Bulletin of Educational Management and Innovation
DOI: https://doi.org/10.56587/bemi.v4i1.139
E-ISSN: 2986-8688 | https://journal.rafandhapress.com/BEMI

The impact of contextual teaching and learning on elementary students' ability to solve mixed arithmetic word problems

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ABSTRACT

Background: The challenges of Mathematics learning in elementary schools include both the conceptual understanding and students capacity to solve a word problems. The solution can thus be through contextualised and meaningful models of learning that help students understand.

Purpose: This research aims to examine the effect of the Contextual Teaching and Learning (CTL) model on understanding concepts and solving story problems in mixed arithmetic operations.

Method: This study was an experimental study with unequal control group (52 students). Data were collected as result of the tests, and subsequently analyzed using the Wilcoxon test to verify any differences before and after treatment.

Findings: There was a statistical significant improvement in multiple areas after the CTL model has been initiated. The average conceptual understanding improved from 63.85 to 84.62 with p value0.000 (<0.05) Next, for the skill to solve mathematical problems gradually increased from 10.00 to 13.62 with a significancy value of 0.000 These results show that the CTL model has a very good effect on the development of students' conceptual understanding and mathematical problem solving abilities.

Article History
Received: 8 May 2026
Revised 1: 19 May 2026
Revised 2: 27 May 2026
Accepted: 28 May 2026

Keyword
Contextual Teaching and Learning (CTL); Conceptual Understanding; Problem Solving Skills; Mixed Arithmetic Operations.

How to cite:
Rahmawati, T., Sucipto, & Listiana, Y. (2026). The impact of contextual teaching and learning on elementary students' ability to solve mixed arithmetic word problems. *Bulletin of Educational Management and Innovation, 4*(1). 99-110. https://doi.org/10.56587/bemi.v4i1.139

INTRODUCTION

National education aims to enhance the skills, character, and cultural values of a respected nation to nurture its social fabric. Furthermore, this education helps students reach their fullest potential as devoted and responsible individuals (Law of the Republic of Indonesia Number 20 of 2003). Therefore, education is intended to cultivate a generation distinguished by both academic success and solid character based on flexibility (Alim et al., 2021; Hidayati et al., 2023). The educational system is structured into primary, secondary,

and higher levels, with primary education being the essential part (Noor, 2018). Basic education is a stage where pupils gain fundamental skills, knowledge, and ethical values, serving as a base for further academic pursuits. At this level, the focus of learning goes beyond simply mastering academic subjects; it also aims to enhance students' cognitive abilities and foster a positive attitude towards education (Nurwahidah, 2023).

Mathematics is a key subject in primary education due to its significant role in fostering logical, critical, and systematic thought processes (Li et al., 2025). The aim of mathematics instruction at the elementary stage is to enable students to grasp concepts thoroughly and utilize them in addressing real-world problems. A vital component of learning mathematics in elementary school involves the skill of solving word problems, especially those involving mixed arithmetic operations. These types of problems are crucial as they teach students to link mathematical ideas to real-life situations, enhance analytical thinking, and strengthen problem-solving skills. Additionally, tackling mixed arithmetic operation story problems requires students to not only grasp computation methods but also to have a thorough understanding of mathematical principles.

Nevertheless, the situation in classrooms shows that numerous elementary students still view mathematics as a challenging, uninteresting, and fear-inducing subject. This perception often leads to a lack of interest in learning and insufficient comprehension of mathematical concepts and skills (Saputra et al., 2022; Zahrah & Febriani, 2020). The challenges become more evident when students face mixed arithmetic operation story problems, as many struggle to interpret the questions, identify the right mathematical operations, and link the concepts correctly. An observation conducted in class II UPTD SDN Kebun 1 Kamal revealed similar issues. Only 9 out of 28 students managed to reach the minimum passing score (KKM), while the other 19 students did not fulfill the required standard. These low educational results indicate that students' understanding of concepts and their ability to solve mixed arithmetic operation story problems remain quite limited. This situation implies that students face challenges in connecting mathematical ideas to the issues they are presented with (Brinus et al., 2019).

This issue might adversely impact the future learning of students since math ideas are built on one another and connected. Insufficient understanding of basic concepts in elementary school may obstruct students when they try to grasp more complex mathematical ideas in higher education (Lestari et al., 2025). Additionally, struggles with solving word problems can also hinder the growth of critical thinking, analytical skills, and decision-making abilities, which are crucial both in academics and everyday life. One reason for this challenge is the limited application of creative learning models that cater to the needs of students. Traditional teaching methods tend to focus heavily on the teacher's role and procedural learning, leading students to take a passive role in their education.

Consequently, learners have fewer chances to actively build their understanding and relate what they learn to their real-world experiences (Peranginangin, A 2020; Dulyapit & Nurmala, 2025).

To tackle these challenges, an innovative and relevant learning approach is essential. One potentially effective model is the Contextual Teaching and Learning (CTL) model. CTL promotes students' active exploration of learning concepts and their connection to real-world situations. This method encourages students to not only memorize concepts but also to comprehend, articulate, and apply them in various scenarios (Budiman, 2021; Nababan, D., & Sipayung, C. A., 2023). By linking educational content to students' daily lives, CTL can enhance the learning experience and boost student involvement during math lessons.

Earlier research has consistently indicated that the Contextual Teaching and Learning (CTL) model positively influences math learning results, especially in enhancing students' engagement, understanding of concepts, and skills in solving math problems (Hefna Alkhila Saira Putri, 2025; Maulida et al., 2024). Many research efforts have pointed out that CTL fosters meaningful learning by linking mathematical ideas to students' real-life situations, which promotes a deeper understanding and greater involvement in the learning process (Dhani & Rahayu, 2023; Pellegrini et al., 2021). Furthermore, studies focused on math education in elementary schools suggest that contextual learning strategies can enhance students' grasp of concepts and their ability to tackle mathematical word problems more effectively.

However, conversations regarding prior studies are still quite narrow and have not offered a thorough overview that clearly illustrates the current state of research and existing gaps. A majority of current research leans towards general math performance or targets students at more advanced educational levels (Siswanto & Meiliasari, 2024), while empirical investigations specifically assessing the impact of the CTL model on understanding concepts and solving mixed arithmetic story problems in younger elementary students are still scarce (Susanti & Susanti, 2023). Moreover, there is a significant difference between the ideal scenarios for math learning, which should stress critical thinking and strong understanding of concepts, and the reality in elementary classrooms, where students' comprehension and problem-solving skills are often lacking. This gap highlights the necessity for learning methods that are more contextual and closely tied to the real experiences of students.

Thus, the uniqueness of this research stems from the targeted application of the Contextual Teaching and Learning (CTL) model aimed at enhancing not only the grasp of concepts but also the skills in solving story problems involving mixed arithmetic operations among younger elementary school pupils. In contrast to earlier research that broadly investigates CTL within wider mathematical educational frameworks, this research zeroes in on arithmetic learning for young students and concurrently examines how contextual

learning experiences correlate with conceptual understanding and proficiency in solving mathematical problems. This specialization is anticipated to offer both theoretical insights and practical advancements in creating innovative mathematical teaching methods for elementary education.

In light of the discovered research gap and the suggested innovation, this research utilized the Contextual Teaching and Learning (CTL) approach in math teaching to explore its possible impact on enhancing students' grasp of concepts and their skills in solving story problems involving mixed arithmetic operations. Therefore, the research was aimed at addressing the following questions: (1) Can the use of the CTL model boost students' understanding of concepts in mathematics learning? and (2) Does the CTL approach improve lower-grade elementary students' skills in solving story problems that require mixed arithmetic operations? These questions were designed to sharpen the study's focus and academic aim while making clear its contribution to advancing contextual strategies for teaching math in elementary education.

METHODS

This research used a quantitative method as it aimed to investigate how the Contextual Teaching and Learning (CTL) model affects students' understanding of concepts and their skills in solving story problems involving various arithmetic operations (Ritonga, Y. H., & Azis, Z., 2022). The quantitative method was seen as suitable because the research aimed to measure the relationship and impact among variables, evaluate research hypotheses, and analyze numerical information gathered from students' educational results with the help of statistical methods (Syahroni, M. I. 2022). Using this approach, the researcher could systematically assess how effective the CTL model was and deliver unbiased results based on the statistical analysis conducted. In addition, this research type used is experimental, where testing the application of the model Contextual Learning and analyze its influence on conceptual understanding and ability to solve word problem focused on mixed operation mathematics namely arithmetic operations in (Farhan Arib et al., 2024).

In experimental research studies dealing with information, it is a general challenge to establish two groups of truly equicalent characteristics (Jeheman, A. A., Gunur, B., & Jelatu, S., 2019). Thus, this study implemented an unequal control cadential design. In addition, this study used a pretest-posttest design in which pretests were carried out before the treatment and post-tests were conducted after the treatment allowing for better observation of changes (Abraham I, & Supriyati Yetti, 2022).

Population is a unit of broader research that consists of objects or subjects with certain characteristics, which were determined by the researcher, and on which they study and hold conclusions (Mushofa et al., 2024). The population in this study was a second-grade student

at UPTD SDN Kebun 1 Kamal, totaling 52 students consisting of class II A (26 students) and class II B (26 students). In addition, the sampling techniques use saturated sampling where all members of the population are used as research samples. So, this study population consisted of all the second-grade students where class II A as an experimental class and class II B as a control class.

An instrument that satisfied validity and reliability standard was utilized for data collection. An Instrument to Assess Conceptual Knowledge of the Mixed Arithmetic Operations and the Capacity for Solving Word Problems The researchers proposed an instrument based on literature review. Instruments: The study instrument was an 10 item multiple choice (MC) test measuring conceptual understanding (xc4nd0-3), and a 10 item essay (EE) test measuring the ability to solve word problems.

In this study the data analysis method used a nonparametric statistical test, Wilcoxon Signed Rank Test. This was examined to see the difference between group differences, meaning that it can give more specificity about the effects of treatments on student abilities pretest and posttest. A non-parametric test suitable for testing all potential associations was selected since this data failed to meet the assumptions of parametric tests.

RESULT AND DISCUSSION

Results

Students' Conceptual Understanding Before and After the Implementation of the CTL Model

This section shows the outcomes of students' grasp of concepts prior to and following the use of the Contextual Teaching and Learning (CTL) approach. The detailed statistics can be found in Table 1, and the differences between the scores from the pre-test and post-test are demonstrated in Figure 1.

Tabel 1.

Conceptual Understanding and Ability to Solve Mixed Arithmetic Operations Story Problems.

	N	Min	Max	Mean±SD
PRCU	26	50	80	63.85±9.414
PSCU	26	60	100	84.62±9.892
PRA	26	5	15	10.00±2.530
PSA	26	8	16	13.62±2.246

Table 1 presents the descriptive statistics of students' conceptual understanding and ability to solve mixed arithmetic operations story problems before and after the implementation of contextual teaching and learning. The results indicate an improvement in students' conceptual understanding, as reflected by the increase in the mean score from

63.85 in the pre-test (PRCU) to 84.62 in the post-test (PSCU). Similarly, students' ability to solve mixed arithmetic operations story problems also improved, with the mean score increasing from 10.00 in the pre-test (PRA) to 13.62 in the post-test (PSA).

In addition, the post-test scores showed higher minimum and maximum values compared to the pre-test scores, indicating better overall student performance after the intervention. The standard deviation values suggest that the distribution of scores remained relatively consistent across the pre-test and post-test results..

Figure 1.

Diagram of the Differences between Pre Post Conceptual Understanding and Solving Mixed Arithmetic Operations Story Problems

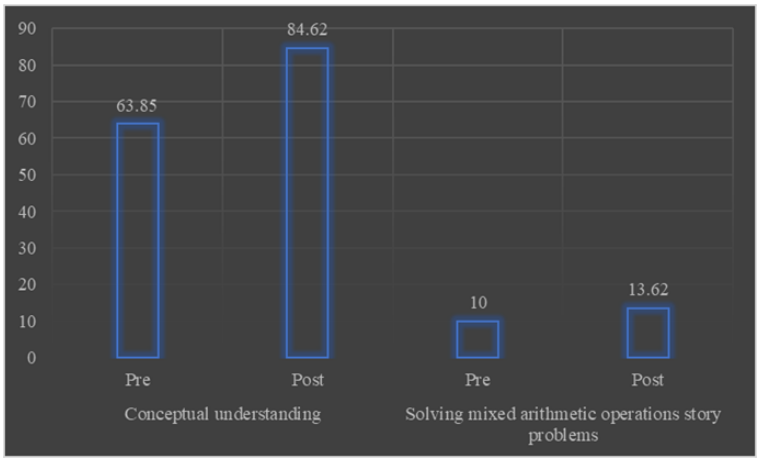

Figure 1 illustrates that learners' understanding of concepts rose following the use of the CTL model. The average score grew from 63.85 in the initial test to 84.62 in the final test, reflecting a rise of 20.77 points. Furthermore, the lowest score went up from 50 to 60, while the highest score increased from 80 to 100. These results suggest that the CTL model played a role in enhancing students' conceptual understanding in mathematics education.

To identify the suitable statistical method, a normality assessment was performed using the Shapiro-Wilk test, which is shown in Table 2.

Tabel 2.

Shapiro-Wilk results

	Sig. Shapiro-Wilk	Information
PRCU	0.007	Abnormal
PSCU	0.012	Abnormal
PRA	0.094	Normal
PSA	0.001	Abnormal

The normality test results indicate that most variables were not normally distributed because the significance values were below 0.05. Therefore, non-parametric statistical analysis was considered more appropriate for the data characteristics.

Tabel 3.

Wilcoxon Signed-Rank Test Results

Variable	Z	Asymp. Sig (2-tailed)	Information
Pre Conceptual Understanding – Post Conceptual Understanding	-4.437	0.000	Significant
Pre Solving – Post Solving	-4.274	0.000	Significant

According to table 3. the results of the Wilcoxon Signed-Rank Test, the significant value for understanding concepts was 0.000 ($p < 0.05$), showing a notable difference between the scores of the pre-test and post-test. These results highlight that using the CTL model greatly enhanced the students' understanding of concepts.

Students' Ability to Solve Mixed Arithmetic Operation Story Problems Before and After the Implementation of the CTL Model

This section examines the capability of students to tackle mixed arithmetic operation story problems before and after the use of the CTL model. The data summary shown in Table 1 and Figure 1 reveals an enhancement in students' problem-solving skills following the educational intervention.

The average score for addressing mixed arithmetic operation story problems rose from 10.00 in the initial test to 13.62 in the final test, reflecting an increase of 3.62 points. Additionally, the lowest score improved from 5 to 8, and the highest score also went up from 15 to 16. These findings suggest that students showed improved skills in recognizing, understanding, and addressing mathematical story problems after engaging in CTL-focused learning activities.

The results of the normality test in Table 2 indicated that one variable was normally distributed, while the others were not. Because the overall characteristics of the data did not entirely conform to the criteria for parametric tests, the Wilcoxon Signed-Rank Test was utilized.

According to Table 3, the Wilcoxon Signed-Rank Test yielded a significance value of 0.000 ($p < 0.05$) regarding students' skills in solving mixed arithmetic operation story problems. This outcome suggests a notable difference between the scores from the pre-test and the post-test following the application of the CTL model. Hence, the results indicate that the CTL model successfully enhanced students' ability to solve mixed arithmetic operation story problems in their mathematics studies.

Discussion

The findings indicate that the Contextual Teaching and Learning (CTL) model contributed positively to improving students' conceptual understanding and mathematical

problem-solving abilities (Yudha et al., 2019). The increase in post-test scores suggests that students were able to understand mathematical concepts more comprehensively after participating in contextual learning activities (Etyarisky & Marsigit, 2022). Through meaningful learning experiences, students not only followed procedural steps but also understood the underlying concepts involved in solving mathematical problems (Siregar et al., 2025). These findings are consistent with previous studies stating that conceptual understanding develops more effectively when students actively construct knowledge through direct learning experiences.

From a theoretical perspective, the results support constructivist learning theory, which emphasizes that knowledge is developed actively through interaction, exploration, and problem-solving activities (Mishra, 2023). The implementation of discussion-based and contextual learning activities enabled students to connect new information with their prior knowledge, thereby strengthening conceptual relationships and improving learning retention.

In addition, the use of contextual problems related to students' daily experiences appeared to enhance students' ability to solve mixed arithmetic operations story problems. Real-life problem situations helped students interpret mathematical concepts more concretely and apply them more flexibly (Basid, A., et al., 2024). This finding aligns with previous research indicating that contextual learning approaches can improve higher-order thinking skills, particularly problem-solving abilities (Hakim & Sari, 2022).

Another factor contributing to the improvement in learning outcomes was the structured and meaningful presentation of learning materials. Well-organized learning activities may reduce students' cognitive load and facilitate better understanding among both high-achieving and low-achieving students. Furthermore, the use of the Wilcoxon Signed-Rank Test was considered appropriate because the normality test results showed that most of the data were not normally distributed, thereby strengthening the validity of the statistical analysis.

Overall, the improvement in learning outcomes can be associated with several interconnected factors, including active student engagement, contextual relevance of learning materials, stronger conceptual connections, and meaningful instructional delivery. Therefore, the CTL model demonstrates potential as an effective learning approach for supporting conceptual understanding and mathematical problem-solving skills in elementary school students.

CONCLUSION

The findings of this study indicate that the implementation of the Contextual Teaching and Learning (CTL) model was associated with improvements in students' conceptual

understanding and their ability to solve mixed arithmetic operations story problems in elementary school mathematics learning. The descriptive analysis showed an increase in post-test scores compared to pre-test scores, while the Wilcoxon Signed-Rank Test demonstrated significant differences between students' scores before and after the learning intervention. These findings suggest that the CTL model contributed positively to the learning process and student learning outcomes.

The results of this study provide both theoretical and practical implications. Theoretically, the findings support the constructivist learning perspective, which emphasizes that students develop understanding more effectively through active engagement and contextual learning experiences. Practically, the CTL model may serve as an alternative instructional strategy for elementary school mathematics learning because it helps students connect mathematical concepts with real-life situations, thereby promoting more meaningful and relevant learning experiences.

Future studies are recommended to involve larger sample sizes and include control groups in order to strengthen the validity of the findings. Further research may also examine the long-term effects of the CTL model on other variables, such as critical thinking skills, learning motivation, and student engagement, to provide a more comprehensive understanding of its effectiveness in mathematics education.

DECLARATION

Author Contribution

Rahmawati, T. contributed to conceptualization, methodology, formal analysis, visualization, and the preparation of the original draft manuscript. **Sucipto** contributed to conceptualization, manuscript review and editing, as well as methodological refinement. **Listiana, Y**. contributed to validation processes and research supervision..

Funding Statement

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

Declaration of AI Use

ChatGPT was used to improve language clarity under author supervision.

Additional Information

Not applicable.

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