

Global Trends in Contextual Trigonometry E-Books: A Scopus Bibliometric Study

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Abstrak

Penelitian ini bertujuan menganalisis tren global terkait pengembangan dan penerapan e-book trigonometri kontekstual berdasarkan publikasi internasional yang terindeks Scopus (2019–2024). Dengan menggunakan metode PRISMA, 82 artikel terpilih dianalisis melalui VOSviewer dan Excel untuk memetakan dinamika publikasi, kutipan, kolaborasi antarnegara, serta fokus penelitian yang diarahkan pada pola pertumbuhan publikasi dan kolaborasi serta arah perkembangan riset. Metode penelitian yang digunakan adalah bibliometrik dengan memanfaatkan perangkat lunak VOSviewer dan analisis data dari basis Scopus. Data yang diperoleh kemudian dikaji untuk mengidentifikasi produktivitas publikasi, jejaring sitasi, serta tema-tema utama yang berkembang. Hasil penelitian menunjukkan peningkatan signifikan publikasi sejak 2020, dengan puncak pada 2022–2024 akibat adopsi teknologi selama pandemi COVID-19. China mendominasi jumlah publikasi (204 dokumen), sementara Amerika Serikat unggul dalam pengaruh kutipan. Topik utama mencakup peningkatan pemahaman konseptual, pembelajaran kontekstual, dan sistem pembelajaran dengan teknologi. Publikasi awal (2019–2020) menjadi rujukan paling berpengaruh dengan 4750 kutipan. Namun, studi mengidentifikasi kesenjangan, termasuk minimnya penelitian dampak jangka panjang, variasi konteks budaya, dan peran pendidik dalam pembelajaran berbasis simulasi.

Kata Kunci: Bibliometrik; E-Book; Trigonometri Kontekstual; Scopus; Tren Global

Abstract

This study aims to analyze global trends related to the development and implementation of contextual trigonometry e-books based on international publications indexed by Scopus (2019–2024). Using the PRISMA method, 82 selected articles were analyzed using VOSviewer and Excel to map the dynamics of publications, citations, international collaborations, and research focus, focusing on publication and collaboration growth patterns and the direction of research development. The research method used was bibliometrics, utilizing VOSviewer software and data analysis from the Scopus database. The obtained data were then reviewed to identify publication productivity, citation networks, and key emerging themes. The results showed a significant increase in publications since 2020, with a peak in 2022–2024 due to technology adoption during the COVID-19 pandemic. China dominated the number of publications (204 documents), while the United States excelled in citation influence. Key topics included improving conceptual understanding, contextual learning, and technology-enabled learning systems. Early publications were the most influential references with 4,750 citations. However, the study identified gaps, including a lack of research on long-term impact, variations in cultural context, and the role of educators in simulation-based learning.

Keywords: Bibliometrics; E-Book; Contextual Trigonometry; Scopus; Global Trends

I. INTRODUCTION

Digital transformation in education has accelerated the adoption of digital learning materials, including interactive e-books designed to improve conceptual understanding and problem-solving skills in mathematics (Ariani, 2023). In the field of intermediate mathematics, particularly trigonometry, the need for materials that link abstract concepts to real-world contexts (contextualization) is increasingly urgent due to the low correlation between theoretical concepts and practical applications experienced by many students (Utami, 2024; Cholily, 2024). A number of studies have shown that a contextual approach can improve students' understanding of mathematical concepts and encourage critical thinking skills (Kurniati et al., 2015; Suyatna et al., 2019; Afriansyah et al., 2021). However, despite the existence of a number of empirical studies and instructional designs related to mathematics e-books, the literature on contextually designed trigonometry e-books is scattered across various disciplines and published in various outlets, making it difficult for researchers and practitioners to understand the research map, strength of evidence, and thematic trends comprehensively. This condition complicates the formulation of evidence-based and meaningful material development strategies for various levels of education (Maulidiya & Nurlaelah, 2019; Nufus & Zubainur, 2020).

The latest review shows several important findings: first, a meta-analysis of the effects of e-books on mathematics learning reports mixed results but shows the potential for positive effects, with

heterogeneity influenced by the type of e-book, education level, and duration of intervention — indicating that the empirical evidence is fragmented and contextual. This makes it difficult to determine which e-book features are most effective for specific topics such as intermediate trigonometry. The underlying problem in this study is the low critical thinking skills of students in trigonometry learning, which has been dominated by procedural and memorization approaches (Saputri & Qohar, 2023). The limitations of teaching media that are able to integrate trigonometry concepts in real-life contexts are also a hindering factor.

Third, in the field of mathematics education, there have been several bibliometric efforts that map major themes (e.g., realistic mathematics education, mathematical modeling), but there has been no Scopus-based bibliometry that specifically explores global trends in contextual trigonometry e-books between 2010 and 2024, with a focus on the period 2020–2024 to capture the latest developments.

This study uses a bibliometric analysis approach, which is a quantitative and qualitative method to observe research trends on specific topics. Bibliometric analysis has been widely conducted in the field of education and other fields (Estévez et al., 2022). Bibliometric analysis provides more systematic insights into the development of a research topic based on metadata from published scientific articles (Biberman-Shalev et al., 2023). Using data from the Scopus index database, this analysis can reveal the dynamics of research related to contextual

trigonometry, including citation patterns, thematic evolution, and the identification of research areas that are still open for further exploration (Maynastiti et al., 2020; Afriani & Asmar, 2020). Second, a bibliometric study in the field of e-learning and educational technology during the 2020–2022 period confirms a surge in publications, a shift in thematic focus, and the emergence of new research clusters after the pandemic. However, these studies are generally macro in scale (e.g., general e-learning) and have not yet mapped narrow subtopics such as contextual trigonometry e-books. Furthermore, bibliometric analysis and recent research will enrich our understanding of contextual trigonometry in the context of education.

Researchers attempted to collect research data related to contextual trigonometry using a bibliometric approach based on data obtained from Scopus. In this context, this article aims to present a comprehensive bibliometric analysis of research on contextual trigonometry in education, including trends in the number of publications, trends in international research collaboration, and research focus. By analyzing journals, conferences, and other related scientific publications, we will try to identify key trends and the most dominant research topics in this scientific literature. Thus, the results of this study are expected to provide a more systematic overview of research trends related to contextual trigonometry and provide recommendations for the future research agenda.

II. METHOD

This study uses a descriptive bibliometric analysis method consisting of four important stages, namely identification, screening, eligibility, and inclusion (McKinley, 2019). In the identification stage, researchers conducted a search using keywords relevant to the research theme, namely “Contextual Learning,” in the Scopus database. Through this step, 39,972 relevant articles were identified. The next stage was screening. At this stage, the researcher filtered the 1,852 articles obtained in the previous stage using the criterion that the keyword “Contextual Learning” must be included in the article title. Based on this criterion, 1,852 articles did not meet the criteria and were not processed further.

Meanwhile, there were 1001 articles that met the criteria and would proceed to the next stage, namely eligibility. At this stage, researchers evaluated whether the 1001 articles that had passed the previous stage were eligible to be included in the final stage of the study. Researchers decided to only include publications published in English, leaving 991 articles that met the criteria. A total of 991 articles that met these criteria could proceed to the inclusion stage. The use of English-language articles was not merely a choice, but a methodological necessity to ensure that the data obtained was valid and representative, that the analysis reflected global trends, and that the research results could be recognized and used by the international scientific community.

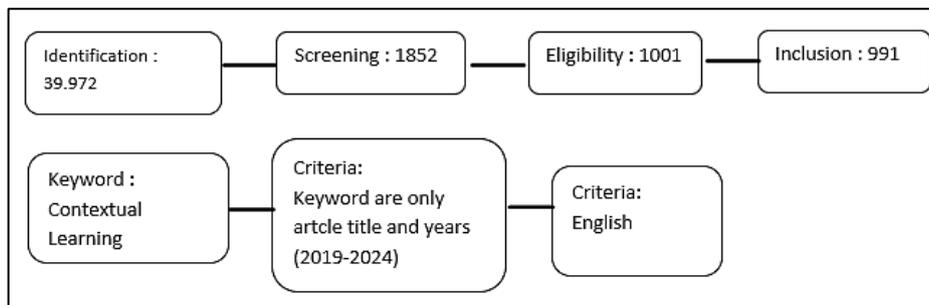


Figure 1. Stages in Data Refinement

Researchers use various applications to help process research data. Microsoft Excel is used to display tables such as publication trends and citation trends. VOSviewer is used to display images of relationships between countries and research focuses related to the field being studied. PoP is used to calculate citation trends such as NCP, C/CP, h-index, and others.

III. RESULT AND DISCUSSION

This section discusses trends in the number of publications, trends in the number of citations, trends in research collaboration between countries, and research focusing on Contextual Learning in Education. Trends in the number of publications reflect the development of scientific publications published in this field during the period from 2019 to 2024. These trends provide an overview of the growth of research conducted by scientists and academics in studying Contextual Learning in Education. Furthermore,

citation trends illustrate the extent to which the research has influenced subsequent research and become a reference for other scientists. An increase in the number of citations indicates a high level of recognition and acceptance within the scientific community of research on Contextual Learning in Education. International collaboration can produce higher quality and more impactful research because it involves diverse perspectives and expertise. Finally, the research focus trend refers to areas of research that received special attention in the study of Contextual Learning in Education during the period 2019 to 2024.

The trend in the number of publications is shown by grouping the number of publications based on their year of publication. The trend in publications from 2019 to 2024 related to Contextual Learning in Education research can be seen in Figure 2.

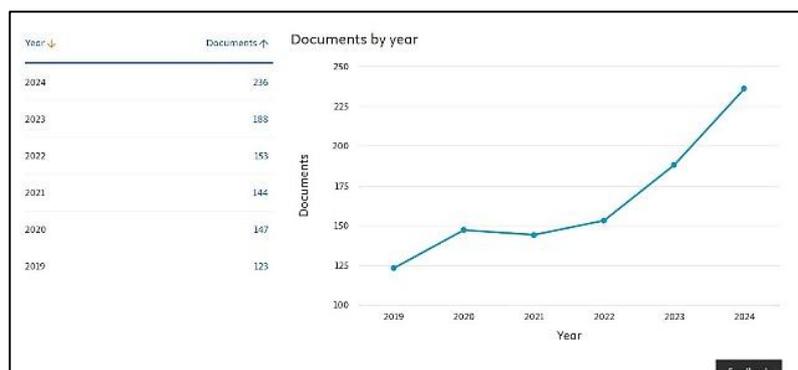


Figure 2. Publication Trends

The graph shows the trend of publications related to Contextual Learning based on data from Scopus between 2019 and 2024. In general, the pattern reflects how academic interest in Contextual Learning has developed over time. In the early period, particularly between 2019 and 2024, the number of publications was still relatively low and tended to fluctuate. Annual publications ranged from zero to four documents, indicating that research on Contextual Learning was still in its early exploratory stages. Several small spikes appeared in some years, such as 2020 and 2022, but then declined again, especially around 2021, which showed the lowest number of publications in the analyzed period. Starting in 2019, there was a gradual increase in the number of publications, reflecting growing academic interest in contextual trigonometry as a more realistic learning approach in mathematics. This trend indicates that more researchers are beginning to explore the benefits of interactive simulations in improving the understanding of science and mathematics concepts. This period marks a transition from initial exploration to a stage of wider adoption in educational research.

A significant surge occurred from 2019 to 2020, with the number of publications reaching its highest level during the observed period. This increase was most likely triggered by the COVID-19 pandemic, which prompted a massive shift towards online learning and forced educators to seek innovative solutions, including the use of contextual trigonometry ebooks. In addition, education policies that

increasingly encourage the integration of digital technology in learning have accelerated this trend (Prastiwi & Listyani, 2019; Wang et al., 2020). Many studies have focused on the effectiveness of contextual trigonometry ebooks in supporting distance learning and their impact on students' conceptual understanding and engagement (Zuriatni & Budiasih, 2020; Laila, 2021).

After peaking in 2019–2020, the number of publications declined sharply in 2021. This phenomenon can be attributed to several possibilities, including the reduced urgency of using e-book-based trigonometry learning technology after the return to face-to-face learning, a shift in research focus to other pedagogical approaches, or the large number of studies that had been published previously during the pandemic, resulting in a decline in the number of new studies. However, the trend began to show signs of recovery in 2023 and 2024. This indicates that research on contextual trigonometry e-books is still ongoing, although perhaps in a more specific context or with a more targeted approach.

Table 1.
Quotation Trends

Year	TP	TC	NCP	H	G
2024	236	468	112	10	15
2023	188	877	133	13	20
2022	341	2312	133	21	32
2021	144	314	68	8	8
2020	245	2648	129	26	43
2019	368	4750	107	33	57

TP : Total Publication; TC : Total Citation; NCP: Number Citation Paper; H: h-INDEX; G: g-index

Table 1 represents citation trends from research related to contextual

trigonometry e-books based on several bibliometric metrics, namely the number of publications (TP), total citations (TC), number of unique citations (NCP), H-index, and G-index. The data shows that although the number of publications in the early years, such as 2019 and 2020, did not grow significantly, the total citations obtained were quite high, peaking in 2019 (TC = 4750) and 2020 (TC = 2648). This indicates that early publications on contextual trigonometry e-books had a significant academic impact and became the main reference for subsequent research. After a period of fluctuation between 2019 and 2021, the publication trend experienced a steady increase starting in 2022, with a significant surge in 2022 (TP = 341, TC = 2312), which is likely related to the increased adoption of simulation-based learning technology during the COVID-19 pandemic.

The H and G indices in 2019 also reached their highest levels (H = 33, G = 57), indicating that publications in that year were not only numerous but also had a wide citation impact. In recent years, citation patterns have shown interesting dynamics. Although the number of publications in 2023 and 2024 is quite high, the total number of citations obtained is still relatively low, namely 877 and 468 citations, respectively. This can be explained by the natural nature of academic citations, which require time before a publication gains wider visibility and recognition in the scientific community. Thus, although research on contextual trigonometry e-books continues to grow in terms of the number of publications, the accumulation of citation

impact requires a longer period, indicating that the academic relevance of a publication depends not only on the time of publication but also on the significance of its scientific contribution to the broader research ecosystem.

Table 2.
Publications with the Most Citations

Author	Title	Journal Name	Citation
(Y.Liu, B. Fan, G. Meng, J. Lu, S. Xiang, C. Pan 2019)	DensePoint: Learning densely contextual representation for efficient point cloud processing	IEEE/CVF International Conference on Computer Vision (ICVV)	271
E. Eldele, M. Ragab, Z. Chen, M. Wu, C.K. Kwoh, X.Li, C. Guan (2021)	Time-Series Representation Learning via Temporal and Contextual Contrasting	IJCAI International Joint Conference on Artificial	234
S. Fan, Q. Dong, F.Zhu, Y.Lv, P. Ye, F-Y. Wang (2021)	SCF-Net: Learning spatial contextual features for large-scale point cloud segmentation	IEEE/CVF International Conference on Computer Vision and Pattern Recognition (CVPR)	232

The article Liu et al. (2019) has become a widely referenced article with 271 citations. DensePoint is a new architecture that is effective for point cloud processing by learning dense contextual representations. By adapting convolution operators to accommodate irregular point configurations while maintaining

permutation invariance, DensePoint enables efficient local pattern learning. Its architecture, inspired by dense connections, enables repeated aggregation of multi-level and multi-scale semantic information, resulting in rich and contextual shape understanding. Experimental results on various tasks and in-depth model analysis show that DensePoint achieves state-of-the-art performance in point cloud processing.

Meanwhile, the article (Eldele et al., 2021) proposes a new framework for unsupervised time-series representation learning, called Temporal and Contextual Contrasting (TS-TCC). This framework is designed to address the challenges of learning good representations from unlabeled time-series data with complex temporal dynamics. TS-TCC adopts a contrastive learning approach with three main stages. First, raw time-series data is transformed into two different but correlated views through weak and strong augmentation. Second, the proposed temporal contrasting module enables more robust temporal representation learning by designing a strict cross-view prediction

task. Third, a contextual contrasting module is built to further strengthen discriminative representations by maximizing similarity between contexts from the same sample and minimizing similarity between different samples.

Experiments conducted on three real-world time-series datasets show that the features learned by TS-TCC are capable of achieving performance equivalent to supervised training, simply by training a linear classifier on them. Furthermore, TS-TCC also demonstrates high efficiency in few-shot learning scenarios and transfer learning to new domains. Thus, TS-TCC makes a significant contribution to the development of representation learning techniques for unlabeled time-series data, which has great potential for application in various real-world time-series prediction and classification tasks.

Figure 3 illustrates international research collaboration related to contextual trigonometry e-books in education. The figure shows circles representing countries that contributed to scientific publications related to this topic.

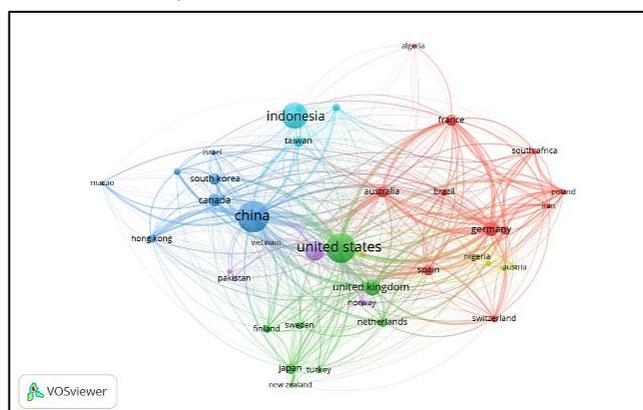


Figure 3. Inter-Country Relations

Figure 3 shows the existence of evidenced by the connections between the cooperation between countries, as circles representing countries, as shown in

the figure. Figure 3 shows four clusters that can be distinguished based on the color of the circles. More detailed information about research collaboration between countries in the context of contextual trigonometry e-books in education can be seen in Figure 4.

Selected	Country	Documents	Citations	Total link strength
<input checked="" type="checkbox"/>	united states	188	2154	7636
<input checked="" type="checkbox"/>	china	204	3077	7276
<input checked="" type="checkbox"/>	germany	42	498	3748
<input checked="" type="checkbox"/>	united kingdom	59	631	3585
<input checked="" type="checkbox"/>	australia	27	333	2924
<input checked="" type="checkbox"/>	france	28	233	2419
<input checked="" type="checkbox"/>	spain	24	238	1496
<input checked="" type="checkbox"/>	hong kong	16	224	1475
<input checked="" type="checkbox"/>	canada	33	182	1295
<input checked="" type="checkbox"/>	india	82	714	1290
<input checked="" type="checkbox"/>	netherlands	18	310	1181
<input checked="" type="checkbox"/>	italy	18	195	1010
<input checked="" type="checkbox"/>	south korea	26	214	800
<input checked="" type="checkbox"/>	japan	24	172	747
<input checked="" type="checkbox"/>	finland	14	60	705
<input checked="" type="checkbox"/>	taiwan	25	554	569
<input checked="" type="checkbox"/>	indonesia	146	470	288

Figure 4. Bibliographic Coupling by Country

Figure 4 shows international research collaboration in the context of contextual trigonometry e-books in education. The threshold used is a minimum of 14 documents, so only countries with at least 14 publications are included in the analysis. There are 60 countries that meet this threshold. It can be seen that China is the country with the highest number of

documents, with 204 publications. The United States has the second highest number of publications. The United States has a large influence in terms of publication citations. This shows that research from this country is highly recognized and cited by researchers in various countries. In addition, the United States is also the country with the largest total link strength, namely 188 total link strength. This shows that both Indonesia and the United States have a significant role in research on contextual trigonometry e-books in education.

The focus of research related to contextual trigonometry e-books in education can be seen in Figure 5. The novelty of the research can be seen in Figure 6. The figures displayed use the VosViewer application with a threshold of 3. This means that the keywords displayed have been used at least 3 times by different documents.

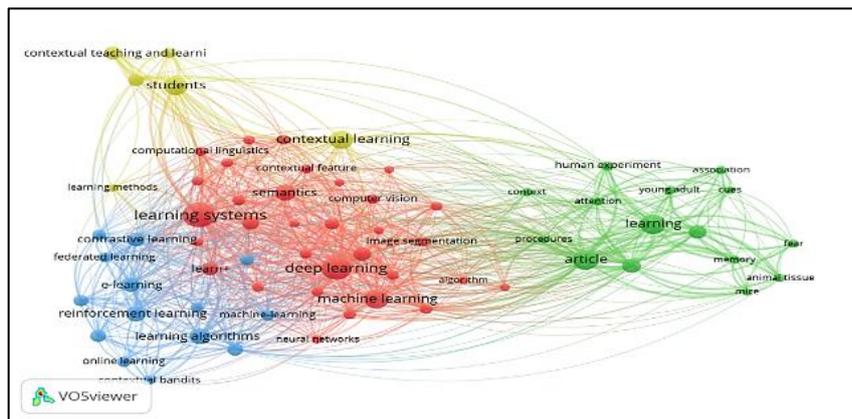


Figure 5. Research Focus

The results of the analysis using VOSviewer show that research related to contextual trigonometry e-books focuses on how interactive e-books can improve students' conceptual understanding, critical thinking skills, and learning motivation,

especially in science education fields such as physics. The main keywords that frequently appear in this research include "learning system," "learning algorithms," "contextual learning," and "deep learning," which indicate that simulation-based

learning technology is an important part of modern education systems. In addition, the research also discusses the use of innovative learning models such as problem-based learning (PBL) and the role of technology in increasing student engagement in learning. Interactive e-books have been proven to help students understand abstract concepts that are difficult to learn through conventional methods, as well as provide a more engaging and in-depth learning experience.

In addition, the relationship between learning systems, online learning, and context shows that learning technology continues to evolve to support context-based learning and technology-based

learning. Interactive e-books not only contribute to academic learning outcomes but also increase student engagement and motivation, as seen in the cluster linking context, memory, and attention. Going forward, research can focus more on comparing the effectiveness of e-book-based learning methods with conventional methods, developing more effective technology-based learning models, and analyzing the long-term impact of learning technology on student skills. Thus, the integration of interactive simulations in education has the potential to be an innovative solution in improving the quality of learning.

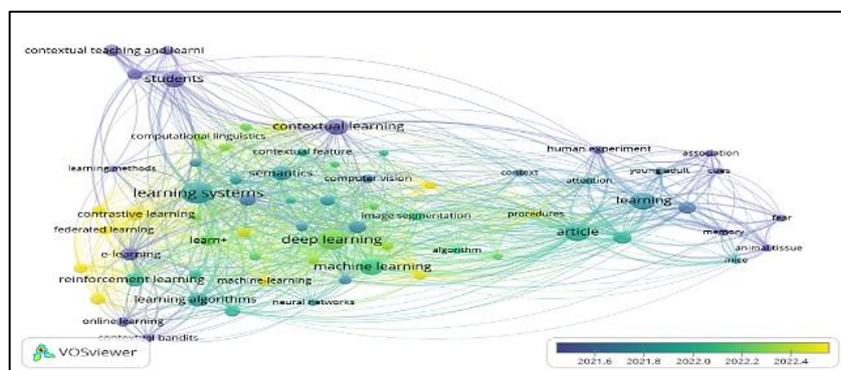


Figure 6. Novelty of Research

In terms of research novelty, it appears that recent studies are beginning to focus on the use of more specific contextual learning models, such as learning algorithms and integration with e-handouts and development models. In addition, the connection with “computational linguistics” and “learning systems” indicates that research is now beginning to examine the effectiveness of e-books in the broader context of technology-based learning. Recent studies also pay attention to human experiments and their influence on learning systems in a more comprehensive

manner. Thus, new research that can be developed includes measuring the long-term impact of contextual trigonometry e-books on higher-order thinking skills, developing more adaptive contextual trigonometry e-books, and further exploring the integration of technology in various STEM learning models.

IV. CONCLUSION

Bibliometric analysis provides deep insights into global trends in research related to contextual trigonometry e-

books. Through this approach, patterns of publication growth, contributions from key authors and institutions, and the most explored research topics over the past five years have been identified. Keyword and citation network analysis reveals that the integration of digital technology and contextual approaches in trigonometry learning is a growing theme, although there are still research gaps in aspects of local wisdom-based implementation and integration into the curriculum. Thus, bibliometric analysis not only maps the development of literature but also provides a strong foundation for subsequent researchers to fill research gaps and develop more relevant and effective e-book-based mathematics learning innovations.

Based on the objectives and results of the study, the hypothesis that can be formulated is that there has been a significant increase in the number of publications related to contextual trigonometry e-books in the last five years (2020–2025) in the Scopus database.

Thus, this study confirms that bibliometric analysis is a very important approach to uncovering the landscape, trends, and new research opportunities in the development of contextual trigonometry e-books.

Bibliometric analysis reveals a rapidly increasing trend in contextual trigonometry research since 2022, peaking during the pandemic. China and the United States are the main contributors, with China dominating in terms of citation impact, while the US excels in the number of publications. Dominant research topics include improving conceptual

understanding, integration with contextual learning, and the relationship between interactive e-books and technology-based education systems. Although publications declined in 2021, the recovery trend in 2022–2024 indicates continued academic interest. The article by Czyż et al. (2024) is the most influential, emphasizing the shift from traditional methods to interactive approaches. Going forward, research needs to focus on long-term impacts, the development of adaptive models, and the exploration of the integration of contextual trigonometry e-books in STEM learning to expand their contribution to the global education ecosystem.

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