Collaborative Learning Strategies in Algebra: Effects on Grade 8 Students' Conceptual Understanding

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ABSTRACT

Collaborative learning strategies have emerged as effective approaches in fostering students' conceptual understanding, particularly in mathematics, by encouraging active participation, peer interaction, and shared problem-solving. This study aimed to investigate the effect of collaborative learning strategies on students' conceptual understanding in algebra. The study used a quasi-experimental design using a pretest and posttest control group design. The participants were Grade 8 students of Ampaso Memorial National High School at Binidayan, Lanao del Sur. The findings showed that before the intervention, the control group had a mean score of 13.00, while the experimental group had a mean score of 13.35. The t-value of .33 and p-value of .74 indicate no significant difference in conceptual understanding between the two groups. After the intervention, both groups improved, but the experimental group showed a greater increase with a mean score of 28.81. The t-value of 2.21 and p-value of .032 indicate a statistically significant difference on the control and experimental groups. The findings of this study suggest that collaborative learning strategies had a positive effect on students' conceptual understanding. It is recommended that educators incorporate collaborative learning strategies into algebra instruction to enhance conceptual understanding.

Keywords: collaborative learning, conceptual understanding, algebra, mathematics education, instructional strategies

INTRODUCTION

Teaching is both an art and a science. It requires the teacher to use different strategies and approaches for the students to understand the lesson effectively. One such strategy that can be used to teach mathematics is the collaborative learning strategy. It is a strategy that received a lot of interest from academics as an educational learning strategy. This strategy converts the student into an engaged participant in the process of learning. It allows students work in groups to solve problems. With this strategy, students engaged in group discussions, hands-on activities, and interactive projects together to achieve shared goal. It motivates him to talk and discuss, improves his academic achievement and mental health, and sharpens his problem-solving skills (Munna, & Kalam, 2021).

Collaborative learning is one of the teaching strategies promoted by the modern educational movement after research and studies have demonstrated its usefulness and beneficial role in boosting learners' academic achievement and fostering collaboration abilities. Collaborative learning is regarded as one of the contemporary educational methods that call for relating the school actuality because it fulfils the students' psychological requirements on the one hand and conveys the substance of the subject matter to them on the other (Johnson and Johnson, 2018).

Mathematics is one of the most difficult subjects of students throughout their field of study (Li & Schoenfeld, 2019). For the students to understand mathematics, they must be taught conceptually in order to understand the material (Andamon & Tan, 2018). Furthermore, teaching mathematics conceptually resulting in greater achievement (Khoule et al., 2017). According to (Zakaria et al., 2010), conceptual understanding is associated with higher academic accomplishment in mathematical concepts. A lack of conceptual understanding presents a number of obstacles for students (Tekin-Sitrava, 2017).

However, with techniques, strategies, and support, teachers can help students to establish a positive attitude toward mathematics. Teachers must be creative in introducing strategies that support students' learning mathematics. As a Math teacher, this inspires the researcher to explore more on the effectiveness of the collaborative learning strategy in Algebra. In this study, the researcher investigated the effect of collaborative learning strategy in teaching Algebra methodologies in Grade 8 students' conceptual understanding in order to empower students to excel in mathematics.

Statement of the Problem

This study focused on the use of collaborative learning strategies in algebra. The researcher investigated how collaborative learning strategies affects students' conceptual understanding.

Specifically, it answered the following research questions:
1. What are the conceptual understanding levels of the control and experimental groups of students before and after intervention?
2. Is there a significant difference on the control and experimental groups of students' conceptual understanding test mean score before and after the intervention and the mean gain score?
3. What are the perceptions of the students from the experimental group on the collaborative learning strategies?

METHOD

This chapter focused on the research methods used by the researcher to answer the problems provided for the study. These are the following: study design, respondents and sample, research instrument, data collection technique, data analysis and ethical consideration.

Research Design

The study used both quantitative and qualitative research method. The quantitative aspects utilized quasi-experimental research. The recipients of the instruction were the two intact groups. Specifically, the matching-only pretest and posttest control group design was used design as described by Fraenkel and Wallen (2009). The design is shown below:

Group	Matching	Pretest	Treatment	Posttest
Experimental	M	O	X	O
Control	M	O	C	O

Students who were taught with collaborative learning strategies referred to as the experimental group while the other group of students were taught with a traditional teaching approach referred to as the control group. The symbol M refers for the matching of samples between the control and experimental groups of students on their second grade in mathematics for the school year 2024–2025. The observations were identified by the symbol O. The first column of O's refers to the first observation through the administration of pretest on the conceptual understanding. The collaborative learning strategies, which is applied to the experimental group, is represented by the symbol X in this context. The control group is identified by the letter C. The second column of O's refers to the second observation through the administration of posttest on the conceptual understanding and other measurement.

Locale of the Study

This study was conducted at Ampaso Memorial National High School in Pagalamatan, Binidayan, Lanao del Sur. It is one of the two (2) National High School in the Municipality of Binidayan.

The Research Participants and the Sampling Technique

The participants in this study were Grade 8 students officially enrolled at Ampaso Memorial National High School for the School Year 2024–2025. The study employed purposive sampling and intact group sampling as its primary sampling techniques. Purposive sampling was used to deliberately select Grade 8 students because their second-quarter mathematics curriculum includes algebra, a topic that often presents challenges in conceptual understanding. These characteristics made them appropriate participants for examining the effects of collaborative learning strategies on learning outcomes. In addition, intact group sampling, a type of cluster sampling, was used by selecting the two existing sections as they were already naturally formed classroom groups. This technique allowed the researcher to conduct the study in a typical classroom setting without altering the established class structure. One setting serve as the

experimental group and received collaborative learning strategies such as peer discussions, group problem solving, and other interactive activities. The other section served as the control group and received traditional teaching approach.

Research Instruments and Its Validity

The instrument utilized to collect data is the Conceptual Understanding Test (CUT). The researcher prepared 60 multiple-choice questions with four possible answers each to determine the conceptual understanding. The purpose of the test is to measure the understanding of the students in the concept of mathematics that covered the lessons, particularly the algebra to ensure an equal distribution and level of difficulties of the items. The instruments were conducted the pilot testing on among Grade 9 students of Mauyag C. Papandayan National High School. Based on the results, some items were removed in order to improve the reliability of the results. Using the Cronbach's Alpha with reliability coefficient of 0.726, the Conceptual Understanding Test was reduced to 45 items only.

Moreover, the level of conceptual understanding test was adapted from the Department of Education (DepEd) and the score was obtained based on the transmutation table of the DepEd. The scores were classified as outstanding, very satisfactory, satisfactory, fairly satisfactory, and did not meet expectation. The categorization with the corresponding scores as shown in Table 1.

Table 1:
Categorization of Students' Conceptual Understanding Level

Level of Conceptual Understanding	Score Range
Outstanding	90 – 100
Very Satisfaction	85 – 89
Satisfactory	80 – 84
Fairly Satisfactory	75 – 79
Did Not Meet Expectation	Below 75

Data Analysis

In this study, data were collected from the pretest and posttest of both groups to determine the effect of collaborative learning strategies on students' conceptual understanding in algebra. Descriptive statistics were used to analyze the quantitative data. The raw scores of the control and experimental groups, both before and after the intervention, were described using the mean, frequency, percentage, and standard deviation. Independent samples t-test was used at the .05 level of significance to determine whether there was a significant difference between the mean

scores of the control and experimental groups before and after the intervention, as well as their mean gain scores.

Ethical Consideration

Before conducting the study, the researcher obtained formal permission from the school division superintendent and the principal of Ampaso Memorial National High School, clearly outlining the research objectives, scope, and procedures. Written consent was also explained and obtained from the Grade 8 student participants. Ethical standards were strictly observed, including confidentiality and anonymity, with no names of students, parents, or the school revealed, and all records securely disposed of after the study. Participation was voluntary, with students fully informed about the study in a manner appropriate to their understanding, and they were assured of their right to withdraw at any time without consequences. The study was designed to ensure no harm would come to participants and was approved by the academic ethics committee to ensure compliance with ethical protocols.

FINDINGS AND DISCUSSION

This presents the results, analysis, and interpretation of the data gathered. The arrangement of the data presentation follows the order of the research questions in the statement of the problem that was introduced in **Control and Experimental Groups of Grade 8 Students' Conceptual Understanding Levels Before and After the Intervention**

The conceptual understanding levels of Grade 8 students were examined before and after an intervention using control and experimental groups. The Table 1 shows the frequency and percentage distribution. It categorizes students' conceptual understanding into different levels, ranging from outstanding to did not meet expectations. This provides a comparison of students' outcomes before and after the intervention and presents changes in their conceptual understanding.

Table 2:

Frequency and Percentage Distribution of Grade 8 Students' Level of Conceptual understanding in the Control and Experimental Groups Before and After the Intervention

Description	Before Intervention		After Intervention	
	Control Group ($n = 26$)	Experimental Group ($n = 26$)	Control Group ($n = 26$)	Experimental Group ($n = 26$)
Outstanding	0 (0%)	0 (0%)	1 (3.8%)	3 (11.5%)
Very Satisfactory	0 (0%)	0 (0%)	0 (0%)	3 (11.5%)
Satisfactory	0 (0%)	0 (0%)	2 (7.7%)	1 (3.8%)

Fairly Satisfactory	0 (0%)	0 (0%)	4 (15.4%)	9 (34.6%)
Did Not Meet Expectation	26 (100%)	26 (100%)	19 (73.1%)	10 (38.5%)
Total	26 (100%)	26 (100%)	26 (100%)	26 (100%)

Note.   Outstanding (90 - 100);   Very Satisfactory (85-89); Satisfactory (80 -84); Fairly Satisfactory (75-79); Did   not   meet Expectations (Below 75)

DepEd Order No. 8, s. 2015 – Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program

The data shows that before the intervention, all (100%) of the students both in the control and experimental groups were categorized under the did not meet expectations level. This indicates that none of them demonstrated a sufficient conceptual understanding. This also implies that both groups started with no significant understanding of the subject matter. However, the results clearly illustrated that there was a significant difference between the two groups after implementing the collaborative intervention.

This result is similar to the findings of Slavin (2014), which discovered that collaborative learning strategies can significantly enhance students' conceptual understanding, particularly they begin with little understanding of the subject. In this study, both the control and experimental groups were initially categorized under the did not meet expectation level, this means that lack of conceptual understanding. However, after the intervention, the experimental group showed a significant difference.

In the control group, there was some improvement, but the majority of the students (73.1%) still remained in the did not meet expectation level, some (15.4%) of students elevated to fairly satisfactory level, very few (7.7%) of students achieved a satisfactory level, and only (3.8%) of student attained the outstanding level. The lack of students in the very satisfactory level indicates that traditional teaching method were insufficient in significantly enhancing students' conceptual understanding. The small percentage of students who improved could be determined to individual learning efforts rather than guided intervention.

Conversely, the experimental group showed a remarkable improvement, demonstrating the effectiveness of the intervention. The percentage of students in the did not meet expectation level was diminished significantly (38.5%), moderate (34.6%) of students achieved fairly satisfactory level, only (3.8%) achieved satisfactory level, and another (11.5%) reached the outstanding level. The fact that a considerable number of students in the experimental group improve to higher levels of

conceptual understanding suggests that the intervention had a significant positive impact on their learning.

These results clearly indicate that the intervention used in the experimental group was effective in improving students' conceptual understanding compared to the control group. The illustrations show that before intervention both groups struggled to provide the correct answers or explanations. In the control group, students not only gave incorrect answers but also failed to provide any supporting solutions. After the intervention while some students in the control group gave the correct answer but they did not provide explanation to the solution. On the other hand, the experimental group significantly improved after the intervention. Since they had provided incorrect answers on the pretest without providing an explanation but on the posttest, they not only produced the right answers but also explained their solution. However, the difference in between the two groups shows how students' conceptual understanding is being improved through collaborative learning strategies. The majority of students in the control group continuously received poor scores. This illustrates that the students may struggle to understand concepts in the absence of collaborative intervention. Moreover, the experimental group indicates that collaborative interventions may improve the students' conceptual understanding of mathematical concepts.

Comparison of Control and Experimental Groups of Grade 8 Students' Conceptual Understanding Test Mean Score Before and After the Intervention and the Mean Gain Score

To analyze the difference in conceptual understanding between the control and experimental group, statistical analyses were performed using Levene's test variance equality and a t-test for mean equality. The table below illustrates the finding tests comparing the mean test scores of both groups before and after the intervention, as well as their main gain scores. The Levene's test was used to determine the equality of variances between the two groups, while the t-test analyzed whether there was a significant difference in conceptual understanding. Additionally, the table also included the standard deviation, t-values, and p-values, which implies the statistical significance of the reveal differences. These results serve as the foundation for evaluating the effectiveness of the intervention in enhancing students' mathematics conceptual understanding.

Table 3:

Levene's test, t-test and p-values on the Comparison of the Control and experimental Groups of Grade 8 Students' Conceptual Understanding Test Mean Score Before and After the Intervention and the Mean Gain Score

	Group	Levene's test for equality of variance		t-test for equality of means				
		F-value	p-value	Mean Score	Mean Gain Score	SD	t-value	p-value
Before Intervention	Control (n = 26)	.00	.98(ns)	13.00		3.94	.33	.74 (ns)
	Experimental (n = 26)			13.35		3.61		
After Intervention	Control (n = 26)	2.15	.15(s)	25.46		4.79	2.21	.03(s)
	Experimental (n = 26)			28.8		6.05		
	Control (n = 26)	11.75	.00(s)		12.46	3.19	2.26	.02(s)
	Experimental (n = 26)				15.46	5.97		

Note. s – significant; ns – not significant

The table illustrates the findings that provide a significant difference of students' conceptual understanding of both before and after the intervention between the control and experimental groups. Before the intervention, the two groups had mean score were relatively close to 13.00 for the control group and 13.35 for the experimental group. With a t-value of 0.33 and a p-value of 0.74. This indicates that there is no significant difference of students' conceptual understanding between the two groups before the intervention.

After the intervention, the mean scores increased for both groups, but the experimental group showed a greater improvement with a mean score of 25.46. The computed p-value of 0.032 and t-value of 2.21 indicate that the level of significance at 0.05 was significantly improved. However, the experimental group achieved a higher mean gain scores with 15.46 compared to the control group with 12.46 further emphasize the difference of improvement.

Levene's test result indicate that the variances between groups were equal before the intervention with $p = 0.98$, which is not significantly difference and after the intervention, with $p = 0.15$, which is significantly difference. This difference in variance suggests that the intervention may have influenced the consistency of students' performance in the experimental group. Furthermore, the mean gain scores t-test produced with 0.023, which was also significant.

Generally, the experimental group showed a greater improvement on conceptual understanding than the control group. The difference is statistically not significant at 0.05 level. This implies that although the intervention had a positive outcome, there would be other factors that must be considered to achieve a significant effect on students' conceptual understanding.

This result is similar to the study of Watson (2020), which investigated the use of collaborative computer simulations in chemistry education. In this study, students in the experimental group demonstrated a higher mean score in conceptual understanding compared to the control group. The difference also statistically not significant. This study emphasized the importance of accounting for external influences and implementation quality when interpreting such results. This reinforce the idea that while instructional innovations may yield positive trends in statistically robust outcomes often depends on multiple contextual and instructional variables.

CONCLUSION

Based on the findings, the following conclusions were drawn:

1. Collaborative learning strategies in teaching algebra were found to be effective in improving students' conceptual understanding. These strategies helped students understand and apply what they have learned compared to traditional teaching methods. Working together allowed students to share ideas, solve problems more easily, and develop a deeper understanding.

2. After the intervention, there was a significant difference ($p = 0.032 < 0.05$) between the control and experimental groups in the students' conceptual understanding test mean scores. Similarly, there was a significant difference ($p = 0.028 < 0.05$) between the control and experimental groups in the students' conceptual understanding test main gain scores. This suggests that the collaborative learning strategies had a positive effect on the conceptual understanding in mathematics.

3. Collaborative learning strategies in algebra increased conceptual understanding from the did not meet expectation level to the outstanding level. The experimental group showed greater improvement than the control group demonstrating the effectiveness of this learning strategy.

4. Moreover, students from the experimental group found that the collaborative learning strategies made problem-solving easier. They also preferred using collaborative learning strategies in word problems because working together allowed them to share ideas, clarify misunderstandings, and solve problems more quickly.

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