

HOW EFFECTIVE IS DIGITAL-ASSISTED CTL FOR MATHEMATICAL REASONING? A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

The integration of digital technology in mathematics education is essential for addressing challenges in students' mathematical reasoning and engagement. This study systematically reviews the effectiveness of Contextual Teaching and Learning (CTL) assisted by digital tools, specifically Thinglink and Kahoot, in enhancing students' mathematical reasoning skills and learning activeness. Following the Systematic Literature Review (SLR) framework, this research analyzed national and international journal articles published over the last decade, selected through predefined inclusion criteria. Data were qualitatively synthesized to identify instructional strategies and evaluate reported learning outcomes across diverse educational settings. Findings indicate that the CTL approach significantly fosters critical thinking and problem-solving abilities by bridging abstract concepts with real-world contexts. Specifically, Thinglink facilitates contextual understanding through interactive visual media, while Kahoot enhances learning activeness through game-based assessment. The synergy between CTL and these digital tools creates a student-centered environment that promotes active participation and deeper conceptual mastery. In conclusion, CTL assisted by Thinglink and Kahoot is an effective strategy for improving mathematical reasoning and student engagement, providing a robust model for innovative mathematics instruction in the digital era.

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INTRODUCTION

In the era of Society 5.0, education plays a strategic and fundamental role in preparing a high-quality young generation capable of facing increasingly complex global challenges. Education is no longer limited to the transmission of knowledge but is expected to develop students' higher-order thinking skills, creativity, adaptability, and problem-solving abilities. In this context, mathematics education becomes one of the core pillars in shaping students' intellectual development, as it trains logical, analytical, and systematic thinking. Mathematical reasoning ability and learning activeness are therefore essential indicators of successful mathematics learning, because students who are able to reason mathematically and actively engage in learning tend to achieve better academic performance and demonstrate stronger problem-solving competence in real-life situations.

However, despite its importance, mathematics is still widely perceived as a difficult, abstract, and monotonous subject by many students. This perception often results in low learning motivation, passive classroom behavior, and limited engagement during instructional activities. Several studies have reported that traditional teacher-centered instructional methods contribute to students' difficulties in understanding mathematical concepts, particularly when learning emphasizes procedural knowledge rather than conceptual understanding. As highlighted by Romadoni et al. (2023), students' negative views toward mathematics can be transformed through the use of innovative teaching approaches supported by technology, which can make learning more engaging and meaningful. Therefore, there is a strong need for instructional strategies that not only improve cognitive achievement but also encourage active participation and meaningful learning experiences.

One instructional model that addresses these challenges is Contextual Teaching and Learning (CTL). CTL emphasizes the connection between academic content and real-life situations, allowing students to construct knowledge actively rather than receiving information passively. Through contextual learning experiences, students are encouraged to explore, analyze, and apply mathematical concepts in situations that are relevant to their daily lives. According to Nababan (2023), CTL promotes students' active involvement in discovering learning materials and relating them to real-world contexts, which supports deeper understanding and long-term retention. The CTL approach is grounded in seven key components: constructivism, inquiry, questioning, learning community, modeling, reflection, and authentic assessment. These components collectively foster critical thinking, mathematical reasoning, collaboration, and reflective learning.

In recent years, the integration of digital technology into education has become an increasingly important trend, particularly in mathematics learning. The rapid development of educational technology offers new opportunities to enhance the implementation of student-centered learning models such as CTL. Digital tools can support visualization, interactivity, collaboration, and immediate feedback, all of which are essential elements of effective learning in the digital era. In this regard, platforms such as ThingLink and Kahoot have gained popularity among educators due to their flexibility and ease of use in classroom settings.

ThingLink is an interactive multimedia platform that allows teachers to design learning materials in the form of images or videos enriched with interactive links, text, and audio. This feature enables abstract mathematical concepts to be presented in a more concrete and contextual manner, helping students visualize relationships and apply concepts meaningfully. Yulianti (2023) states that ThingLink supports contextual learning by allowing students to explore learning materials independently and interactively. Meanwhile, Kahoot is a game-based learning platform that transforms assessments into competitive and enjoyable activities. By incorporating quizzes with time limits and instant feedback, Kahoot increases students'

motivation, learning activeness, and engagement. Sulistiawati et al. (2023) emphasize that Kahoot creates a dynamic learning atmosphere that encourages students to participate actively and enthusiastically.

Although numerous studies have investigated the effectiveness of CTL, ThingLink, and Kahoot individually, existing research tends to be fragmented and lacks comprehensive synthesis. Many studies focus solely on the impact of CTL on learning outcomes or examine the use of digital tools without integrating them within a coherent pedagogical framework. As a result, there is limited understanding of how the combined implementation of CTL assisted by digital tools influences students' mathematical reasoning abilities and learning activeness. This gap highlights the need for a systematic literature review that consolidates existing findings and provides a holistic overview of research trends, outcomes, and implementation strategies related to technology-assisted CTL.

Therefore, this study aims to systematically review, analyze, and synthesize existing research on the implementation of Contextual Teaching and Learning integrated with ThingLink and Kahoot in mathematics education. The primary focus of this review is to examine the collective impact of this integrated approach on students' mathematical reasoning abilities and learning activeness. In addition, this study seeks to identify common instructional patterns, research methodologies, and implementation challenges reported in previous studies. By addressing these aspects, the review is expected to provide valuable insights for educators and researchers in designing more effective mathematics learning models.

This systematic literature review is guided by several research questions. First, how does the integration of CTL with digital tools affect students' mathematical reasoning abilities? Second, in what ways does the use of ThingLink and Kahoot within the CTL framework enhance students' learning activeness? Third, what instructional strategies and implementation trends are commonly found in studies related to technology-assisted CTL in mathematics education? These questions are intended to guide the synthesis of findings and ensure that the review addresses both cognitive and behavioral aspects of learning.

The scope of this study includes national and international peer-reviewed journal articles published between 2014 and 2024 that focus on mathematics education, CTL, digital learning tools, mathematical reasoning, and learning activeness. The remainder of this article is structured as follows: the Method section describes the systematic literature review procedures, including data sources, selection criteria, and analysis techniques; the Results section presents the synthesized findings from the reviewed studies; the Discussion section interprets the results in relation to previous research; and the Conclusion section summarizes the key findings and offers recommendations for future research and educational practice.

METHOD

This study employed a Systematic Literature Review (SLR) approach to synthesize empirical evidence related to the effectiveness of Contextual Teaching and Learning (CTL) assisted by digital tools in mathematics education. The SLR method was selected because it allows for a structured, transparent, and reproducible process in reviewing existing research, enabling researchers to systematically identify patterns, trends, and research gaps related to students' mathematical reasoning abilities and learning activeness. By integrating findings from multiple studies, this approach provides a comprehensive understanding of how digital tools can support the implementation of CTL in mathematics learning.

The literature search was conducted using several reputable academic databases and search engines, including Scopus, ERIC, Google Scholar, and Web of Science. These databases were chosen due to their wide coverage of peer-reviewed national and international journals in

education and educational technology. Using multiple databases increased the likelihood of capturing relevant and high-quality studies related to CTL, ThingLink, Kahoot, and mathematics learning outcomes.

The article search process utilized a set of predefined keywords connected by Boolean operators to ensure search accuracy and relevance. The keywords used were “Contextual Teaching and Learning” AND “ThingLink” AND “Kahoot” AND “mathematical reasoning” AND “learning activeness.” These keywords were selected based on the main variables and focus of the study. The search was limited to articles published between 2014 and 2024 to reflect recent advancements in digital-based learning and the integration of technology in mathematics education.

Clear inclusion and exclusion criteria were established to ensure the quality and relevance of the selected literature. The inclusion criteria consisted of: (1) peer-reviewed journal articles, (2) studies focusing on mathematics education at any educational level, (3) research examining the implementation of CTL or CTL integrated with digital tools such as ThingLink and Kahoot, and (4) studies reporting outcomes related to students’ mathematical reasoning skills and/or learning activeness. Conversely, the exclusion criteria included: (1) conference proceedings, dissertations, book chapters, and unpublished studies, (2) articles not written in English or Indonesian, and (3) studies that did not address mathematics learning or were unrelated to the specified research variables.

The article selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The process began with the identification of articles retrieved from the selected databases. Duplicate records were removed to avoid redundancy. Subsequently, the titles and abstracts of the remaining articles were screened to assess their relevance to the research topic. Articles that met the inclusion criteria proceeded to the full-text review stage, where their eligibility was further evaluated. As a result of this systematic screening process, 22 national and international journal articles were selected for inclusion in the final review.

Data extraction was conducted systematically to ensure consistency and accuracy. From each selected article, relevant information was recorded, including the author(s), year of publication, country of study, research design, educational level, learning intervention, type of digital tools used, and key findings related to students’ mathematical reasoning and learning activeness. This structured extraction process facilitated effective comparison across studies.

The extracted data were analyzed using thematic analysis to identify recurring themes, instructional strategies, and reported learning outcomes. The studies were grouped based on similarities in CTL implementation, the use of ThingLink and Kahoot, and their impact on mathematical reasoning and student engagement. This synthesis directly addressed the research questions and provided a comprehensive overview of the effectiveness of CTL integrated with digital tools in enhancing students’ mathematical reasoning skills and learning activeness.

RESULTS AND DISCUSSION

Results

The results of data analysis from various studies show that the Contextual Teaching and Learning (CTL) approach consistently improves students’ mathematical reasoning ability and learning activeness. Research by Samosir et al. found that the average score of students’ mathematical reasoning ability using CTL was higher (82.63) compared to the control group that used conventional learning methods (60.59). Bustami et al. also showed that the CTL approach significantly increased students’ critical thinking scores, with an average post-test score of 82.56 compared to the expository method, which only reached 68.37. In addition, a

study by Tari and Rosana emphasized that CTL has seven main components knowledge construction, inquiry, learning community, reflection, and discussion which support the development of practical and critical thinking skills. Another study using a quasi-experimental approach with pre-test and post-test design showed that the use of CTL, especially when combined with additional media such as mathematical comics (Lestari et al.), strengthened students' discipline and perseverance and improved their learning outcomes from the good to the very good category.

The results of other studies, such as those conducted by Syachputra and Muktiari, show that the development of CTL-based mathematical models in a problem-solving approach can improve students' mathematical reasoning ability. Raharjo also emphasized that the CTL method provides better results compared to conventional methods in improving high school students' mathematical reasoning. Meanwhile, research by Septianawati and Abdilah compared the Problem-Based Learning (PBL) and CTL models, showing that both approaches are effective in improving mathematical reasoning, although PBL performed slightly better in the final test.

The reviewed literature shows that CTL effectively enhances students' critical thinking, mathematical reasoning, and collaborative skills. Research by Haryanto and Arty found that CTL strengthens students' higher-order thinking skills (HOTS) and self-efficacy by connecting learning materials with real-life contexts. This enables students to analyze, evaluate, and create relevant solutions to the problems they face. Another study by Afni and Hartono confirmed that CTL improves students' mathematical literacy through a contextual approach in understanding and solving problems. The use of learning aids such as Geoboard media in the study by Trimurtini et al. also proved to improve student learning outcomes, with mastery reaching 75% and an increase in student activity from 88.34% to 96.66%. In addition, Abu Nawas showed that the CTL strategy with the REACT approach significantly improved students' writing skills, which are relevant in supporting mathematical communication skills.

Another study by Mulbasari and Surmilasari showed that CTL-based teaching materials have a positive impact on improving high school students' mathematical reasoning ability. Meanwhile, Purnama Sari et al. showed that the CTL approach in junior high school mathematics learning produced higher results compared to conventional learning. This was reinforced by research conducted by Sapta, who used the Classroom Action Research (CAR) method and found that students' mathematical reasoning ability increased significantly from cycle 1 to cycle 2.

Table 1. Data Analysis Matrix of Articles Used in the Literature Review

No	Author	Title	Journal	Method	Result
1	Faizal Imam Syachputra, Bondan Ramadhan Muktiari	Kajian Teori: Pengembangan Modul Matematika pada Pembelajaran <i>Problem Solving</i> dengan Pendekatan Kontekstual untuk Meningkatkan Kemampuan Penalaran Matematis Siswa	PRISMA (2023)	literature review	The development of a contextual-based mathematics module can improve students' mathematical reasoning ability
2	Zulwansyah, Marfi Ario, Ratri Isharyadi	Pengaruh Pendekatan <i>Contextual Teaching and Learning</i> (CTL) Terhadap	Jurnal Pendidik Indonesia	<i>Quasi-experimental study using a posttest-only design</i>	The Contextual Teaching and Learning (CTL) approach significantly influences

		Kemampuan Penalaran Matematis Siswa Kelas VIII SMP Negeri 5 Ujungbatu			students' mathematical reasoning skills
3	Sigit Raharjo	Pengaruh Metode <i>Contextual Teaching and Learning</i> (CTL) Terhadap Kemampuan Penalaran Matematis Siswa SMA	Syntax Literate	<i>Quasi-eksperimental</i>	here is a significant difference in students' mathematical reasoning abilities between the CTL method and the conventional learning method.
4	Erni Septianawati, Ervin Abdilah	Kemampuan Penalaran Matematis Ditinjau dari Model <i>Problem Based Learning</i> dengan <i>Contextual Teaching and Learning</i>	Kontinu (2021)	<i>Quasi-experimental study using a pretest-posttest design</i>	The PBL model yielded a higher average final test score than the CTL model; however, both models were equally effective in enhancing students' mathematical reasoning skills..
5	Anggria Septiani Mulbasari, Nora Surmilasari	Pengaruh Bahan Ajar Berbasis <i>Contextual Teaching and Learning</i> (CTL) Terhadap Kemampuan Penalaran Matematis Siswa SMA	Jurnal Elemen (2018)	<i>Quasi-experimental study using a posttest-only design</i>	The use of Contextual Teaching and Learning (CTL)-based teaching materials significantly influences students' mathematical reasoning skills.
6	Andy Sapta	Penerapan Model CTL dalam Meningkatkan Kemampuan Penalaran Matematika	Seminar Nasional Royal (SENAR) (2018)	A Classroom Action Research (CAR) study	There was an improvement in students' mathematical reasoning ability from cycle 1 to cycle 2, indicated by an increase in the average score and overall (classical) mastery level.
7	Nurfadhilah, Zubaidah Amir MZ	Kemampuan Penalaran Matematis Melalui Pembelajaran <i>Contextual Teaching and Learning</i> (CTL) pada Siswa SMP	Jurnal Elemen (2018)	<i>Quasi-experimental study using a posttest-only design</i>	There is a significant difference in students' mathematical reasoning abilities between those taught using the CTL model and those taught through direct instruction.
8	Intan Purnama Sari, Yenni, Aji Raditya	Pengaruh Pendekatan Pembelajaran <i>Contextual Teaching and Learning</i> (CTL) Terhadap	Prima: Jurnal Pendidikan Matematika (2017)	<i>Quasi-eksperimental</i> with <i>nonequivalent control group design</i>	Students taught using the CTL approach demonstrate higher mathematical reasoning ability compared to those

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|----|---|--|---|--|--|
| | | Kemampuan
Penalaran Matematis
Siswa SMP | | | taught using
conventional learning
methods. |
| 9 | Mardiati,
Fahrur Nisa
Rani | Pengaruh Model
Pembelajaran
<i>Contextual Teaching
and Learning (CTL)</i>
Terhadap
Kemampuan
Penalaran
Matematika | Matematic
s
Paedagogi
c (2018) | <i>Quasi-
eksperimen
with pretest-
posttest
design</i> | The CTL learning
approach is effective in
enhancing students'
mathematical
reasoning skills,
showing an effect of
70.56%. |
| 10 | Y. Bustami,
D.
Syafuruddin,
R. Afriani | <i>The Implementation
Of Contextual
Learning To
Enhance Biology
Students' Critical
Thinking Skills</i> | Jurnal
Pendidika
n IPA
Indonesia | Quasi-
eksperimen
with pretest-
posttest
design | The average post-test
score of students taught
using the CTL
approach was 82.56
(very good), whereas
those taught through
the expository method
achieved an average
score of 68.37 (fair).
The improvement in
students' critical
thinking scores was
greater in the CTL
group (36.06) than in
the expository group
(19.42). |
| 11 | Putri
Chandra
Haryanto,
Indiyah
Sulistyo Arty | <i>The Application of
Contextual Teaching
and Learning in
Natural Science to
Improve Student's
HOTS and Self-
efficacy</i> | Journal of
Physics:
Conferenc
e Series | literature
review | The CTL approach can
improve students'
higher-order thinking
skills (HOTS) and self-
efficacy by linking
learning materials to
real-life contexts,
allowing students to
analyze, evaluate, and
generate solutions. |
| 12 | N Afni,
Hartono | <i>Contextual teaching
and learning (CTL)
as a strategy to
improve students
mathematical
literacy</i> | Journal of
Physics:
Conferenc
e Series | descriptive-
analytical
research | The CTL approach
helps students
understand and solve
mathematical problems
within real-life
contexts, thereby
improving their
mathematical literacy
through enhanced
comprehension,
problem-solving, and
communication skills. |
| 13 | Lily
Thamrin,
Uray
Gustian,
Suhardi, Wei | <i>The Implementation
of Contextual
Learning Strategies
to Stimulate
Students' Critical
Thinking Skills</i> | Journal:
Retos:
nuevas
tendencias
en
educación | Quantitative | The contextual
learning strategy
significantly enhances
students' critical
thinking abilities.
Moreover, CTL fosters |

- | | | | | | |
|----|--|---|---|---|---|
| | Zhongfulin,
Didi Suryadi | | física,
deporte y
recreación | | learning motivation,
facilitates peer
discussion and
interaction, and
supports students in
summarizing and
reflecting on the
lessons learned. |
| 14 | Detri Kurnia
Tari, Dadan
Rosana | <i>Contextual Teaching
and Learning to
Develop Critical
Thinking and
Practical Skills</i> | Journal of
Physics:
Conferenc
e Series | literature
review | CTL comprises
components that
facilitate the
development of
students' critical
thinking and practical
skills, including
knowledge
construction, inquiry,
learning community,
reflection, and
discussion. |
| 15 | Farida Puput
Lestari, Farid
Ahmadi,
Rochmad
Rochmad | <i>The Implementation
of Mathematics
Comic through
Contextual Teaching
and Learning to
Improve Critical
Thinking Ability and
Character</i> | European
Journal of
Education
al
Research | <i>Quasi-
eksperimenta
l</i> | he use of mathematics
comics integrated with
Pancasila values has
been proven effective
in enhancing students'
critical thinking skills
and character
development,
particularly in terms of
discipline and hard
work, which improved
from the good category
to the very good
category. |
| 16 | Nanda Laura
Samosir,
Theresia
Monika
Siahaan,
Golda
Novatrasio
Sauduran | <i>The Influence of
Contextual Teaching
and Learning (CTL)
Learning Approach
on Mathematical
Reasoning Ability of
Class VIII Students
of SMP Negeri 3
Pematangsiantar</i> | EduMatika
: Jurnal
MIPA | <i>Quasi-
eksperimenta
l with
posttest only
control
design.</i> | RataThe average
mathematical
reasoning score of
students in the
experimental class
(CTL) was 82.63,
which was higher than
that of the control class
(60.59), indicating that
the CTL approach had
a significant effect on
students' mathematical
reasoning ability. |
| 17 | Epi Nurlinda,
Zainal Azis,
Marah Doly
Nasution | <i>Students'
Mathematical
Reasoning Ability
and Self-Efficacy
Viewed from the
Application of
Problem-Based
Learning and</i> | Journal of
Mathemati
cs
Education
and
Applicatio
n (JMEA),
Vol. 3, | <i>Quasi-
eksperimenta
l</i> | Both the PBL and CTL
models significantly
enhance students'
mathematical
reasoning skills and
self-efficacy, showing
an interaction effect |

		<i>Contextual Teaching and Learning Models Assisted</i>	No. 2, Juni 2024		with students' initial ability levels.
18	Detri Kurnia Tari, Dadan Rosana	<i>Contextual Teaching and Learning to Develop Critical Thinking and Practical Skills</i>	Journal of Physics: Conference Series 1233 (2019)	literature review	CTL comprises seven components that are effective in fostering the development of students' critical thinking and practical skills.
19	T Trimurtini, T R Safitri, E F Sari and N Nugrahen	<i>The Effectivity of Contextual Teaching and Learning (CTL) Approach with Geoboard Media on Mathematics Learning for Four-Grade Elementary Students</i>	Journal of Physics: Conference Series	<i>Quasi-eksperimen with pretest-posttest design</i>	The CTL approach utilizing a Geoboard enhanced students' learning outcomes, achieving a mastery level of 75%, while student activity increased from 88.34% to 96.66%.
20	Abu Nawas	<i>Contextual Teaching and Learning (CTL) Approach Through REACT Strategies on Improving the Students' Critical Thinking in Writing</i>	International Journal of Management and Applied Science	<i>Quasi-eksperimen with pretest-posttest design</i>	The CTL strategy implemented through the REACT approach significantly enhanced students' writing abilities ($M = 4.9$, $SD = 0.43$) compared to the control group ($M = 3.49$, $SD = 0.25$).
21	D. Selvianiresa, S. Prabawanto	<i>Contextual Teaching and Learning Approach of Mathematics in Primary Schools</i>	Journal of Physics: Conference Series	<i>Quasi-eksperimental</i>	CTL enhances students' mathematical connection abilities through the implementation of collaborative and contextual learning approaches.
22	G. I. D. Purba, E. Surya	<i>The Improving of Mathematical Understanding Ability and Positive Attitudes of Unimed FMIPA Students by Using the Contextual Teaching Learning (CTL) Approach</i>	Journal of Physics: Conference Series	<i>Quasi-eksperimental</i>	The CTL approach enhances students' mathematical communication and understanding skills, as well as fosters positive attitudes among FMIPA students.

Based on Table 1, the reviewed studies indicate that the Contextual Teaching and Learning (CTL) approach has a positive effect on students' mathematical reasoning abilities. Most studies report higher learning outcomes for students taught using CTL compared to conventional methods.

The findings also show that CTL enhances students' learning activeness through increased participation, engagement, and collaboration during learning activities. Overall, the results

confirm that CTL is effective in improving students' mathematical reasoning and learning activeness, especially when supported by appropriate learning media and digital tools.

Discussions

The findings of this systematic literature review indicate that the Contextual Teaching and Learning (CTL) approach consistently improves students' mathematical reasoning abilities and learning activeness across various educational levels. This result aligns with the studies conducted by Zulwansyah et al. (2023) and Samosir et al. (2023), which reported significantly higher mathematical reasoning scores among students taught using CTL compared to those taught through conventional learning methods. The consistency between these findings and the present review suggests that CTL is an effective instructional approach regardless of differences in student backgrounds, school settings, or instructional contexts.

Furthermore, when compared with the findings of Raharjo (2023) as well as Mulbasari and Surmilasari (2018), this study reinforces the argument that CTL-based instructional strategies and learning materials play an important role in enhancing students' mathematical reasoning. These previous studies emphasized the effectiveness of CTL in encouraging students to actively connect mathematical concepts with real-life situations, thereby strengthening their reasoning processes. The present review extends these findings by highlighting that the integration of digital tools within the CTL framework can further amplify these benefits by increasing student interactivity, visualization, and engagement during learning activities.

In comparison with the study by Septianawati and Abdilah (2021), which found that the Problem-Based Learning (PBL) model slightly outperformed CTL in improving students' mathematical reasoning, the findings of this review indicate that CTL remains equally effective when supported by appropriate learning media. This comparison suggests that the effectiveness of CTL may depend not only on the instructional model itself but also on how it is implemented. When enriched with digital tools such as Thinglink and Kahoot, CTL has the potential to achieve learning outcomes comparable to other student-centered learning approaches.

Additionally, the results of this review are consistent with the findings of Thamrin et al. (2023) and Tari and Rosana (2019), who emphasized that CTL significantly enhances higher-order thinking skills, including critical thinking, reflection, and student motivation. However, while their studies mainly examined CTL in general learning environments, the present review highlights the added value of technology-assisted CTL. The use of digital platforms encourages students to participate more actively, engage in reflective learning processes, and collaborate with peers, which are essential components of meaningful mathematics learning.

Moreover, when compared with the findings of Trimurtini et al. (2019), who reported increased student activity through CTL supported by concrete learning media such as geoboards, this study suggests that digital tools can serve a similar and even more flexible function. Interactive digital platforms like Thinglink enable students to visualize abstract mathematical concepts contextually, while Kahoot promotes learning activeness through gamified assessments that increase motivation and participation. These tools contribute to a more dynamic and engaging learning environment that supports students' active involvement.

Overall, compared with previous research, this systematic literature review extends existing knowledge by demonstrating that the integration of CTL with digital tools not only maintains the effectiveness of traditional CTL but also enhances students' mathematical reasoning and learning activeness. These findings indicate that technology-supported CTL represents a promising instructional strategy to address the demands of modern mathematics education in the digital era, particularly in fostering meaningful learning and essential 21st-century skills.

CONCLUSION

Based on the literature review conducted, the Contextual Teaching and Learning (CTL) model integrated with Thinglink and Kahoot demonstrates strong potential to enhance students' mathematical reasoning abilities and learning engagement. CTL effectively connects instructional content with real-life contexts, enabling students to understand and apply mathematical concepts in a more meaningful and reflective manner. The integration of digital technologies such as Thinglink and Kahoot further enriches the learning process by incorporating interactive visual media and game-based assessments that foster active participation and motivation. In addition, this integrated approach supports the development of higher-order thinking skills, including critical thinking and problem-solving, which are essential competencies in the digital era. Overall, this study contributes to the advancement of innovative mathematics learning strategies, particularly at the secondary education level, by offering an effective solution to improve students' motivation and academic achievement.

Despite these positive findings, several recommendations can be proposed for future research. First, future studies are encouraged to employ experimental or quasi-experimental designs to empirically examine the effectiveness of CTL integrated with Thinglink and Kahoot in real classroom settings. Such studies would provide stronger causal evidence regarding its impact on mathematical reasoning and learning activeness. Second, further research could explore the implementation of this integrated approach across different educational levels, such as elementary and higher education, to examine its adaptability and effectiveness in diverse learning contexts. Third, future researchers may investigate additional variables, including students' self-efficacy, creativity, problem-solving strategies, and digital literacy, to gain a more comprehensive understanding of the broader educational impact of technology-assisted CTL. Finally, longitudinal studies are recommended to examine the long-term effects of this learning model on students' cognitive development and learning sustainability. These directions are expected to strengthen the empirical foundation and practical application of CTL integrated with digital tools in mathematics education.

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