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Contextualized Problem-Based Learning: Mastering Algebraic Expressions

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Abstract **Review Article**

This study investigated novel instructional approaches for tackling ongoing obstacles in students' understanding of algebraic expressions. Particularly, this research aimed to examine the effectiveness of Contextualized Problem-Based Learning (CPBL) approach in improving the performance of Grade 7 learners in solving problems involving algebraic expressions at Diffun National High School for School Year 2025–2026. Applying quasi-experimental non-equivalent pretest-posttest control group design, purposive sampling was used to determine two intact classes to be assigned into experimental and control groups. The statistical tools used were frequency count and percentage, mean, standard deviation, paired samples t-test, independent samples t-test, Levene's test, Shapiro-Wilk test, and Cohen's d. Pretest was administered prior to the implementation of the intervention then, right after the intervention, the posttest was administered. Outcomes uncovered that the control group gained slightly higher mean score (74.76%, SD = 6.72) than the experimental group (71.52%, SD = 7.79); however, the difference was not statistically significant (t = -1.734, p = 0.088). Within-group analysis revealed that the experimental group improved significantly from pretest to posttest (mean gain = 2.99; t = -2.531, p = 0.016), indicating CPBL's favorable effect on student learning. Cohen's d value of -.442 indicates that the participants in the control group showed a higher mean gain than the participants in the experimental group.

Keywords: contextualized, problem-based, algebraic expressions, performance, quasi-experimental design.

1. Introduction

Mathematics is often regarded by students as an abstract, difficult, and divorced from real-world circumstances, resulting in low motivation and performance. This problem is typically blamed on the continued use of old teaching methods that prioritize passive learning. To overcome this, learner-centered approaches such as Problem-Based Learning (PBL) and contextualized instruction have been praised for their ability to actively engage students and connect mathematical concepts to real-world situations.

PBL promotes deeper comprehension and motivation by encouraging students to research real-world issues (Régio et al., 2022). Similarly, research indicates that PBL improves conceptual knowledge,

problem-solving abilities, and favorable attitudes toward mathematics (Sinaga et al., 2023). By connecting lessons to students' experiences, contextualized instruction further lowers abstraction while increasing engagement and performance (DepEd, 2023). While Regis and Gomez (2023) highlighted the importance of contextualized education in fostering critical thinking and meaningful learning, Cambaya and Tan (2022) discovered that it greatly enhances students' cognitive, behavioral, and problem-solving abilities.

Despite these advantages, gaps remain. Existing research frequently focuses on overall mathematical ability rather than specialized skills such as algebraic expressions. There is relatively little study on the combined use of contextualization and PBL, especially in local contexts like Diffun National High School. Furthermore, few studies have directly measured the influence of contextualized PBL on students' performance in solving algebraic equations.

Thus, the purpose of this study is to address these gaps by investigating the efficacy of Contextualized Problem-Based Learning (CPBL) in enhancing Grade 7 students' performance in solving problems using algebraic expressions.

Methodology

The study used a quasi-experimental non-equivalent pretest-posttest control group design to examine the efficacy of Contextualized Problem-Based Learning (CPBL) in enhancing Grade 7 students' algebraic expression skills. The study included 62 Grade 7 learners chosen through purposive sampling from two intact classes that were statistically homogeneous according to Levene's Test. One class acted as the experimental group (CPBL), and the other as the control group (conventional teaching).

A standardized diagnostic test for group comparability was used in the study, as well as a pretest and posttest (30-item multiple-choice) created by the researcher and validated by a pool of experts from the department and the university.

Data were collected in three stages: pre-intervention (pretest), intervention (two-week implementation in which the experimental group got CPBL and the control group received standard teaching), and post-intervention.

Strict adherence to ethical principles, such as informed permission, voluntary involvement, confidentiality, and data protection, was maintained. All information was utilized exclusively for academic reasons, and participants' rights were guaranteed.

Results and Discussions

Table 1. Demographic Profile of the Participants

Profile	Particulars	Group			
		Experimental Group	Percent	Control Group	Percent
Sex	Male	16	47.06	13	46.43
	Female	18	52.94	15	53.57
Age Mean = 12.27	11 years old	1	2.94	5	17.86
	12 years old	14	41.18	20	71.43

	13 years old	18	52.94	3	10.71
	14 years old	1	2.94	0	0.00

Experimental Group ($N = 34$)
Traditional group ($N = 28$)

The demographic profile of the participants in table 1 reveals the slim difference in the distribution as to sex and age both in the Traditional and CPBL Group. As to sex distribution, the Traditional Group is composed of 13 male and 15 female learners which corresponds to 46.43 percent and 53.57 percent, respectively, while the CPBL Group consists of 16 male and 18 female learners which translates to 47.06 percent and 52.94 percent, respectively.

This shows the slight disparity of the frequency of male and female with a difference of just 2 for the Traditional Group and the same difference for the CPBL Group. This indicates a relatively insignificant difference between the frequency of male against the frequency of female learners in the distribution. As to age distribution, the Traditional Group consists of ages ranging from 11 to 13 wherein 5 learners or 17.86 percent are 11, 20 learners or 71.43 percent are 12, and 3 learners or 10.71 percent are 13 years old. The CPBL Group, on the other hand, is composed of learners with ages ranging from 11 to 14, slightly more diverse compared to the traditional group, wherein 1 learner is 11 years old or 2.94 percent, while 14 learners or 41.18 percent are 12, 18 learners or 52.94 percent are 13, and at least 1 learner is 14 years old.

The table reveals that learners from the Traditional Group are mostly 12 years old while the CPBL Group are mostly 13 and 12 years old. This suggests that both Traditional and CPBL Group still fall within the ideal age class for grade 7 learners, considerably belonging to similar developmental stages, hence, the disparity of their ages would not invariably influence the outcome of the study.

The initial figure shows a reduction in the frequency of participants in the experimental and control group from the homogeneity test to post test. Originally, there were 32 participants in the experimental group while the control group had 34. For some reasons, during the administration of the pretest, four students from the control group were not able to take the test which reduced the number of takers to just 30 and the number of participants in the experimental group increased to 34 due to the increase in attendance during the test. During the administration of the posttest, the number of takers in the control group was further slashed to just 28 due to the failure of the two takers in the pretest to take the posttest, on the other hand, the frequency of takers in the experimental group in the posttest held up to 34.

To sum it up, the distribution of learners in the Traditional and CPBL Group, based on the preceding information, is relatively uniform with respect to the sex and age distribution. Therefore, any empirical difference between the performance of the Traditional and CPBL Group can be largely characterized by their exposure to the interventions employed and not by their disparity in terms of demographic profile.

Table 2. Pretest Mean Percent Score in Algebra of the Participants

Group	N	Mean Percent Score	SD	t	p-value	Decision
Experimental Group	34	68.53	4.71	-.308	0.759	Fail to reject Ho

Control Group	28	68.93	5.49			

p-value ≤ 0.05 is significant

Table 2 shows the mean percent score in Algebra of the participants. The pretest results show that the Experimental Group (M = 68.53%, SD = 4.71) and the Control Group (M = 68.93 percent, SD = 5.49) had almost the same amount of algebra knowledge before the test. The calculated t-value (t = -0.308) and p-value (p = 0.759) indicate that the disparity between the two groups is not statistically significant at the 0.05 level. This means that both groups had similar levels of skill before the intervention was put into place.

The absence of a significant difference in pretest scores strengthens the internal validity of the study, as it confirms that both groups started from a similar level of understanding. This equivalence ensures that any observed changes in posttest performance can be more confidently attributed to the instructional interventions rather than pre-existing differences. It also indicates that the grouping process was effective in maintaining comparability between the experimental and control conditions.

The findings are consistent with Gray (2023), who stated that establishing baseline equivalency is critical in quasi-experimental designs to ensure accurate comparisons between groups. Similarly, the Co, A. E. (2025) stated that pretests give essential baseline data that researchers can use to credit learning increases to treatments rather than beginning group disparities.

Table 3. Posttest Mean Percent Score in Algebra of the Participants

Group	N	Mean Percent Score	SD	t	p-value	Decision
Experimental Group	34	71.52	7.79	-1.734	0.088	Fail to reject Ho
Control Group	28	74.76	6.72			

p-value ≤ 0.05 is significant

The Control Group (M = 74.76%, SD = 6.72) did somewhat better than the Experimental Group (M = 71.52%, SD = 7.79), according to the posttest data. Nevertheless, this difference is not statistically significant, according to the independent samples t-test (t = -1.734, p = 0.088). As a consequence, the null hypothesis is upheld, implying that student performance levels were similar for both instructional strategies.

Although the control group had a numerically higher mean score, the lack of statistical significance suggests that the CPBL methodology did not generate a better result than the traditional method. This shows that, while CPBL may improve learning, its benefit over traditional education may depend on factors such as implementation time, teacher proficiency, and student preparation. The findings also suggest that traditional teaching approaches are still helpful at improving algebra proficiency under certain conditions.

This result is in line with the findings of Suparman and Juandi (2022), who found that although Problem-Based Learning (PBL) generally has

beneficial benefits, these are not always noticeably higher than those of conventional methods. Furthermore, Gufron et al. (2025) observed that implementation fidelity and instructional environment had an impact on PBL's efficacy.

Table 4. Comparison of Mean Difference of the Posttest and Pretest in Algebra of the Participants in the Experimental Group

Group	N	Mean Percent Score	SD	t	p-value	Decision
Pretest	34	68.53	4.71	-2.531	0.016	Reject Ho
Posttest	34	71.52	7.79			

p-value ≤ 0.05 is significant

The performance of the group exposed to the Contextualized Problem-Based Approach yielded statistically significant improvement in Algebra. Results reveal, as shown in Table 5, that the students' mean percent scores increased from the pretest mean percent of 68.53 (SD = 4.71) to a posttest mean percent of 71.52 (SD = 7.79). While this shows a modest absolute gain of 2.99 percentage points, a paired-samples t-test established the increase was statistically significant (t = -2.531, p = 0.016). Therefore, the null hypothesis was rejected, because the p-value fell below the 0.05 alpha level, signifying that the observed improvement in the performance of the students was a direct effect of the intervention rather than lack or random chance.

The notable improvement indicates that CPBL is successful in improving students' comprehension of algebraic expressions. By relating abstract ideas to actual circumstances, the use of contextualized challenges probably promoted meaningful learning. This suggests that CPBL can be a useful teaching strategy for enhancing conceptual comprehension and engagement, especially in subjects that students typically struggle with.

The outcome corroborates the findings of Amalia et al. (2024), who found that contextualized problem-based techniques greatly enhance students' algebraic problem-solving abilities. Similarly, contextualized instruction increases student engagement and accomplishment by making learning more relevant and meaningful, according to Cambaya and Tan (2022).

Table 5. Comparison of Mean Difference of the Posttest and Pretest in Algebra of the Participants

Group	N	Mean Gain	SD	t	p-value	Decision
Experimental Group	34	2.99	6.89	-1.733	0.088	Fail to reject Ho
Control Group	28	5.83	5.82			

p-value ≤0.05 is significant

The table compares the mean gain scores of the experimental and control groups based on the difference between their posttest and pretest results in Algebra. The experimental group (n = 34) achieved a mean increase of 2.99, SD = 6.89, but the control group (n = 28) had a greater mean gain of 5.83, SD = 5.82. The estimated t-value of -1.733, with a corresponding p-value of 0.088, shows that the difference in mean gain scores between the two groups is not statistically significant at the 0.05 level of significance. Because the p-value exceeds 0.05, the null hypothesis is not rejected.

These findings suggest that there is no adequate statistical proof to establish the existence of significant difference between the improvement of scores of the experimental and control groups. The relatively high standard deviations in both groups also shows variability in the performance gains of the respondents. Hence, based on the statistical analysis, the instructional intervention employed for the experimental group did not produce a significantly higher improvement in performance compared with the control group in terms of the measured learning outcomes.

This result is consistent with that of Nisa et al. (2023), who observed that although PBL enhances learning outcomes, variations from conventional approaches are not always statistically significant. Furthermore, Dorimana et al. (2022) stressed that contextual elements like student engagement and implementation quality determine how beneficial PBL is.

Table 6. Effect of Contextualized Problem-Based Learning Approach in Enhancing Algebra Performance of the Participants

Group	N	Mean Gain	Mean Difference	*t*	p-value	*Cohen's d*
Experimental Group	34	2.99	-2.84	-1.733	0.088	-0.442
Control Group	28	5.83				

p-value ≤0.05 is significant

Cohen's d: small effect size = around 0.2
medium effect size = around 0.5
large effect size = around 0.8 or higher

Table 6 presents the effect of the CPBL Approach on the Algebra performance of the respondents calculated through the mean gain between the posttest and pretest scores of the experimental and control groups. The Experimental Group had a mean increase of 2.99, whereas the Control Group achieved 5.83, resulting in a mean difference of -2.84. The estimated t-value (t = -1.733) and p-value (p = 0.088) show no significant difference between the groups. Cohen's d value of -0.442 indicates a larger mean gain of 5.83 in the control group than the mean gain of 2.99 in the experimental group. The difference between the two groups was not statistically significant with a p-value of 0.088.

The results show that CPBL did not have a statistically significant effect when compared to the traditional method of teaching, although it did contribute to progress in the experimental group. This suggests that CPBL may be more effective as a supplement to traditional instruction than as a

replacement. This outcome is congruent with Bron and Prudente (2024), who discovered that PBL has moderate but varying impacts depending on the setting. Furthermore, Thamrin et al. (2024) stated that, while contextualized PBL improves engagement and knowledge, it may not always outperform traditional approaches in short-term deployments.

Generally, these findings suggest that the CPBL approach did not generate a statistically significant effect in improving the performance of the participants in the experimental group compared with the traditional approach employed in the control group. Though differences in mean gain were evident, these were not sufficient to be considered statistically significant, this indicates that other factors could have influenced the students' gains in performance. In the implementation of the lesson, a contextualized problem scenario is presented in Phase 1 of the CPBL process, requiring students to read, analyze, and identify the given values or information as well as the unknown variable. However, it was often noted that many learners had trouble completing these tasks. This difficulty points to potential difficulties with reading comprehension and converting spoken information into mathematical representations, as well as a limitation in their capacity to understand and analyze the problem's contextual aspects. According to Fadzil (2025), students' incapacity to interpret and transform verbal statements into mathematical representations is largely responsible for their difficulty in answering algebraic word problems, highlighting the importance of linguistic competency in mathematical reasoning. Moreover, Hattie (2023) noted that academic performance is significantly influenced by student-related factors, such as language ability, prior achievement, and motivation, which might occasionally exceed the benefits of instructional interventions. This suggests that learners' individual variations may limit the efficiency of Contextualized Problem-Based Learning (CPBL), even if it is pedagogically valid.

The study concludes that the Contextualized Problem-Based Learning (CPBL) approach enhanced the performance of Grade 7 students in solving problems related to algebraic expressions; however, this enhancement was not significantly superior to that obtained through conventional instructional methods. Prior to the intervention, both the experimental and control groups exhibited similar levels of prior knowledge. Although the experimental group exhibited a statistically significant increase from pretest to posttest, the difference in posttest performances between the two groups was not statistically significant. Additionally, the control group achieved a marginally superior mean gain score, as indicated by the negative effect size. These results show that although CPBL is a useful teaching strategy for improving group learning, it does not always outperform conventional teaching techniques in terms of generating noticeably better academic results in the particular setting.

Based from the findings, it can be conjectured that CPBL is a realistic and useful pedagogical strategy for teaching algebraic expressions, particularly in terms of fostering student involvement, collaboration, and contextual knowledge of mathematical concepts. However, its efficacy may be influenced by a variety of circumstances, including implementation time, instructor skill, and student preparation, particularly in terms of reading comprehension and the capacity to interpret real-life situations into mathematical representations.

According to the findings, CPBL might be more successful when applied in conjunction with standard teaching methods rather than as a substitute. The study also emphasizes how crucial it is to address learners' prior knowledge and language skills since these factors have a big impact on how well they can profit from contextualized and problem-based tasks. These findings can be used by educational stakeholders, such as educators, curriculum designers, and school administrators, to create well-rounded teaching strategies that combine cutting-edge and traditional techniques to maximize student learning outcomes.

This study had significant limitations, which may have influenced the findings. First, the use of a quasi-experimental approach with non-random sampling limits the findings' generalizability because

participants were chosen from only two intact classrooms within a single school. Second, the intervention's brief length (two weeks) may have been insufficient to fully capture the long-term impacts of the CPBL strategy. Third, the study concentrated on a single topic in mathematics, algebraic expressions, and only included Grade 7 pupils, restricting its relevance to other mathematical areas and grade levels. Furthermore, learner-related factors such as reading comprehension issues, prior knowledge, motivation, and the capacity to identify contextual problems may have influenced the results, thereby overshadowing the impact of the instructional intervention. Finally, differences in implementation fidelity and classroom dynamics may have altered the success of the CPBL strategy.

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