the overall evolution of CTL research have not been systematically

documented. This highlights the need for a comprehensive approach to map the development of CTL research.

In this context, bibliometric analysis provides an appropriate method for examining publication productivity, citation performance, author collaboration, and keyword relationships to identify research trends and the intellectual development of a particular field (W. Ratnasari et al., 2026). Previous bibliometric studies have examined broader topics related to science education, including context-based learning (Fayzullina et al., 2023; Kan & Kumas, 2023), and scientific literacy in primary education (Kutlu-Abu et al., 2023). However, these studies have focused on broader areas of science and primary education rather than specifically examining Contextual Teaching and Learning (CTL) in elementary science education. Consequently, a comprehensive understanding of publication trends, author collaboration patterns, thematic development, methodological characteristics, citation performance, and research gaps in CTL research within elementary science education remains limited. To address this gap, it is essential to examine recent developments in CTL research to provide an updated understanding of publication patterns, thematic evolution, and future research directions. The period from 2021 to 2025 was selected because it represents the most recent phase of educational research, characterized by an increasing emphasis on student-centered learning, scientific literacy, and 21st-century competencies in elementary science education. Examining this period provides an up-to-date overview of publication trends, emerging research themes, and recent developments in CTL research. Therefore, this bibliometric study aims to provide a systematic mapping of CTL research and identify future research directions and opportunities.

Based on these considerations, this study offers a novel contribution by comprehensively mapping the development of Contextual Teaching and Learning (CTL) research in elementary science education during the period 2021–2025 through a bibliometric approach. Unlike the study conducted by Baskoro et al. (2021), which employed a Systematic Literature Review (SLR) to synthesize the effects of the CTL learning model in elementary science education, this study examines the CTL research landscape through bibliometric analysis, including publication trends, collaboration patterns, and thematic development. In addition, this study integrates Publish or Perish and VOSviewer to analyze publication trends, authors, journals, collaboration networks, and research themes through co-authorship and co-occurrence analyses. Thus, this study not only provides insights into the effectiveness of CTL but also identifies research gaps, thematic developments, and opportunities for future research. The findings are expected to serve as a valuable reference for guiding future research, strengthening inter-institutional collaboration, and enhancing the quality and visibility of CTL publications at both the national and international levels.

Based on the above discussion, this study aims to answer the following research questions:

1. How do publication trends in Contextual Teaching and Learning (CTL) research in basic science education evolve during the period 2021–2025?
2. How has the thematic evolution and pattern of author collaboration in Contextual Teaching and Learning (CTL) research in basic science education evolved, as revealed through the analysis of bibliometric co-incidence and co-authorship?

3. What are the methodological characteristics of Contextual Teaching and Learning (CTL) research in basic science education based on the research approach used?
4. What are the characteristics of the most frequently cited articles on Contextual Teaching and Learning (CTL) in basic science education published during the period 2021–2025?

## Method

This study employed bibliometric analysis to map the development of Contextual Teaching and Learning (CTL) research in elementary science education published between 2021 and 2025. Bibliometric analysis is a quantitative method used to examine bibliographic data in order to identify publication trends, collaboration patterns, influential publications, and the development of research themes based on publication metadata (Solimun et al., 2023). The research process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure that article identification, screening, eligibility assessment, and study selection were conducted in a systematic, transparent, and reproducible manner (Page et al., 2022). Articles were retrieved from the Google Scholar and Scopus databases using the Publish or Perish application. In addition, Covidence AI was used to manage the retrieved records, remove duplicate articles, and support the screening of titles, abstracts, and full-text articles based on predefined inclusion and exclusion criteria. The selected articles were subsequently analyzed using Microsoft Excel to classify publication characteristics, while VOSviewer version 1.6.20 was used to visualize co-authorship networks, keyword co-occurrence, overlay visualization, and density visualization (van Eck & Waltman, 2010).

### Data search strategy

The literature search was conducted systematically using the Publish or Perish application to retrieve articles from the Google Scholar and Scopus databases. The detailed search strategy for each database is presented in Table 1.

**Table 1. Database search strategy**

| Filter                                                      | Description                                                                                           |
|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Years                                                       | 2021-2025                                                                                             |
| Subject Areas                                               | Education                                                                                             |
| Search string                                               | "Contextual Teaching and Learning" or "CTL" and "Science" and "Elementary School" or "Primary School" |
| Source string                                               | Journal                                                                                               |
| Language                                                    | English, Indonesian                                                                                   |
| Document type                                               | Journal                                                                                               |
| Google Scholar literature search and Scopus database by PoP | Indexed by sinta 1-4, and scopus                                                                      |

Literature searches were conducted using the Publish or Perish (PoP) application to retrieve articles from the Google Scholar and Scopus databases. The search yielded a total of 353 articles, comprising 350 articles from Google Scholar and 3 articles from Scopus. All retrieved records were subsequently managed and screened using Covidence AI based on predefined inclusion and exclusion criteria. This systematic procedure was implemented to

minimize selection bias and ensure that only studies relevant to the research objectives were included in the bibliometric analysis(Shabira et al., 2024).

### Inclusion and exclusion criteria

The retrieved articles were screened according to predefined inclusion and exclusion criteria to ensure their relevance to the research objectives. The detailed selection criteria are presented in Table 2.

**Table 2. Inclusion and exclusion criteria**

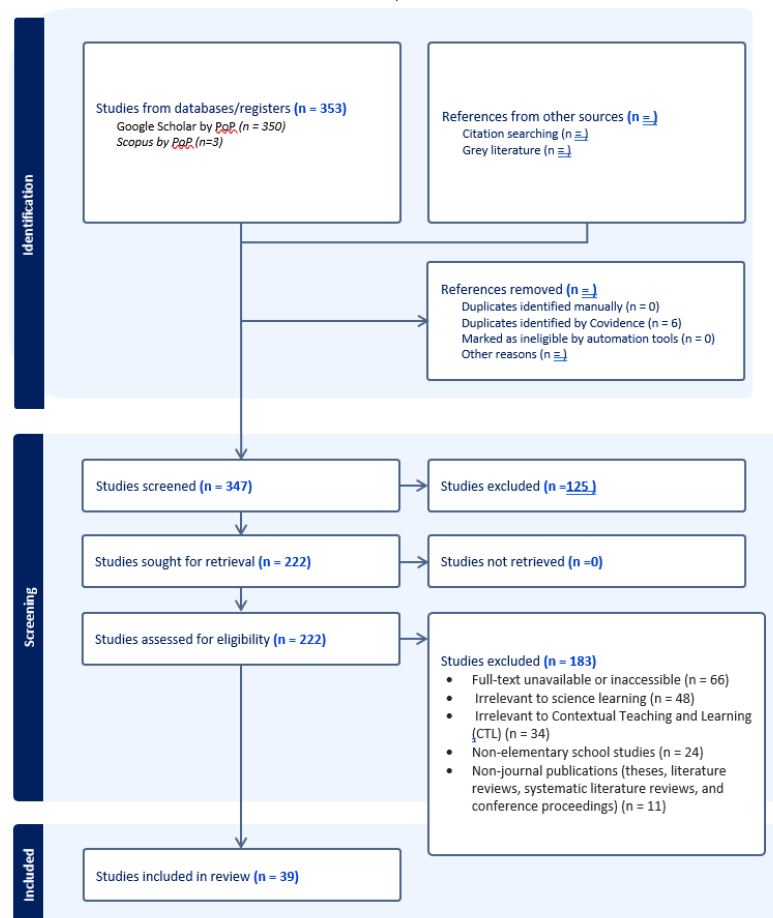
| Criteria              | Inclusions                                               | Exclusion                                                                                                  |
|-----------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Learning model        | Implementation of Contextual Teaching and Learning (CTL) | Problem-Based Learning (PBL), Project-Based Learning (PjBL), Discovery Learning, and other learning models |
| Year of Publication   | 2021-2025                                                | Publications outside the period 2021–2025                                                                  |
| Types of publications | Journal articles only.                                   | Reviews, editorials, and non-empirical study articles                                                      |
| Language              | English and Indonesian                                   | Languages other than English and Indonesian                                                                |
| Subject Areas         | Basic science education                                  | Subjects other than basic science education                                                                |
| Participants          | Elementary school students                               | Junior high, high school, and university students                                                          |
| Accessibility         | Full-text articles and open access                       | Articles that require a subscription or payment                                                            |
| Journal Index         | Articles indexed in Scopus or SINTA 1–4                  | Articles indexed in SINTA 5–6 or another index                                                             |

Based on Table 2, the data selection process is a critical component of a systematic literature review, as it ensures the validity and reliability of the research findings(Page et al., 2021). To maintain data integrity and minimize potential selection bias, this study employed Covidence AI to support the systematic review process in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. Covidence AI was used to manage the retrieved records, identify and remove duplicate records, facilitate the screening of titles, abstracts, and full-text articles based on the predefined inclusion and exclusion criteria, and systematically document each screening decision (McDonald et al., 2023). Any discrepancies arising during the selection process were resolved through discussion until consensus was reached.

### Study selection process and data analysis

The article selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, which consist of four stages: identification, screening, eligibility assessment, and inclusion (Figure 1). Initially, 353 articles were identified through searches of the Google Scholar and Scopus databases. After duplicate removal using Covidence AI, six duplicate records were excluded, leaving 347 records for the screening stage. During the title, keyword, and abstract screening, 125 records were excluded because they did not meet the predefined inclusion criteria, resulting in 222 articles being assessed for full-text eligibility. All 222 full-text articles were successfully retrieved (reports not retrieved = 0) and assessed according to the predefined eligibility criteria, including topic relevance, educational level, publication type, and full-

text availability. Of these, 183 articles were excluded for the following reasons: unavailable or inaccessible full-text articles ( $n = 66$ ), irrelevance to science education ( $n = 48$ ), irrelevance to Contextual Teaching and Learning (CTL) ( $n = 34$ ), studies conducted outside the elementary school context ( $n = 24$ ), and publication types other than journal articles, such as theses, literature reviews, systematic reviews, and conference proceedings ( $n = 11$ ). Consequently, 39 articles met all eligibility criteria and were included in the final bibliometric analysis.



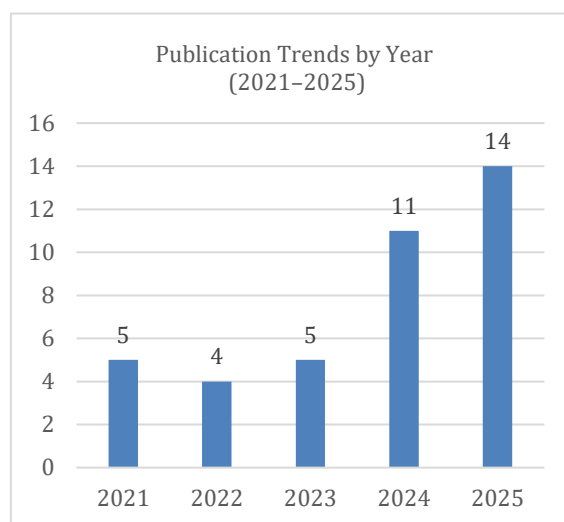
**Figure 1. PRISMA Flow Diagram**

All articles that met the inclusion criteria were exported in RIS and CSV formats. The RIS files were imported into Mendeley to verify the completeness of the bibliographic metadata and manage the reference database (Waskita & Sulistyaningtyas, 2022). In addition, the data were analyzed using VOSviewer to visualize bibliometric networks, including keyword co-occurrence, author collaboration (co-authorship), and citation networks (van Eck & Waltman, 2010). Meanwhile, the CSV files were analyzed using Microsoft Excel to facilitate the descriptive analysis of publication trends, journal index distribution, research methodologies, and thematic development. The analysis focused on annual publication trends, author productivity, journal distribution, citation performance, and the development of research topics related to CTL in elementary science education. The

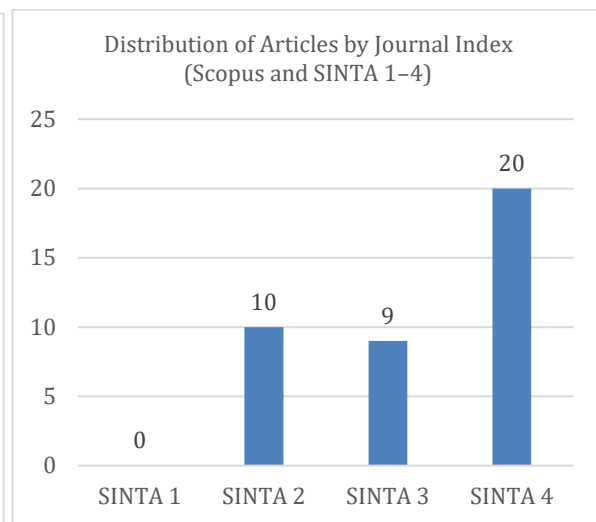
findings were used to identify research trends, publication patterns, and potential research opportunities, thereby providing a foundation for future research recommendations on the implementation of CTL in elementary science education.

## Results and Discussion

This section presents the results of a bibliometric analysis of 39 articles that met the inclusion criteria. The analysis was conducted to identify publication trends in Contextual Teaching and Learning (CTL) research in elementary science education based on publication year and journal indexing during the 2021–2025 period.



**Figure 2. Publication Trends By Year (2021–2025)**



**Figure 3. Article Distribution by Journal Index**

Based on Figure 2, publications on Contextual Teaching and Learning (CTL) in elementary science education showed an overall increasing trend during the 2021–2025 period, despite a slight decline in 2022. This pattern indicates growing scholarly interest in CTL as a relevant instructional approach in science education. The increasing publication trend may reflect the growing recognition of CTL for its ability to connect scientific concepts with students' real-life experiences, thereby promoting more meaningful learning. Previous studies have reported that the implementation of CTL contributes to improved learning outcomes, enhanced critical thinking skills, and greater student participation (Aningsih & Shalecha, 2023; Rahmadhar, 2022). These findings are consistent with constructivist theory, which views students as active participants in constructing knowledge through experience and interaction with their environment.

From a bibliometric perspective, the increasing number of publications indicates that CTL research in elementary science education has continued to develop and attract greater academic attention during the 2021–2025 period. In bibliometric analysis, growth in publication productivity generally reflects the development of a research field as well as increasing scholarly interest in a particular topic (Donthu et al., 2021). These findings are consistent with previous bibliometric studies by Fayzullina et al., (2023), Kan & Kumas, (2023), and Kutlu-Abu et al. (2023) which also reported increasing publication productivity

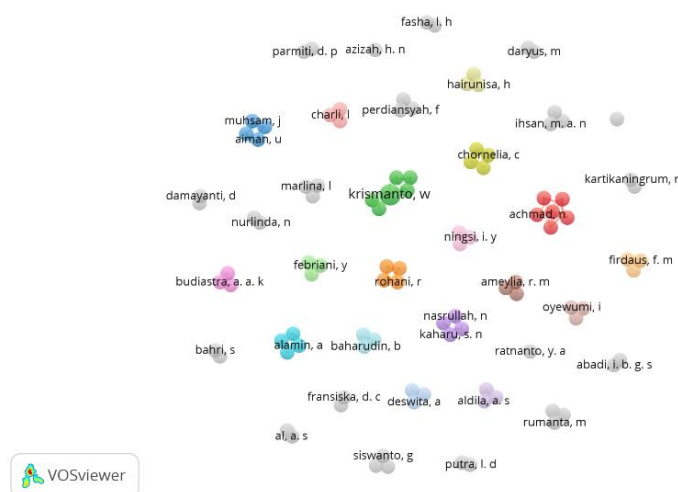
in the fields of educational innovation and science education. However, unlike those studies, which examined science education more broadly, the present study specifically demonstrates that CTL has become an increasingly important research focus in elementary science education. Therefore, the upward trend in publications not only reflects the growing volume of research but also indicates increasing academic interest in the development and implementation of CTL in elementary science education.

Based on Figure 3, the distribution of publications by journal indexing indicates that the final dataset of Contextual Teaching and Learning (CTL) research in elementary science education was dominated by SINTA-indexed national journals, with no Scopus-indexed publications included in the final analysis. Although the initial database search identified three articles from Scopus, all of these articles were excluded during the screening and eligibility assessment because they did not meet the predefined inclusion criteria. Consequently, the final dataset consisted exclusively of articles published in SINTA-indexed journals. This finding suggests that empirical CTL research in elementary science education remains largely concentrated within the national publication landscape, limiting its international visibility and academic reach. According to Donthu et al., (2021), publication productivity, scientific collaboration, and international visibility are important indicators of the development of a research field. Therefore, the absence of Scopus-indexed articles in the final dataset may indicate that CTL research continues to be dominated by implementation studies conducted in local educational contexts, while international collaboration and publication in internationally indexed journals remain limited. These findings are consistent with Bond et al. (2021), who emphasized that scientific collaboration and publication in internationally recognized journals play a crucial role in enhancing research visibility and scholarly impact. Therefore, strengthening international collaboration, improving methodological rigor, and increasing publication in internationally indexed journals are important strategies for expanding the global contribution of CTL research in elementary science education

**Table 3. Publication Trends by Journal**

| <b>Journal</b>                                | <b>Quantity</b> | <b>Spraying</b> |
|-----------------------------------------------|-----------------|-----------------|
| PENDAS: Scientific journal of basic education | 3               | 4               |
| Journal of Science Education Research         | 3               | 2               |
| Indonesian Action Research Journal (ARJI)     | 2               | 4               |
| Journal of Education and Human Development    | 2               | 2               |

Based on Table 3, the distribution of publication sources indicates that CTL research in elementary science education is dispersed across several journals, with no single journal serving as the dominant publication outlet. *PENDAS: Scientific Journal of Basic Education* and the *Journal of Science Education Research* were the most productive sources, each publishing three articles, followed by the *Indonesian Action Research Journal (ARJI)* and the *Journal of Education and Human Development*, each contributing two articles. From a bibliometric perspective, this distribution suggests that CTL research is still scattered across multiple publication outlets rather than concentrated within a well-established group of core journals. According to Bradford's Law, a developing research field typically exhibits a pattern in which publications are distributed across numerous journals before a stable group of core sources emerges. As a research field matures, a limited number of highly productive journals generally become the primary venues for scholarly communication (N & Martis, 2026). Consequently, the current distribution indicates that CTL research in elementary science education remains in a developing stage, with publication output spread across various journals. Increasing publication in high-impact journals and strengthening collaboration among researchers may contribute to the establishment of more influential publication outlets and enhance the visibility of CTL research at the international level (N & Martis, 2026).



**Figure 4. Visualization of Author Collaboration Network**

Based on Figure 4, the co-authorship network was generated from the 39 articles included in this study, involving a total of 105 authors. The visualization shows that the authors formed several small collaboration clusters with relatively limited connections between groups, while a number of authors appeared as isolated nodes with no substantial collaborative links. This pattern indicates that collaboration in Contextual Teaching and Learning (CTL) research in elementary science education remains fragmented and is primarily concentrated within small research groups or individual institutions. From a bibliometric perspective, such a collaboration pattern suggests that the CTL research field has not yet established an integrated research network, indicating that knowledge dissemination and scientific collaboration are still evolving (Donthu et al., 2021). This finding implies that opportunities for broader collaboration, methodological exchange, and research innovation have not yet been fully realized. These findings are consistent with Duan, (2024), who reported that fragmented collaboration networks are characteristic of

emerging research fields that have not yet developed a well-established scientific community capable of driving sustained research development.

In addition, the absence of a central node connecting most of the clusters indicates that no individual researcher or research group serves as a central collaboration hub in the field of CTL research. From a bibliometric perspective, well-established collaboration networks contribute to higher research productivity, greater methodological diversity, enhanced research visibility, and increased citation impact (Vélez-Estevez et al., 2022). Therefore, strengthening collaboration among research institutions, universities, and countries is essential for expanding research networks, improving publication quality, and enhancing the contribution of CTL research in elementary science education.

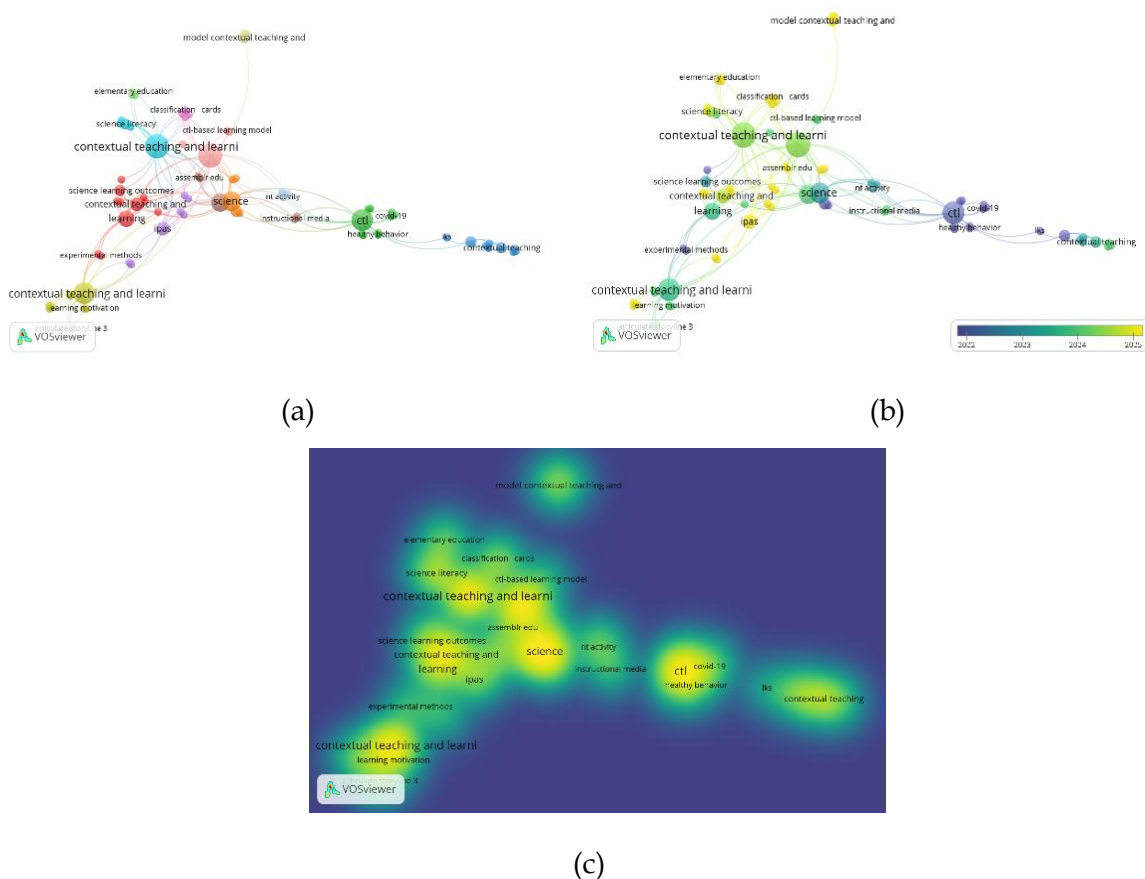
**Table 4. Most Frequently Appearing Keywords**

| Keywords                               | Events | Total linkage/strength |
|----------------------------------------|--------|------------------------|
| Contextual teaching and learning       | 9      | 29                     |
| Learning outcomes                      | 9      | 29                     |
| ctl                                    | 7      | 19                     |
| Contextual teaching and learning (ctl) | 7      | 18                     |
| Elementary school                      | 5      | 17                     |
| Science                                | 6      | 17                     |
| Learning                               | 4      | 14                     |
| Ipas                                   | 3      | 12                     |
| Contextual teaching and learning       | 3      | 11                     |
| Contextual teaching                    | 2      | 7                      |
| ipa                                    | 2      | 6                      |
| Science learning outcomes              | 2      | 6                      |
| Classification card                    | 1      | 5                      |
| Creativity                             | 1      | 5                      |
| Media                                  | 1      | 5                      |
| NT Activity                            | 1      | 5                      |
| Science learning                       | 2      | 5                      |
| Science literacy                       | 2      | 5                      |
| stude                                  | 1      | 5                      |
| Types of animals based on food         | 1      | 5                      |

Based on Table 4 and Figure 5, a keyword co-occurrence analysis was conducted using VOSviewer to examine the relationships among research themes in Contextual Teaching and Learning (CTL) research. A total of 91 keywords were identified from the 39 articles included in this study. Based on the total link strength analysis, the 20 keywords with the highest level of interconnectedness were identified and are presented in Table 4. Meanwhile, the network visualization in Figure 5 displays 19 interconnected keywords that met the threshold for co-occurrence analysis, enabling the relationships among the main research themes to be observed more clearly (Donthu et al., 2021). The analysis indicates that CTL research in elementary science education is predominantly centered on the theme of learning outcomes. From a bibliometric perspective, the dominance of a keyword reflects the research themes that receive the greatest scholarly attention within a particular field.

This finding suggests that the implementation of CTL has primarily been evaluated based on students' learning outcomes as the principal indicator of instructional effectiveness. These findings are supported by previous studies reporting that CTL has been more frequently implemented to improve learning outcomes than to develop other competencies, such as critical thinking and problem-solving skills (Aningsih & Shalecha, 2023; Rahmadhar, 2022)

On the other hand, the emergence of keywords such as science literacy, creativity, media, and IPAS indicates the beginning of a growing focus on 21st century competency development and learning innovation. According to Narong & Hallinger, (2023) Co-occurrence analysis allows the identification of dominant themes as well as showing the direction of development of a research field through the relationships between keywords. Thus, although learning outcomes are still the main focus, the emergence of these themes suggests that CTL research is beginning to evolve towards broader studies. This condition opens up opportunities for future research to explore CTL's contribution to the development of science literacy, creativity, critical thinking skills, problem-solving, and competence in the 21st century more comprehensively



**Figure 5. (a) Co-occurrence Network Visualization, (b) Overlay Visualization of Co-occurrence Keyword Co-occurrence, and (c) Co-occurrence Keyword Density Visualization**

Based on Figure 5, the keyword co-occurrence network visualization was generated from the analysis of 91 keywords identified across the 39 articles included in this study. Of

these, 19 interconnected keywords met the co-occurrence criteria and were visualized to illustrate the conceptual structure of Contextual Teaching and Learning (CTL) research in elementary science education during the 2021–2025 period. From a bibliometric perspective, keyword co-occurrence analysis is used to map the conceptual structure of a research field, identify relationships among research topics, and reveal dominant research themes (Donthu et al., 2021; Narong & Hallinger, 2023). The analysis shows that the keywords *Contextual Teaching and Learning*, *learning outcomes*, *learning*, and *science education* occupied central positions within the research network, indicating that CTL research has primarily focused on evaluating instructional effectiveness through students' learning outcomes. These findings are consistent with previous bibliometric studies by Fayzullina et al., (2023), Kan & Kumas, (2023), and (Marshall, 2025), which reported that research on context-based learning and CTL continues to be dominated by themes related to learning effectiveness and learning outcomes. This finding also suggests that topics such as scientific literacy, creativity, critical thinking, and 21st-century competencies remain underexplored and provide promising directions for future research.

the *overlay visualization* illustrates the temporal evolution of research themes in Contextual Teaching and Learning (CTL) research in elementary science education during the 2021–2025 period. Earlier studies primarily focused on the implementation of CTL in response to learning challenges during the COVID-19 pandemic, whereas more recent studies have increasingly emphasized themes such as scientific literacy, learning motivation, and CTL-related instructional approaches. This pattern suggests a gradual shift in research interests from evaluating instructional effectiveness toward supporting the development of broader educational competencies, including those associated with 21st-century learning (Rahim et al., 2024). From a bibliometric perspective, overlay visualization enables the identification of thematic evolution by illustrating how research topics emerge and develop over time (Avenali et al., 2023). These findings are consistent with previous studies by Kutlu-Abu et al., (2023) and Romli et al., (2024), which reported an increasing emphasis on scientific literacy and 21st-century competencies in science education research.

Meanwhile, visualization *Density* shows that the main themes still have a higher research intensity than the newly developed themes. In bibliometric analysis, the level of density of a theme reflects the level of attention the research pays to that topic, while lower density indicates opportunities to develop themes that have not been widely explored (Avenali et al., 2023). These findings indicate that CTL research still has a wide scope to develop, especially in the aspects of science literacy, creativity, critical thinking skills, learning motivation, and problem solving. In line with Oktasari et al., (2025) and Sayadi & Pangandaman, (2025), further research needs to expand the focus of CTL studies through

more innovative, collaborative, and methodologically supported learning approaches so that its contribution to elementary school science learning becomes more comprehensive.

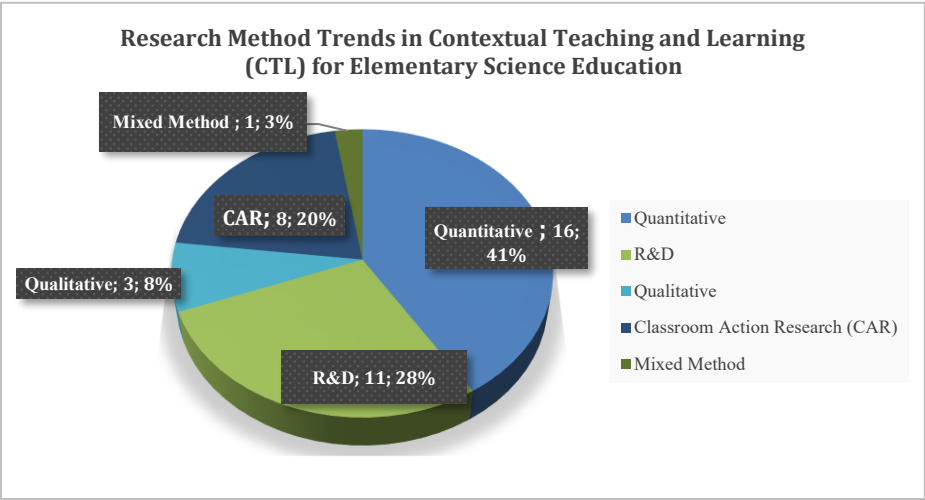


Figure 6. Proportion of research methods used in CTL studies

Based on Figure 6, the distribution of research methodologies across the 39 articles included in this study shows that Contextual Teaching and Learning (CTL) research in elementary science education was predominantly conducted using quantitative approaches, followed by Research and Development (R&D), Classroom Action Research (CAR), qualitative research, and mixed-methods research. From a bibliometric perspective, the predominance of a particular research methodology reflects the methodological preferences within a specific research field(Donthu et al., 2021). The dominance of quantitative approaches suggests that CTL research published during the 2021–2025 period primarily focused on evaluating the effectiveness of CTL implementation by measuring learning outcomes, learning motivation, and students' thinking skills. These findings are consistent with those reported by Romli et al., (2024) and Shabira et al.,(2024) who found that research in elementary education and science education continues to be dominated by quantitative approaches for evaluating the effectiveness of instructional models.

In addition, the relatively high proportion of Research and Development (R&D) studies indicates growing scholarly attention to the development of CTL-based learning media, instructional modules, and teaching materials as forms of educational innovation. These findings suggest that CTL research has gradually expanded beyond evaluating instructional effectiveness to developing more contextual and adaptive learning solutions that address the demands of 21st-century education However, the limited use of mixed-methods research indicates that CTL studies have rarely integrated quantitative and qualitative data, despite the potential of this approach to provide a more comprehensive understanding of both the effectiveness and implementation of CTL(Gierus et al., 2025). Therefore, greater adoption of mixed-methods and other diverse methodological approaches would provide more comprehensive empirical evidence regarding the effectiveness, implementation, and broader educational impact of CTL.

Table 5. Five Most Influential Articles in Elementary Education Published During 2021–2025

| Article Title | Quotes (Index) | Author | Key Findings | Learning Media |
|---------------|----------------|--------|--------------|----------------|
|---------------|----------------|--------|--------------|----------------|

|                                                                                                                                                                     |                 |                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Tri Hita Karana-based Contextual Teaching and Learning (CTL) model for Integrated Science and Social Studies (IPAS) in elementary schools.                          | 28<br>(S3)      | Dewi, L. P. A. F<br>Abadi, I. B. G. S                    | The Contextual Teaching and Learning (CTL) model that integrates the values of Tri Hita Karana developed in this study shows adequate validity and is considered suitable for implementation in the classroom. This is evidenced by the results of the validation of experts, who confirmed that this model meets the required standards of validity, as well as positive evaluations from teachers and students, who rated this model as very effective. In addition, the application of this model significantly increases students' interest in learning and learning motivation related to the knowledge competencies of Integrated Science and Social Studies (IPAS). The course also encourages an active, meaningful, and fun learning environment, thus supporting more engaging and effective classroom teaching. | Card-based instructional media and concrete learning materials (visual aids and other learning resources that support CTL). |
| The impact of the use of the Teaching and Contextual Learning (CTL) learning model on the cognitive value of elementary school students                             | 25<br>(Sinta 2) | Riza, S<br>Mardhatillah, M<br>Rizki, D<br>Ihsan, M. A. N | The findings show that the application of the Contextual Teaching and Learning (CTL) model has a positive effect on the cognitive achievement of fifth grade students at SDN 16 Banda Aceh. The average students' cognitive scores improved, and statistical analysis showed a significant effect of the treatment ( $t = 2.49 > t = 1.69$ ). However, the level of classical learning mastery did not reach the predetermined target of 80%. In addition to improving students' cognitive performance, the implementation of the CTL model enhances the learning experience of teachers and students by encouraging greater engagement, participation, and enthusiasm throughout the teaching process.                                                                                                                    | Textbooks and teaching aids                                                                                                 |
| Development of Science Encyclopedia Learning Media based on the Contextual Teaching and Learning (CTL) approach for Teaching Energy and its Transformation to Third | 24<br>(Sinta 4) | Daughter, R. H<br>Rini, C. P<br>Perdiansyah, F           | The findings show that the Science Encyclopedia based on Contextual Teaching and Learning (CTL) developed in this study is suitable for use in classroom teaching. This learning media is validated very appropriately by material and media experts and receives positive evaluations from teachers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | CTL-based Science encyclopedia with lift-the-flap technique                                                                 |

|                                                                                                                                                                            |                 |                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Grade Elementary School Students                                                                                                                                           |                 |                                                          | and students. In both small and large-scale field tests, the media achieved an average score of 4.6 and 4.7, placing it in the "Excellent" category. These results show that the learning media that has been developed effectively meets the learning needs of students while increasing their interest and understanding of the topic of energy and its transformation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                          |
| Implementation of contextual teaching and learning as well as authentic assessment of science learning outcomes (IPA) of grade 4 elementary school students in Kupang City | 23<br>(Sinta 2) | Uslan, USA<br>Muhsam, J<br>Hasyda, S<br>Aiman, U         | The findings reveal significant differences in science learning outcomes between students taught using the Contextual Teaching and Learning (CTL) model with authentic assessments and those who received conventional teaching. Students who learn through the CTL model combined with authentic assessments show superior learning outcomes. Significant differences were also found between students assessed through performance assessments and those assessed through project assessments. In addition, significant interactions were identified between instructional models and assessment methods in influencing students' science achievement. Overall, the integration of the CTL model with authentic assessments has been shown to be effective in improving science learning outcomes for fourth-grade elementary school students. | Student worksheets (LKS), lesson plans, and validation instruments                       |
| Development of e-learning modules based on teaching and contextual learning on the transformation of energy forms to improve students' science literacy                    | 12<br>(Sinta 2) | Nature, A<br>Nurhanurawati, A<br>Rohman, F<br>Premium, R | The findings show that the Contextual Teaching and Learning (CTL)-based electronic modules developed for energy transformation topics meet the criteria of validity, practicality, and effectiveness in improving the scientific literacy of elementary school students. The electronic module achieved an average validity score of 0.813, which indicates validity, while the evaluation of teachers and students showed a very high level of practicality, with an approval rate                                                                                                                                                                                                                                                                                                                                                              | Digital electronic modules based on the Contextual Teaching and Learning (CTL) approach. |

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of 86.88% and 97.59%, respectively. In addition, the paired t-test showed a statistically significant difference between students' pre-test and post-test scores ( $p = 0.000$ ,  $p < 0.005$ ), suggesting that the use of e-modules significantly improved students' scientific literacy competencies.

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Based on Table 5, the five most highly cited articles among the 39 studies included in this review represent the publications that have made the greatest scholarly contribution to the development of Contextual Teaching and Learning (CTL) research in elementary science education during the 2021–2025 period. From a bibliometric perspective, citation counts are widely used as indicators of the scientific influence, visibility, and intellectual contribution of publications within a particular research field (Donthu et al., 2021). All five highly cited articles were published in SINTA-accredited journals (SINTA 1–3), reflecting the important role of nationally accredited journals in disseminating influential CTL research within the scope of this study. In addition to publication age, citation impact is influenced by the conceptual and practical contributions that a study makes to the advancement of scientific knowledge (Bornmann et al., 2025). Consistent with previous bibliometric studies Fayzullina et al., (2023), the most highly cited CTL studies primarily focus on evaluating instructional effectiveness and developing educational innovations, making them important references for subsequent research.

Substantively, the five most highly cited articles consistently demonstrate that the implementation of Contextual Teaching and Learning (CTL) has a positive impact on elementary science education, particularly in improving learning outcomes, cognitive skills, scientific literacy, learning motivation, and students' active engagement. These findings are consistent with constructivist theory, which emphasizes that knowledge is constructed through meaningful learning experiences and the integration of academic concepts with real-life contexts (Wijayati, 2026). These results are also supported by (Aningsih & Shalecha, 2023; Deswita et al., 2025; Rahmadhar, 2022), who found that the implementation of CTL contributes to improvements in students' learning outcomes, critical thinking skills, creativity, and learning motivation. Compared with previous bibliometric studies that examined context-based learning more broadly (Fayzullina et al., 2023; Kan & Kumas, 2023), the present study demonstrates that CTL research has established a strong empirical foundation for enhancing the quality of elementary science education. Nevertheless, future research should extend its focus beyond learning effectiveness to include scientific literacy, creativity, higher-order thinking skills, problem-solving skills, and 21st-century competencies (Rahim et al., 2024). Broadening these research directions is expected to strengthen both the theoretical and practical contributions of CTL in elementary science education, ensuring that future studies move beyond an exclusive emphasis on learning outcomes.

## Conclusion

Based on the bibliometric analysis of 39 articles, Contextual Teaching and Learning (CTL) research in elementary science education during the 2021–2025 period demonstrated a steady increase in publication output. The final dataset was dominated by articles published in SINTA-accredited national journals, with no Scopus-indexed articles meeting the inclusion criteria. The analysis further revealed that CTL research has primarily focused

on learning effectiveness, with quantitative and Research and Development (R&D) approaches representing the predominant research methodologies, while author collaboration remained limited to small research groups. Nevertheless, recent studies have shown an increasing emphasis on themes such as scientific literacy, learning motivation, creativity, learning media, and 21st-century competencies, indicating expanding opportunities for the future development of CTL research in elementary science education.

These findings highlight the need to strengthen collaboration among institutions and across countries to enhance the visibility, quality, and scientific impact of CTL research, while encouraging publication in internationally indexed journals. Future studies should also promote greater methodological diversity by adopting approaches such as mixed-methods research and by exploring underrepresented themes, including scientific literacy, higher-order thinking skills, creativity, problem-solving, and 21st-century competencies. Since this study included only articles published between 2021 and 2025 retrieved from Google Scholar and Scopus, future bibliometric research should expand database coverage and incorporate advanced citation-based analyses, such as co-citation analysis, bibliographic coupling, and citation impact analysis, to provide a more comprehensive understanding of the evolution of CTL research.

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