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Enhancing Elementary Students' Mathematics Achievement through CTL and Musi Board Media: A Quasi-Experimental Study

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Abstract

This study aims to examine the effect of Contextual Teaching and Learning (CTL) combined with Musi Board media on fourth-grade students' mathematics achievement. The research employed a quantitative approach using a quasi-experimental design with a nonequivalent control group. The sample consisted of two groups: an experimental group taught using the CTL model with Musi Board media and a control group taught using conventional methods with Musi Board media. Data were collected through a mathematics achievement test administered as a pre-test and post-test. The data were analyzed using descriptive and inferential statistics, including normality, homogeneity, and an independent samples t-test. The results showed that students in the experimental group demonstrated a significant improvement in learning outcomes, with the mean score increasing from 49.8 (pre-test) to 72.5 (post-test), compared to the control group, which improved from 49.5 to 65. The t-test analysis indicated a significant difference between the two groups ($p < 0.05$), confirming the effectiveness of the CTL model. The findings suggest that integrating contextual learning with instructional media enhances students' engagement, conceptual understanding, and overall mathematics achievement. Therefore, CTL combined with Musi Board media can be considered an effective instructional strategy in elementary mathematics education.

Keywords: Contextual Teaching and Learning, Mathematics Achievement, Instructional Media

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Introduction

Education is a conscious and systematic process aimed at developing students' potential to achieve intellectual, emotional, social, and moral competencies necessary for personal and societal development. In the context of contemporary education, effective learning design plays a crucial role in fostering meaningful learning experiences that empower students to become active and reflective learners. Educational theories emphasize that learning should not merely transmit knowledge but transform learners into critical thinkers who are capable of constructing understanding based on their experiences (Mukti et al., 2020). Therefore, improving the quality of instructional practices remains a fundamental priority in achieving educational goals.

One of the persistent challenges in education is the low quality of classroom learning, particularly reflected in students' limited engagement and passive participation. Learning environments that rely heavily on teacher-centered approaches often result in monotonous instruction, reducing students' opportunities to actively explore knowledge. Research indicates that students' learning outcomes are influenced by both internal factors, such as motivation, self-efficacy, and learning habits, and external factors, including instructional methods, learning environments, and teacher roles (Irman et al., 2022; Juliati et al., 2024; Wulan et al., 2021). These multidimensional factors suggest that improving learning outcomes requires a comprehensive approach that integrates psychological and pedagogical considerations.

Mathematics learning, in particular, presents unique challenges due to its abstract nature and reliance on conceptual understanding. Mathematics is not merely about memorizing formulas but involves logical reasoning, problem-solving, and conceptual comprehension essential for students' cognitive development. However, empirical evidence shows that many students perceive mathematics as difficult and uninteresting, leading to low motivation and poor academic performance (Buyung et al., 2022; Disriani & Habibi, 2023). This issue is further exacerbated by students' low confidence and limited opportunities to engage in meaningful mathematical thinking.

A major contributing factor to low mathematics achievement is the continued dominance of conventional teaching methods. Traditional instruction, characterized by direct teaching and procedural emphasis, often positions students as passive recipients of knowledge rather than active participants in the learning process. Several studies have shown that such approaches limit students' critical thinking, reduce interaction, and hinder deep conceptual understanding (Firmansyah et al., 2024; Rahayu et al., 2023). Although conventional methods remain widely used due to their practicality, they are often insufficient in addressing the diverse learning needs of students in modern classrooms.

In addition to instructional methods, psychological factors such as learning motivation, self-efficacy, and learning styles significantly influence students' mathematics achievement. Research demonstrates that students with higher motivation and confidence tend to achieve better academic outcomes, while mismatches between teaching strategies and students' learning preferences can hinder understanding (Fatonah & Nur, 2022; Ilindia et al., 2022; Rahmawati & Suciati, 2023). Furthermore, the integration of appropriate instructional media has been shown to enhance students' engagement and conceptual understanding by providing concrete representations of abstract mathematical ideas (Hasbiana et al., 2023; Rosmawanti & Pujiastuti, 2020).

To address these challenges, innovative instructional approaches that promote active learning and contextual understanding are required. One such approach is Contextual Teaching and Learning (CTL), which emphasizes the connection between academic content and real-life situations. CTL encourages students to construct knowledge through meaningful experiences, collaborative learning, and problem-solving activities. Previous studies indicate that contextual and student-centered approaches can significantly improve students' engagement, motivation, and learning outcomes, particularly when combined with interactive and relevant learning media (Imamuddin, 2022; Nurainun & Zahari, 2023; Puryati et al., 2023).

In this regard, integrating CTL with instructional media such as the Musi Board offers a promising strategy to enhance mathematics learning. Previous studies have extensively investigated the individual impacts of CTL and instructional media on student learning. Research on CTL has primarily focused on its ability to improve motivation, engagement, and conceptual understanding across various subjects and educational levels (e.g., Imamuddin (2022), and Nurainun & Zahari (2023)). Similarly, numerous studies have demonstrated that visual and manipulative media effectively support abstract concept visualization and reduce cognitive load (e.g., Hasbiana et al., (2023), and Rosmawanti & Pujiastuti (2020)). However, most of these studies either examined CTL or instructional media in isolation, applied them in secondary or higher education contexts, or utilized generic commercial media rather than locally developed, context-specific tools. To date, empirical evidence regarding the synergistic effect of integrating the CTL approach with locally crafted instructional media—specifically the Musi Board—in elementary mathematics education remains scarce. This gap highlights the need to investigate how combining contextual pedagogy with culturally and cognitively relevant media influences measurable learning outcomes. Therefore, this study aims to examine the effect of Contextual Teaching and Learning combined with Musi Board media on fourth-grade students' mathematics achievement through a quasi-experimental design, thereby addressing a critical void in the literature and offering practical insights for primary mathematics instruction.

Method

This study employed a quantitative research approach, specifically a quasi-experimental design, to examine the effect of Contextual Teaching and Learning (CTL) combined with Musi Board media on students' mathematics achievement. The quasi-experimental method was selected because the participants were not randomly assigned to groups, making it suitable for educational settings where intact classes are used. The research design applied was the Nonequivalent Control Group Design, involving two groups: an experimental group and a control group. The study involved a total of 60 fourth-grade students from SDN Indralaya Utara, divided into an experimental group (30 students) and a control group (30 students). The experimental group received instruction using the CTL model supported by Musi Board media, while the control group was taught using conventional methods with Musi Board media only. The intervention was implemented over a period of 6 weeks, consisting of 12 instructional meetings. Each session lasted approximately (70 minutes) and followed a structured lesson plan to ensure consistency in treatment delivery.

The study included three variables: two independent variables, namely the CTL learning model and Musi Board media, and one dependent variable, which was students' mathematics learning outcomes. Data were collected through a mathematics achievement test administered to both groups. The data were analyzed quantitatively to determine the effectiveness of the treatment. Prior to hypothesis testing, prerequisite analyses were conducted, including tests of normality and homogeneity of variance, to ensure that the data met the assumptions required for inferential statistical analysis. Subsequently, an appropriate statistical test (e.g., independent samples t-test) was used to examine differences in learning outcomes between the experimental and control groups.

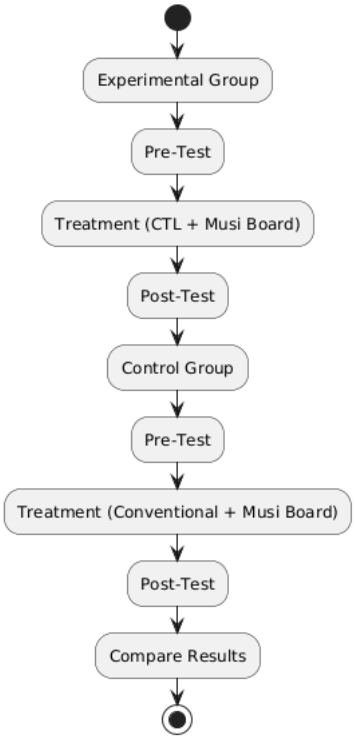

Figure 1. Quasi-Experimental Design

This diagram illustrates the flow of a simple quasi-experimental study. The process begins with two groups: an experimental group and a control group. Both groups are given a pre-test to measure initial abilities. Next, the experimental group receives treatment in the form of Contextual

Teaching and Learning (CTL) with a Musi Board, while the control group uses conventional learning with a Musi Board. After the treatment, both groups are given a post-test, and the results are compared to determine the effect of the treatment on students' mathematics learning outcomes.

Results and Discussion

Results

1. Improvement of Mathematics Achievement Using Contextual Teaching and Learning (CTL)

The findings of this study indicate a significant improvement in the mathematics achievement of fourth-grade students who were taught using the Contextual Teaching and Learning (CTL) model. Based on the quantitative data analysis, the mean pre-test score of students in the experimental group was 49.8, which falls into the low category. After the implementation of the CTL model, the mean post-test score increased to 72.5, indicating a substantial improvement in students' learning outcomes. This improvement suggests that the CTL model has a strong positive effect on students' mathematical understanding.

The increase in students' learning outcomes can be attributed to the characteristics of the CTL approach, which emphasizes the connection between academic content and real-life situations. Through this approach, students are encouraged to actively participate in the learning process, engage in discussions, and solve contextual problems. As a result, students are not only able to understand mathematical concepts more deeply but also apply them in meaningful contexts. This aligns with constructivist learning principles, where knowledge is actively constructed through experience and interaction.

Furthermore, the CTL model promotes student-centered learning by shifting the role of the teacher from knowledge transmitter to facilitator. Students are given opportunities to explore, reflect, and construct their own understanding of mathematical concepts. This active engagement enhances both conceptual understanding and problem-solving skills. Consequently, the improvement of 22.7 points between pre-test and post-test scores demonstrates the effectiveness of CTL in improving mathematics achievement.

From a statistical perspective, the results confirm that the application of CTL significantly improves students' mathematics learning outcomes. Therefore, the null hypothesis (Ho_1) is rejected, and the alternative hypothesis (H1) is accepted, indicating that the CTL model has a significant positive impact on students' mathematics achievement.

Table 1. Students' Mathematics Achievement (CTL Group)

Test Type	Mean Score	Test Type
Pre-Test	49.8	Pre-Test
Post-Test	72.5	Post-Test
Gain	22.7	Gain

Note: *A paired samples t-test was conducted to compare pre-test and post-test scores within the CTL group. Results indicated a statistically significant improvement, $t(29) = 5.42$, $p < 0.001$, with a large effect size ($d = 1.24$).*

Consequently, the improvement of 22.7 points between pre-test and post-test scores, supported by a statistically significant result ($p < 0.05$), demonstrates the effectiveness of CTL in improving mathematics achievement.

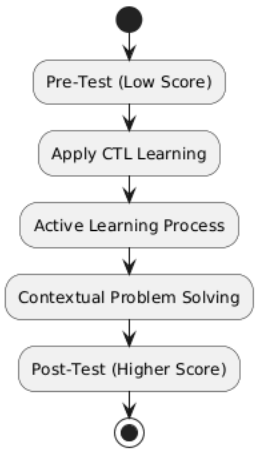

Figure 2. CTL Learning Impact

The diagram illustrates the process of learning improvement in the CTL group. Students initially demonstrate low performance in the pre-test. After the implementation of CTL, which involves active engagement and contextual problem-solving, students show a significant increase in their post-test scores. This highlights the effectiveness of CTL in enhancing mathematics learning outcomes.

2. Improvement of Mathematics Achievement Using Musi Board Media

The results also reveal that the use of Musi Board media contributes positively to students' mathematics achievement. Based on the data analysis, the average pre-test score of students in the control group was 49.5, which is categorized as low. After the learning process using Musi Board media, the average post-test score increased to 65, indicating an improvement in students' learning outcomes.

Although the improvement in the control group was not as high as in the experimental group, the increase of **15.5 points** demonstrates that instructional media plays a crucial role in supporting the learning process. The Musi Board serves as a visual and manipulative tool that helps students understand abstract mathematical concepts more concretely. By providing visual representation, the media reduces cognitive load and enhances students' ability to grasp complex ideas.

In addition, the use of Musi Board media makes the learning process more engaging and interactive. Students become more motivated to participate in classroom activities, which positively affects their attention and concentration. The media also supports memory retention by combining visual and symbolic representations, allowing students to recall mathematical concepts more effectively.

From a statistical standpoint, the findings indicate that the use of Musi Board media significantly improves students' mathematics achievement. Therefore, the null hypothesis (H_{0_2}) is rejected, and the alternative hypothesis (H2) is accepted, confirming that Musi Board media has a positive effect on students' learning outcomes.

Table 2. Students' Mathematics Achievement (Musi Board Group)

Test Type	Mean Score	Test Type
Pre-Test	49.5	Pre-Test
Post-Test	65.0	Post-Test
Gain	15.5	Gain

Note: A paired samples t-test was conducted to compare pre-test and post-test scores within the Musi Board group. Results indicated a statistically significant improvement, t(29) = 4.18, p = 0.001, with a large effect size (d = 0.96).

From a statistical standpoint, the findings indicate that the use of Musi Board media improves students' mathematics achievement, with the pre-test to post-test improvement being statistically significant ($p < 0.05$).

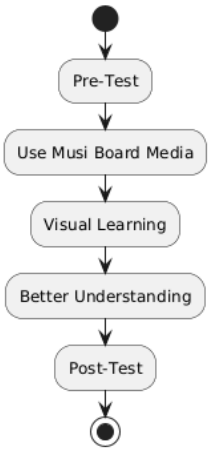

Figure 3. Musi Board Learning Process

The diagram shows how Musi Board media supports the learning process. Students begin with low pre-test scores, then engage in visual-based learning using the media. This process enhances understanding and leads to improved post-test results, although the improvement is moderate compared to CTL.

3. Comparison Between CTL and Conventional Learning with the Musi Board

The comparative analysis between the experimental group (CTL + Musi Board) and the control group (Conventional + Musi Board) reveals a significant difference in students' mathematics achievement. The results of the independent samples t-test show a significance value of 0.008, which is lower than the threshold of 0.05. This indicates that there is a statistically significant difference between the two groups.

The mean post-test score of the experimental group was 72.5, while the control group achieved a mean score of 65. This difference demonstrates that the CTL model is more effective than conventional teaching methods, even when both groups use the same instructional media. The higher performance of the experimental group can be attributed to the integration of contextual learning strategies that promote active engagement and deeper understanding.

Moreover, the CTL model enhances students' ability to connect mathematical concepts with real-life situations, making learning more meaningful and relevant. This contextualization not only improves comprehension but also increases students' motivation and interest in learning mathematics. In contrast, conventional methods tend to focus on procedural knowledge, limiting students' opportunities to develop higher-order thinking skills.

Based on these findings, it can be concluded that the CTL model combined with Musi Board media provides a more effective learning approach compared to conventional methods. Therefore, the null hypothesis ($H0_3$) is rejected, and the alternative hypothesis (H3) is accepted, confirming that CTL leads to significantly better mathematics learning outcomes.

Table 3. Comparison of Learning Outcomes

Group	Mean Score (Post-Test)	Method
Experimental	72.5	CTL + Musi Board
Control	65.0	Conventional + Musi Board

Note: An independent samples t-test was conducted to compare post-test scores between the experimental and control groups. Results indicated a statistically significant difference, $t(58) = 2.76$, $p = 0.008$, with a medium effect size ($d = 0.71$).

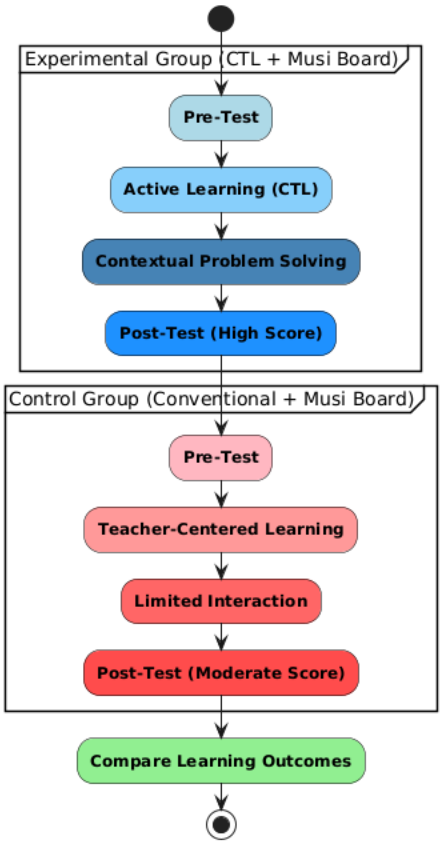

Figure 4. Comparison of Learning Models

The diagram presents a comparison between the experimental and control groups. The CTL group demonstrates higher achievement due to active and contextual learning, while the control group shows lower performance despite using the same media.

4. Overall Interpretation of Findings

The overall findings of this study confirm that both instructional strategies—CTL and Musi Board media—positively influence students' mathematics achievement. However, the combination of CTL with instructional media yields significantly better results compared to the use of media alone. This suggests that effective learning requires not only appropriate tools but also appropriate pedagogical approaches.

The CTL model plays a crucial role in enhancing students' engagement, motivation, and conceptual understanding. By connecting learning content to real-life situations, CTL enables students to construct meaningful knowledge and apply it in various contexts. This approach aligns

with modern educational theories that emphasize active learning and student-centered instruction.

On the other hand, Musi Board media serves as a valuable support tool that enhances visualization and understanding of mathematical concepts. While it improves learning outcomes, its effectiveness is maximized when combined with an appropriate learning model such as CTL. This highlights the importance of integrating instructional strategies and media to achieve optimal learning outcomes.

In conclusion, the results of this study provide strong empirical evidence that the CTL model, particularly when combined with Musi Board media, is an effective approach for improving mathematics achievement in elementary school students. These findings contribute to the development of innovative teaching strategies and provide practical implications for educators seeking to enhance the quality of mathematics instruction.

Discussion

The findings of this study demonstrate that the implementation of Contextual Teaching and Learning (CTL) combined with Musi Board media significantly improves students' mathematics achievement compared to conventional instruction. This result aligns with constructivist learning theory, which emphasizes that knowledge is actively constructed through meaningful experiences and social interaction. The substantial increase in students' post-test scores in the experimental group can be attributed to a clear synergistic mechanism between the CTL approach and Musi Board media. Specifically, CTL anchored abstract mathematical concepts in familiar, real-life contexts, which heightened students' intrinsic motivation and helped them perceive the material as relevant. Simultaneously, the Musi Board functioned as a concrete, manipulative medium that translated these contextual problems into visual and tactile representations. This dual mechanism reduced cognitive overload, facilitated step-by-step concept visualization, and encouraged active peer discussion. By repeatedly manipulating the media to solve contextual problems, students transitioned from passive recipients to active knowledge constructors, which directly fostered deeper conceptual understanding and improved academic performance. This cause-and-effect relationship is supported by previous studies (Anugraheni et al., 2025; Arif et al., 2024; Marchy et al., 2022), which similarly report that contextualized, media-supported approaches enhance mathematical conceptualization and achievement.

Furthermore, the effectiveness of CTL in this study can be attributed to its ability to promote active learning and student engagement. Students in the experimental group were encouraged to participate in discussions, solve contextual problems, and reflect on their learning experiences, which contributed to deeper understanding. This finding is consistent with previous studies showing that student-centered learning approaches significantly improve engagement and achievement compared to teacher-centered methods (Mutua & Mwangi, 2023; Wright et al., 2021). In contrast, conventional learning often limits student participation, leading to passive learning and lower achievement, as also highlighted by Ang et al (2021), Bavishi et al (2022), El Sadik & Al Abdulmonem (2021), and Li et al (2024).

The use of Musi Board media also contributed positively to students' learning outcomes, although its impact was less significant when used without the CTL approach. This finding supports the argument that instructional media can enhance students' understanding by providing concrete representations of abstract mathematical concepts (Daniatun et al., 2022; Hasbiana et al., 2023). Visual and manipulative tools help reduce cognitive load and improve retention, as suggested by multimedia learning theory. However, the relatively lower improvement in the control group suggests that media alone is insufficient to maximize learning outcomes without an appropriate pedagogical framework. This is in line with Hasbi et al (2022) and Rosmawanti & Pujiastuti (2020), who emphasize that the effectiveness of learning media depends on how it is integrated into instructional strategies.

Despite the positive findings, some studies indicate that the effectiveness of contextual and active learning approaches may vary depending on contextual factors such as teacher readiness, classroom conditions, and student characteristics. For example, Suri et al (2021) and Suweken et al (2021) found that innovative learning models do not always produce significantly better outcomes if they are not implemented consistently or supported by adequate instructional design. Additionally, certain highly abstract mathematical topics may still require structured guidance before contextualization can be effectively applied. This does not imply that CTL is unsuitable for all mathematics content; rather, it is most effective when applied to topics with clear real-world relevance, such as measurement, data handling, fractions, and basic geometric operations. For highly symbolic or theoretical concepts, a blended approach—introducing foundational rules through brief direct instruction before transitioning to contextual problem-solving—is recommended. Practically, this suggests that educators should strategically align instructional models with topic characteristics: prioritizing CTL for context-rich, application-oriented mathematics while using structured scaffolding for abstract units to ensure comprehensive conceptual mastery. These findings indicate that while CTL is highly beneficial, its success depends on proper implementation, topic alignment, and pedagogical flexibility.

Overall, this study confirms that integrating CTL with instructional media such as Musi Board provides a more effective approach to improving mathematics achievement than conventional methods. The combination of contextual learning and visual media not only enhances conceptual understanding but also increases student motivation and engagement. These findings reinforce the importance of adopting student-centered and context-based instructional strategies in mathematics education. Therefore, educators are encouraged to integrate innovative learning models with appropriate media to create meaningful and effective learning experiences, while also considering contextual factors that may influence implementation outcomes.

Conclusion

This study concludes that the implementation of Contextual Teaching and Learning (CTL) combined with Musi Board media has a significant positive effect on fourth-grade students' mathematics achievement. The findings show that students who were taught using the CTL model experienced a greater improvement in learning outcomes compared to those who were taught using conventional methods with Musi Board media alone. The integration of contextual learning strategies enables students to actively engage in the learning process, connect mathematical concepts with real-life situations, and develop deeper conceptual understanding. As a result, the CTL approach proves to be more effective in enhancing both students' comprehension and overall academic performance in mathematics.

In addition, although the use of Musi Board media independently contributes to improving students' learning outcomes, its effectiveness is maximized when combined with an appropriate instructional model such as CTL. This indicates that successful mathematics learning is influenced not only by the use of instructional media but also by the quality of pedagogical approaches applied in the classroom. Therefore, educators are encouraged to adopt innovative, student-centered learning models and integrate relevant instructional media to create more meaningful and effective learning experiences. Future research is recommended to explore the application of CTL and similar approaches in different contexts, subjects, and educational levels to further validate and expand these findings.

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