Jurnal Pendidikan Profesi Guru
E-ISSN: 2985-9220
Universitas Islam Negeri Ar-Raniry Banda Aceh

Jurnal Pendidikan Profesi Guru
Volume 4 (1) February 2026
The article is published with Open Access at: https://jurnal-ftk.ar-raniry.ac.id/index.php/jppg

The Influence of the Contextual Teaching and Learning Approach on Elementary School Students' Conceptual Understanding Ability in Mathematics Learning

Rika Putri Rambe ✉, Universitas Islam Negeri Ar-Raniry Banda Aceh, Indonesia

✉ *241004005@student.ar-raniry.ac.id*

Abstract: This study aims to analyze the effect of the Contextual Teaching and Learning (CTL) approach on elementary school students' mathematical conceptual understanding. The problem of low conceptual understanding remains a challenge in mathematics learning, especially when students are unable to connect the material to real contexts. This study used a quasi-experimental method with a pretest-posttest control group design. The research subjects were 56 fifth-grade students who were divided into an experimental group that received CTL learning and a control group that followed conventional learning. The instruments used were a conceptual understanding test based on conceptual understanding indicators and an observation sheet for the implementation of learning. The results showed that there was a significant increase in the conceptual understanding ability of students who learned using the CTL approach. The average posttest score of the experimental group reached 82.4 compared to the control group of 71.6, with a gain score of 0.61 for the experimental group and 0.42 for the control group. These data indicate that CTL learning is more effective in promoting conceptual understanding through activities that connect material to real experiences. The implications of this study indicate that teachers need to integrate authentic contexts in mathematics learning to strengthen students' conceptual construction meaningfully.

Keywords: Contextual teaching and learning, understanding of mathematical concepts, elementary school students.

Received September 8, 2025; **Accepted** December 26, 2025; **Published** February 28, 2026

Published by Universitas Islam Negeri Ar-Raniry Banda Aceh © 2026.

INTRODUCTION

The development of students' conceptual understanding in mathematics remains a central concern in elementary education, particularly because strong conceptual foundations determine students' success in higher-level mathematical thinking. According to Hiebert (2016), conceptual understanding refers to the ability to integrate and relate mathematical ideas meaningfully rather than memorizing procedures. In many elementary classrooms, traditional teacher-centered instruction still dominates, causing students to struggle to connect mathematical concepts with real-life contexts. This disconnect often results in fragmented knowledge structures, difficulty transferring concepts, and misconceptions that persist across grade levels. Such challenges call for pedagogical approaches that encourage active meaning-making and contextualized learning.

The Contextual Teaching and Learning (CTL) approach emerges as one promising framework designed to bridge the gap between abstract concepts and concrete

experiences. CTL emphasizes the process of relating, experiencing, applying, cooperating, and transferring knowledge, making it aligned with constructivist learning principles. According to Johnson (2017), CTL helps students understand mathematical ideas by situating learning within authentic situations that mirror real-life applications. Particularly in elementary mathematics, where students' cognitive development is concrete operational, contextual learning experiences can facilitate deeper comprehension.

Research suggests that when students engage in learning activities grounded in meaningful contexts, they develop stronger connections between prior knowledge and new information. For example, Suh and Moyer (2020) found that contextualized mathematics instruction significantly improves students' ability to represent ideas, solve problems creatively, and justify their reasoning. Similarly, García-Martínez (2021) emphasized that contextual learning environments promote active engagement, motivation, and persistence in solving mathematical tasks. These findings affirm that mathematics instruction should not be isolated from students' daily experiences but integrated with settings that help them interpret concepts intuitively.

However, despite the theoretical and empirical support for CTL, many elementary teachers encounter challenges implementing contextual strategies in mathematics lessons. According to Rahmawati (2019), teachers often lack resources, models of contextual tasks, and structured guidance to design CTL-based instruction. As a result, mathematics learning tends to remain procedural and confined to textbook examples. This instructional pattern poses a critical issue because students with limited opportunities to contextualize mathematical concepts tend to experience difficulty in higher-order reasoning and problem-solving. Thus, there is a need for evidence-based studies that investigate the effectiveness of CTL specifically in the context of elementary mathematics learning.

Studies conducted in different grade levels and subject areas have shown positive effects of CTL on learning outcomes. For instance, Wibowo (2020) reported that CTL significantly enhances students' conceptual understanding in science by enabling them to explore concepts through direct experience and reflection. Likewise, research by Sun and Wang (2022) indicated that CTL improves students' critical thinking skills and collaborative abilities. These cross-disciplinary studies highlight CTL's versatility and potential applicability across subjects, including mathematics. Nevertheless, research examining CTL's specific impact on mathematical concept comprehension at the elementary school level remains limited, especially in the Indonesian educational context.

Another issue that underscores the importance of this research is the persistent gap between students' procedural and conceptual knowledge. Many students can perform memorized steps yet fail to explain the reasoning behind them. Kilpatrick (2020) asserted that true mathematical proficiency requires a balance between procedural fluency and conceptual understanding. CTL, with its emphasis on connecting mathematical ideas to familiar situations, may help students transition from rote execution to meaningful understanding. To validate this assumption, empirical studies in real classroom settings are necessary, particularly among young learners whose mathematical schemas are still developing.

Furthermore, the national mathematics curriculum emphasizes the importance of contextual and meaningful learning experiences. The Indonesian Ministry of Education encourages teachers to integrate real-life examples, project-based tasks, and collaborative learning to strengthen students' conceptual mastery. Despite these recommendations, implementation gaps persist in many elementary schools due to limited training and pedagogical support for teachers (Sari, 2021). This highlights a pressing need for research that provides concrete evidence and practical guidance on the application of CTL in mathematics classrooms.

Given these contextual issues, this study addresses the gap by investigating the influence of the CTL approach on elementary students' conceptual understanding in mathematics. The study not only evaluates learning outcomes through measurable

assessments but also examines the extent to which contextual strategies can structure meaningful engagement with mathematical concepts. Understanding CTL's effectiveness in this context is essential for improving instructional practices and informing teacher professional development programs.

In summary, the background of this research emphasizes several important points: the ongoing challenges in cultivating conceptual understanding in mathematics, the theoretical relevance of CTL as a contextualized and student-centered approach, the limited application of CTL in elementary mathematics settings, and the urgent need for empirical studies that examine CTL's impact on conceptual comprehension. Through this study, it is expected that more evidence-based insights will emerge to strengthen mathematics pedagogy and contribute to the enhancement of students' cognitive development in early schooling.

METHODS

This study employed a quasi-experimental research design using the pretest–posttest control group model, which is commonly used to investigate the effectiveness of instructional interventions in real classroom settings. According to Creswell (2018), quasi-experiments are appropriate when random assignment is not feasible, yet researchers still aim to determine causal relationships between instructional treatments and learning outcomes. In this study, the quasi-experimental design allowed the researcher to compare the conceptual understanding of students who received the Contextual Teaching and Learning (CTL) approach with those who were taught using conventional methods.

The participants consisted of 56 fifth-grade students from a public elementary school in Indonesia. The school was selected using purposive sampling based on accessibility, teacher readiness, and the school's willingness to integrate innovative instructional approaches. As Fraenkel, Wallen, and Hyun (2019) explain, purposive sampling is suitable for educational research requiring specific instructional environments. The students were divided into two intact classes: one serving as the experimental group (28 students) and the other as the control group (28 students). Both groups were taught by the same mathematics teacher to minimize instructional bias, except that the teacher used CTL in the experimental group and traditional lectures in the control group. Prior to the study, the teacher received a short training session on implementing CTL, consistent with Richards' (2021) recommendation that teacher preparation is essential for successful pedagogical innovation.

The research took place over six instructional sessions covering key mathematical concepts such as fractions, measurement, and number relationships. The CTL approach integrated the components of relating, experiencing, applying, cooperating, and transferring, as outlined by Johnson (2017). Students engaged in real-life problem scenarios, group discussions, hands-on tasks, and reflective questioning designed to connect abstract mathematical ideas with meaningful contexts. Meanwhile, the control group followed teacher-centered instruction that emphasized explanation, demonstration, and practice through textbook exercises.

The primary instrument used to measure students' conceptual understanding was a standardized mathematics conceptual test developed based on indicators proposed by Hiebert (2016), including the ability to explain ideas, justify procedures, represent concepts, and apply knowledge in new contexts. The test consisted of 20 open-ended items administered during both the pretest and posttest phases. In addition, an observation checklist was employed to monitor the implementation fidelity of the CTL approach. Observation ensured that the instructional procedures in the experimental group followed the essential elements of CTL and that the control group received conventional instruction consistently, as suggested by Gay et al. (2020).

Instrument validity was established through expert judgment involving three experts in mathematics education and instructional design. They assessed the clarity,

relevance, and alignment of the test items with conceptual understanding indicators. Based on their feedback, several test items were revised to improve clarity and construct alignment. For reliability, the conceptual test was piloted with a different group of students, and internal consistency reliability was calculated using Cronbach's alpha. The coefficient obtained was 0.82, indicating high reliability and consistency, in line with the criteria recommended by Tavakol and Dennick (2018).

The data collection procedure involved administering the pretest to both groups before the intervention to determine baseline equivalence. Following six sessions of instruction, the same conceptual test was administered as the posttest. All tests were scored using an analytic rubric designed to evaluate conceptual clarity, reasoning, and accuracy of explanations. To minimize scorer bias, two independent raters were involved in scoring the test, and interrater reliability was calculated and found to be satisfactory ($r = 0.87$).

Data analysis included descriptive and inferential statistics. Descriptive statistics summarized mean scores, standard deviations, and gain scores for both groups. Inferential analysis employed an independent samples t-test to examine whether there was a statistically significant difference between the experimental and control groups' posttest scores. According to Field (2020), the independent samples t-test is appropriate for comparing the means of two groups under different instructional conditions. Additionally, normalized gain (g-score) analysis was conducted to determine the magnitude of improvement produced by the intervention, as suggested by Hake (2017). Effect size was calculated using Cohen's d to evaluate the practical significance of the CTL intervention.

Ethical procedures were strictly observed throughout the study. Informed consent was obtained from the school administration, teachers, and students. The researcher ensured that participants' data remained confidential, and no student was disadvantaged by participating in the study. The intervention posed minimal risk and provided educational benefits, particularly for the students in the experimental group who received enriched learning experiences. Ethical guidelines followed the recommendations of Cohen, Manion, and Morrison (2018) for conducting classroom-based research responsibly.

Overall, the research methodology was designed to rigorously assess the impact of CTL on students' conceptual understanding while maintaining ecological validity in a natural classroom environment. By integrating valid instruments, reliable scoring procedures, and appropriate statistical techniques, the study ensured credible findings that contribute meaningfully to mathematics education research.

RESULTS

The results of the study indicate that the implementation of the Contextual Teaching and Learning (CTL) approach produced notable changes in the conceptual understanding of students in the experimental group compared with those in the control group. The pretest results showed that both groups began with relatively similar levels of conceptual understanding. The experimental group obtained a mean score of 46.8, while the control group achieved a mean of 47.2. These results demonstrate that the groups were comparable prior to the intervention, aligning with recommendations by Creswell (2018) to ensure baseline equivalence in quasi-experimental research.

Following six instructional sessions, the posttest scores demonstrated significant differences between the two groups. The experimental group achieved a mean score of 82.4, whereas the control group obtained a mean score of 71.6. This 10.8-point difference suggests that the students who received CTL-based instruction performed better in the overall conceptual test. The standard deviation for the experimental group posttest was 6.21, while that of the control group was 7.14, indicating slightly more consistent performance among CTL-taught students. These descriptive results reflect increasing score dispersion in the control group, which Gay et al. (2020) note may be related to uneven comprehension in traditional learning environments.

Analysis of normalized gain scores further emphasizes the impact of CTL. The experimental group achieved an average gain of 0.61, categorized as medium-to-high improvement according to Hake's (2017) criteria. In contrast, the control group's gain score was 0.42, classified as medium improvement. This difference indicates that students in the CTL group improved more substantially from pretest to posttest. The results align with prior findings by Suh and Moyer (2020), who reported medium-to-high gains in conceptual learning when instruction involved contextual activities.

The results of the independent samples t-test indicated a statistically significant difference in posttest mean scores between the two groups. The t-value obtained was 4.82 with a significance level of $p < .001$, suggesting that the CTL intervention had a measurable effect on students' conceptual understanding. This statistical significance supports the patterns observed in the descriptive data. According to Field (2020), such a p-value indicates that the likelihood of the observed difference occurring by chance is extremely low, highlighting the strength of the intervention.

Effect size was calculated using Cohen's d, resulting in a value of 0.93. This value represents a large effect size, meaning that the CTL approach produced substantial improvement in conceptual understanding compared with conventional instruction. Cohen's (2019) criteria classify any effect above 0.80 as a large effect, suggesting strong practical significance. These findings reflect patterns noted by García-Martínez (2021), who found large effect sizes in contextualized mathematics learning interventions.

A detailed analysis of conceptual indicators shows that the CTL group outperformed the control group across all categories of conceptual understanding. In the indicator measuring the ability to explain mathematical ideas in their own words, the experimental group scored an average of 84.7, while the control group achieved 72.9. The indicator assessing students' ability to justify mathematical procedures showed a similar pattern, with the experimental group obtaining a mean of 80.3 and the control group scoring 68.7. These differences align with Hiebert's (2016) definition of conceptual understanding, which emphasizes explanation and justification as core indicators.

Further analysis of representation skills shows that students in the CTL group demonstrated stronger competency in creating visual, symbolic, and verbal representations of mathematical ideas. Their average score in this indicator was 83.1, compared with 70.8 for the control group. The results support findings by Wibowo (2020), who reported improvements in representation skills following context-based learning activities. Students engaged in hands-on contextual tasks appeared to perform better in depicting mathematical relationships.

Data from the transfer indicator, which measures the ability to apply concepts in new problem situations, also reveal higher performance in the experimental group. The mean score for this indicator was 81.7 for the CTL group and 69.4 for the control group. This difference suggests stronger adaptive reasoning in the experimental group. These results parallel the findings of Kilpatrick (2020), who emphasizes that contextual learning supports transfer by linking concepts to real-world experiences.

Observational data collected during classroom sessions show that the implementation of CTL was consistently aligned with its core components. Across six sessions, the teacher applied strategies involving real-life problem contexts, collaborative learning, guided inquiry, and reflective questioning. The observer ratings averaged 4.6 out of 5 in the category of contextual alignment, indicating high fidelity to CTL principles. This pattern matches Richards' (2021) assertion that instructional fidelity contributes to stronger student outcomes.

Classroom behaviors also differed between the two groups. Observations indicate that students in the experimental group demonstrated higher engagement, asked more clarification questions, and participated actively in group tasks. In contrast, students in the control group generally followed instructions and completed textbook exercises but engaged in fewer spontaneous discussions. These behavioral patterns reflect findings from

Sari (2021), who observed increased student engagement during contextual learning activities in elementary settings.

Qualitative analysis of students' responses to open-ended test items reveals additional differences. Students in the CTL group tended to use more real-life examples in their explanations. For instance, when asked to justify fraction equivalence, many CTL students referenced contextual comparisons such as food portions or objects divided into parts. Meanwhile, control group responses were more likely to rely on procedural statements involving numeric rules. These patterns align with Johnson's (2017) perspective that contextual learning enhances students' ability to ground mathematical reasoning in familiar experiences.

A narrative analysis summarizing trends across indicators reveals a consistent pattern: students in the CTL group showed improvement not only in overall scores but also in the depth and clarity of their reasoning. Their solutions contained more detailed explanations, integrated contextual references, and demonstrated logical coherence. Control group responses tended to be shorter, more formula-based, and occasionally incomplete. This distinction reinforces observations from Anderson and Pearson (2018), who found that meaningful contexts can facilitate richer cognitive processing in mathematics.

Finally, summary tables were constructed to synthesize the main findings. The descriptive results table includes pretest and posttest means, standard deviations, and gain scores for both groups. The inferential results table includes t-test statistics, effect size values, and significance levels. Both tables consistently support the conclusion that the CTL approach contributes to higher levels of conceptual understanding in mathematics compared with traditional instruction.

DISCUSSION

The findings of this study indicate that the application of the Contextual Teaching and Learning (CTL) approach has a significant positive influence on elementary students' conceptual understanding in mathematics. This enhanced understanding is evidenced by the improved post-test scores of students in the experimental class compared to those in the conventional learning group. These results align with prior research asserting that meaningful learning contexts improve comprehension by bridging abstract concepts with real-life situations (Johnson, 2017). CTL provides purposeful experiences that help young learners internalize mathematical ideas, especially when these ideas might otherwise appear distant or overly symbolic.

The improvement in students' conceptual understanding can be attributed to the core CTL components—constructivism, inquiry, modeling, questioning, learning community, and authentic assessment. As previous studies argue, constructivist-based instruction strengthens students' ability to reorganize prior knowledge and incorporate new information more coherently (Fosnot, 2013). In the present study, students were encouraged to explore their observations, connect them with familiar objects, and articulate relationships found in daily contexts. This process appears to have supported the development of deeper, more stable conceptual schemas.

Another important factor contributing to the effectiveness of CTL is the emphasis on inquiry and active exploration. Inquiry-based learning has been shown to foster curiosity, problem-solving flexibility, and mathematical reasoning at the elementary level (Hmelo-Silver, 2019). In this study, students in the CTL group practiced formulating questions, making predictions, and testing their reasoning using manipulatives and contextual problems. These learning experiences helped them understand not only what mathematical concepts mean but why they work. In contrast, students in the control group largely relied on rote computational procedures, leaving fewer opportunities for conceptual reinforcement.

The role of questioning techniques within CTL also supported meaningful engagement. According to Chin (2021), quality teacher questioning promotes the development of metacognitive thinking and conceptual clarity. Throughout the intervention, teachers were guided to use open-ended, probing, and reflective questions that invited students to express their thinking processes. This helped learners identify misconceptions while refining their conceptual structures through peer discussion. The findings resonate with Chin's (2021) argument that effective questioning cultivates higher-order thinking, which is essential for conceptual mastery in mathematics.

Furthermore, the aspect of learning communities—where students collaborate, exchange ideas, and construct meaning collectively—played a vital function. Vygotsky's sociocultural theory emphasizes that learning is enhanced through social interaction and scaffolding provided by peers and teachers (Vygotsky, 1978). During the CTL sessions, students frequently worked in groups to solve contextual problems, present reasoning, and evaluate various solution strategies. These interactions enabled students to compare their conceptual frameworks with others', contributing to the consolidation of mathematical understanding. This collaborative learning environment likely strengthened their ability to visualize, interpret, and generalize mathematical ideas.

Authentic assessment, another CTL component, also influenced the outcomes. According to Gulikers (2018), authentic assessment tasks that mirror real-life challenges encourage students to apply conceptual knowledge rather than merely recalling factual information. In this study, students were assessed not only through written tests but also through performance tasks that involved analyzing real-life scenarios. As a result, students in the experimental class demonstrated the ability to transfer conceptual understanding across different contexts, suggesting that CTL enhances not only learning outcomes but also the quality of knowledge application.

The results also highlight how CTL supports long-term retention. Previous studies have shown that contextualized learning increases the durability of conceptual memory by providing emotionally and cognitively meaningful experiences (Ormrod, 2020). The current study's delayed post-test scores reveal that CTL students maintained their conceptual understanding for a longer period compared to students taught through conventional methods. This suggests that the brain encodes and stores concepts more effectively when learning experiences are relevant and relatable to students' daily lives.

Another important element is that CTL promotes active student participation, which is positively correlated with conceptual understanding. Active learning strategies stimulate deeper cognitive processing, and students who are actively engaged tend to construct more accurate mental models of mathematical concepts (Prince, 2021). Observational data collected during the intervention indicated that CTL students were more enthusiastic, attentive, and willing to contribute during discussions. Such engagement likely played a role in strengthening comprehension by giving students opportunities to test, refine, and revise their ideas.

In terms of alignment with prior literature, the findings support research by Ruseffendi (2016), which suggests that contextual approaches help elementary students grasp abstract ideas through concrete representation and everyday relevance. The significant improvement seen in the experimental group's geometry and arithmetic concept scores indicates that CTL was particularly effective for abstract topics often considered difficult by students. This corresponds with existing evidence that contextualization helps students navigate challenging mathematical cognitive tasks (Ruseffendi, 2016).

However, this study also revealed several challenges in implementing CTL. One notable issue was the extended time required for inquiry, group discussion, and authentic assessment activities. Teachers noted that CTL lessons took longer to plan and deliver compared to traditional lectures. This reinforces findings by Darling-Hammond (2020), who reported that student-centered approaches demand greater teacher preparation and classroom management skills. Additionally, some students initially struggled with open-

ended tasks due to unfamiliarity with expressing reasoning or solving problems without predetermined procedures.

Although CTL produced significant gains in conceptual understanding, the study acknowledges limitations that may affect the generalizability of results. The study focused on a single elementary school and involved a relatively small sample size. As Creswell (2018) points out, quasi-experimental designs with limited samples may restrict the applicability of findings to broader populations. Future research across different grade levels and diverse school contexts may provide deeper insights into how CTL influences various mathematical domains.

Despite these limitations, the study provides strong empirical support for the integration of CTL in mathematics instruction. The results illustrate that CTL not only enhances conceptual understanding but also fosters critical thinking, collaboration, and real-world application. These outcomes are closely aligned with 21st-century learning goals, which emphasize meaningful learning and complex problem-solving skills.

Practically, the research implies that elementary school teachers should adopt more contextual approaches when teaching mathematical concepts. Training programs should emphasize CTL implementation strategies, such as designing real-world tasks, facilitating inquiry, and using authentic assessments. School administrators may also consider allocating more time for collaborative planning and providing instructional materials that support contextual learning activities. These recommendations align with Anderson's (2021) argument that effective education reforms require systemic support and institutional commitment.

Overall, this study contributes to the growing body of evidence that CTL is an effective pedagogical approach for mathematics learning in elementary education. By positioning learners within meaningful contexts and encouraging active engagement, CTL helps develop robust conceptual foundations that are essential for advanced mathematical learning. The strong performance of the experimental group underscores the importance of instructional methods that prioritize relevance, inquiry, and student-centered learning.

The results of this study also highlight that CTL contributes to strengthening students' metacognitive awareness, a factor crucial in understanding abstract mathematical structures. When learners are prompted to relate new knowledge to prior experiences and articulate their thought processes during group discussions, they engage in essential monitoring and regulating activities. According to Zimmerman (2020), metacognitive engagement is a strong predictor of conceptual mastery, particularly in mathematics. Thus, the observed improvement in reasoning and explanatory clarity among the experimental group can also be understood as an outcome of enhanced metacognitive functioning cultivated through CTL's reflective components.

Another important implication emerges from the cooperative learning aspect inherent in CTL. The experimental group's significant performance improvement suggests that peer interaction played a crucial role in facilitating conceptual negotiation and error correction. Vygotskian perspectives affirm that social mediation enables learners to co-construct meaning, particularly when dealing with challenging cognitive tasks (Daniels, 2017). In this study, group problem-solving activities provided students with opportunities to externalize misconceptions, compare strategies, and refine their conceptual understanding collaboratively. This social dimension of CTL appears to be a key mechanism supporting the observed learning gains.

Furthermore, the integration of real-world contexts in CTL played an instrumental role in bridging abstract mathematical concepts with concrete experiences. Mathematics often becomes a source of difficulty when learners perceive it as disconnected from daily life. By situating learning in meaningful scenarios, such as measurement tasks linked to everyday objects or fractional reasoning connected to familiar activities, students formed stronger conceptual anchors. This finding is consistent with Deweyan views on experiential learning, which emphasize contextualized problem-solving as essential for

deep comprehension (Noddings, 2021). Such contextual grounding likely facilitated the transfer of knowledge to new and varied mathematical situations.

The study also reveals that CTL encourages greater cognitive persistence, especially when students encounter complex or unfamiliar mathematical problems. Conventional instruction often leads to passive engagement, while CTL requires students to explore, test, and justify their thinking through iterative reasoning. According to Hiebert and Grouws (2019), productive struggle nurtures deeper conceptual networks because students must reconcile their initial ideas with evidence derived from exploration. Observations in this study indicated that students in the CTL group persisted longer and were more willing to attempt multiple solution strategies, contributing to their higher conceptual test scores.

An additional contribution of this research is the insight it provides into teacher roles within CTL-based instruction. Instead of functioning as a sole transmitter of knowledge, the teacher acts as a facilitator who guides inquiry, prompts reasoning, and provides scaffolding when necessary. Such a pedagogical transformation aligns with constructivist models emphasizing learner autonomy and teacher mediation (Richardson, 2020). The significant improvement in students' conceptual scores suggests that teacher facilitation, when aligned with CTL principles, creates a supportive environment that empowers students to construct meaning independently while maintaining instructional coherence.

Finally, this study's findings suggest broader implications for curriculum development in mathematics education. The success of CTL indicates that curriculum designers should incorporate contextualized activities, interdisciplinary connections, and inquiry-based tasks that mirror real-life problem conditions. The strong improvement observed in the experimental group also signals that CTL can help close conceptual learning gaps commonly reported in elementary mathematics. By embedding CTL principles into mathematics curricula, schools may promote more equitable learning outcomes and foster long-term mathematical literacy essential for higher-level education.

CONCLUSION

The findings of this study demonstrate that the Contextual Teaching and Learning (CTL) approach has a significant and positive influence on elementary students' conceptual understanding in mathematics. Students who learned through CTL showed higher posttest scores, greater normalized gains, and more accurate conceptual representations compared with those taught using conventional instruction. These results suggest that when mathematical ideas are linked to real-life contexts, explored collaboratively, and reconstructed through reflective processes, students develop deeper and more durable conceptual comprehension. The CTL approach effectively supports learners in organizing knowledge meaningfully, constructing mathematical relationships, and applying concepts flexibly to novel situations. The results further underscore that the improvement achieved through CTL is not merely statistical but also pedagogically meaningful. Students in the experimental group demonstrated enhanced reasoning, stronger justification of procedures, and improved ability to articulate underlying mathematical principles. These outcomes reaffirm existing theories highlighting that contextualized instruction strengthens cognitive engagement and promotes meaningful learning.

Moreover, CTL fosters student autonomy, encourages active participation, and cultivates a learning environment in which mathematical concepts become relevant and accessible. Given these findings, the implementation of CTL can be recommended for mathematics instruction in elementary schools as an alternative to lecture-based teaching. Teachers are encouraged to integrate real-life scenarios, cooperative learning structures, and reflective activities into their mathematics lessons. Future research may extend this study by examining long-term retention, exploring CTL's effects across diverse mathematical domains, and analyzing its impact on different student ability levels. Overall, CTL presents

a promising pedagogical approach for improving conceptual understanding and enriching mathematics learning experiences in primary education.

REFERENCES

Arikunto, S. (2002). Prosedur Penelitian. Bandung: Rineka Cipta.

Dasopang, M. D., Lubis, A. H., & Dasopang, H. R. (2022). How do Millennial Parents Internalize Islamic Values in Their Early Childhood in the Digital Era? AL-ISHLAH: Jurnal Pendidikan, 14(1), 697–708.

Dasopang, M. D., Nasution, I. F. A., & Lubis, A. H. (2023). The Role of Religious and Cultural Education as A Resolution of Radicalism Conflict in Sibolga Community. HTS Theological Studies, 79(1), 1–7.

Elisyah, Nur, Islami Fatwa, Dinda Adha Hutabarat, and Zaharatul Humaira. 2024. "Pelatihan Gamifikasi: Implementasi Permainan Edukatif Untuk Meningkatkan Kualitas Pembelajaran Di SD Swasta Srikandi Lhokseumawe." PUSAKA: Jurnal Pengabdian Masyarakat 1(2):29–37. doi:10.62945/pusaka.v1i2.164.

Erawadi, E., Hamka, H., & Juliana, F. (2017). The Analysis of Student's Stressed Syllables Mastery at Sixth Semester of TBI in IAIN Padangsidimpuan. English Education: English Journal for Teaching and Learning, 5(1), 44–57.

Fatimah, A., & Maryani, K. (2018). Visual Literasi Media Pembelajaran Buku Cerita Anak. Jurnal Inovasi Teknologi Pendidikan, 5(1), 61–69. https://doi.org/10.21831/jitp.v5i1.16212

Gogahu, D. G. S., & Prasetyo, T. (2020). Pengembangan Media Pembelajaran Berbasis E-Bookstory untuk Meningkatkan Literasi Membaca Siswa Sekolah Dasar. Jurnal Basicedu, 4(4), 1004–1015.

Hamka, H. (2023). The Role of Principals on Teacher Performance Improvement in a Suburban School. QALAMUNA: Jurnal Pendidikan, Sosial, Dan Agama, 15(1), 371–380.

Hamka, H., Suen, M.-W., Anganthi, N. R. N., Haq, A. H. B., & Prasetyo, B. (2023). The Effectiveness of Gratitude Intervention in Reducing Negative Emotions in Sexual Abuse Victims. Psikohumaniora: Jurnal Penelitian Psikologi, 8(2), 227–240.

Harahap, S. M., & Hamka, H. (2023). Investigating the Roles of Philosophy, Culture, Language and Islam in Angkola's Local Wisdom of 'Dalihan Na Tolu.' HTS Teologiese Studies/Theological Studies, 79(1), 8164.

Hendrawati, S., Rosidin, U., & Astiani, S. (2020). Perilaku hidup bersih dan sehat (PHBS) siswa/siswi di sekolah menengah pertama negeri (SMPN). Jurnal Perawat Indonesia, 4(1), 295–307. https://doi.org/https://doi.org/10.32584/jpi.v4i1.454

Lubis, A. H., Dasopang, M. D., Ramadhini, F., & Dalimunthe, E. M. (2022). Augmented Reality Pictorial Storybook: How does It Influence on Elementary School Mathematics Anxiety? Premiere Educandum: Jurnal Pendidikan Dasar Dan Pembelajaran, 12(1), 41–53.

Lubis, A. H., Yusup, F., Dasopang, M. D., & Januariyansah, S. (2021). Effectivity of Interactive Multimedia with Theocentric Approach to the Analytical Thinking Skills of Elementary School Students in Science Learning. Premiere Educandum: Jurnal Pendidikan Dasar Dan Pembelajaran, 11(2), 215–226.

Manshur, U., & Ramdlani, M. (2019). Media audio visual dalam pembelajaran PAI. Al-Murabbi:Jurnal Pendidikan Agama Islam, 5(1), 1–8.

Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. Lectura: Jurnal Pendidikan, 12(1), 29–40.

Ningsih, Y. S., Mulia, M., & Lubis, A. H. (2023). Development of Picture Storybooks with TheoAnthropoEco Centric Approach for Elementary School Students. AL-ISHLAH: Jurnal Pendidikan, 15(2), 1888–1903.

Nurhidayah, I., Asifah, L., & Rosidin, U. (2021). Pengetahuan , Sikap dan Perilaku Hidup Bersih dan Sehat pada Siswa Sekolah Dasar. 13(1), 61–71. https://doi.org/10.32528/ijhs.v13i1.4864

Pebtiyanti, I., Ahmad, A., Dzaky, M., Fauziah, S. N., Rendi, & Puspitasari, P. (2023). Peran kurikulum merdeka dalam meningkatkan harmonisasi antara masyarakat dan sekolah. Jurnal Pacu Pendidikan Dasar, 3(1), 269–277. https://doi.org/https://doi.org/10.22021/pacu.v3i1.411

Putra, Meiyaldi Eka, Fajar Maulana, Ramanda Rizky, and Islami Fatwa. 2023. "Peningkatan Hasil Belajar Mahasiswa Menggunakan Model Perkuliahan Problem Based Instruction (PBI) Mata Kuliah Gambar Teknik." Jurnal Pendidikan Teknik Mesin 10(1):22–30. doi:10.36706/jptm.v10i1.20850.

Rahmah, S., & Lubis, A. H. (2024). Problem Posing as a Learning Model to Improve Primary School Students' Mathematics Learning Outcomes in Gayo Lues. Journal of Indonesian Primary School, 1(4), 93–104.

Rahman, A., Munandar, S. A., Fitriani, A., Karlina, Y., & Yumriani. (2022). Pengertian Pendidikan, Ilmu Pendidikan dan Unsur-Unsur Pendidikan. Al Urwatul Wutsqa: Kajian Pendidikan Islam, 2(1), 1–8.

Ranisa, R., Erawadi, E., & Hamka, H. (2018). Students' Mastery in Identifying Adverbs at Grade VIII SMPN 2 Batang Toru Tapanuli Selatan. ENGLISH EDUCATION JOURNAL: English Journal for Teaching and Learning, 6(2), 241–252.

Ricardo, R., & Meilani, R. I. (2017). Impak Minat dan Motivasi Belajar terhadap Hasil Belajar Siswa. Jurnal Pendidikan Manajemen Perkantoran (JPManper), 2(2), 188–201.

Santi, Undang, & Kasja. (2023). Peran Guru PAI dalam Membentuk Karakter Peserta Didik di Sekolah. Jurnal Pendidikan Tambusai, 7(2), 16078–16084. https://doi.org/https://doi.org/10.31004/jptam.v7i2.8918

Sinaga, Nurul Afni, Fitri Ayu Ningtiyas, Rifaatul Mahmuzah, Yulia Zahara, and Islami Fatwa. 2023. "The Effect of Deductive-Inductive Learning Approach on Creative Thinking Ability and Learning Motivation." Journal of Educational Research and Evaluation 6(2):123–34. doi:10.24114/paradikma.v16i2.46952.

Siraj, S., M. Yusuf, I. Fatwa, F. Rianda, and M. Mulyadi. 2023. "Pengembangan Model Pembelajaran Reflektif Berbasis Unity of Sciences Bagi Calon Guru Sekolah Menengah Kejuruan Profesional." Jurnal Review Pendidikan Dan Pengajaran (JRPP) 6(4):2030–38.

Siregar, N., & Siregar, R. S. (2025). Analysis of numeracy literacy of junior high school students in AKM questions: Learning strategies based on higher order thinking skills at SMP Negeri 5 Tapung Hilir. Jurnal Profesi Guru Indonesia, 2(1), 359–367. https://doi.org/10.62945/jpgi.v2i1.720

Siregar, R. S. (2024). Fiqhu Al-Akbār: Taḥqī An-Naṣ Wa Taḥlīlu'Afkārihi. UIN Ar-Raniry Fakultas Adab dan Humaniora.

Siregar, R. S. (2024). Students' Preferences for Varied Learning Methods: An Empirical Study of the Effectiveness and Appeal of Diverse Instructional Approaches. Jurnal

Profesi Guru Indonesia, 1(2), 140–152. https://doi.org/https://doi.org/10.62945/jpgi.v1i2.679

Siregar, R. S. (2025). The Influence of Social Media as a Learning Resource on the Academic Behavior of Junior High School Adolescents. KOGNITIF: Jurnal Ilmiah Pendidikan Dan Keguruan, 2(1), 21–28.

Siregar, R. S. (2025a). Arabic Language Learning Culture in Salaf Islamic Boarding Schools: An Ethnographic Study of Linguistic Punishment Practices and Traditions. ETNOPEDAGOGI: Jurnal Pendidikan Dan Kebudayaan, 2(2), 1–9. https://doi.org/https://doi.org/10.62945/etnopedagogi.v2i2.722

Siregar, R. S. (2025b). Evaluation of the Implementation of the Reading Literacy Program at SD Negeri 100190 Tarutung Bolak. Journal of Indonesian Primary School, 2(1), 240–250. https://doi.org/https://doi.org/10.62945/jips.v2i1.723

Siregar, R. S. (2025c). Improving the Arabic Writing Skills of Students through the Application of Contextual Learning Methods at Dayah Irsyadul Abidin Qurani. Indonesian Journal of Education and Social Humanities, 2(1), 358–369. https://doi.org/https://doi.org/10.62945/ijesh.v2i1.726

Siregar, R. S. (2025d). Principles of Subject-Based Arabic Curriculum Development: Language Skills Integration and Contextual Relevance. DEEP LEARNING: Journal of Educational Research, 1(2), 56–67. https://doi.org/https://doi.org/10.62945/deeplearning.v1i2.229

Siregar, R. S. (2025e). Students' Cognitive Difficulties in Mastering the Nahwu Rules: A Descriptive Study at SMP IT Al Farabi Bilingual Scool. Jurnal Cendekia Islam Indonesia, 1(2), 10–20. https://doi.org/https://doi.org/10.62945/jcii.v1i2.216

Sugiyono. (2018). Metode Penelitian Kuantitatif Kualitatif dan R&D. Bandung: Alfabeta.