CONSTRUCTIVISM Approach in Teaching Linear Equation among Junior High School STUDENTS

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ABSTRACT

This study aimed to determine the effectiveness of the constructivist approach in teaching linear equations to junior high school students on selected topics in the system of linear equations. Employing a quasi-experimental design, the researcher administered the pre-test and post-test to purposively selected Grade 8 students at one of the private schools in Cabantian, Davao City, using a validated questionnaire. The control groups were taught using a traditional approach, while the experimental group was taught using a constructivist approach. The mean, standard deviation, paired t-test, and effect size were used to analyze and interpret the data. The pre-test results showed that neither the control nor the experimental group met expectations. However, the post-test results showed a significant difference in student achievement between the traditional and constructivist approaches. The results of this study revealed that using constructivist approaches with manipulatives, peer teaching, and the jigsaw method successfully increased students' mathematics achievement in selected linear equation topics.

KEYWORDS: *Education, mathematics, constructivism approach, quasi-experimental, Philippines.*

INTRODUCTION

Linear equations are a significant part of teaching algebra elements in secondary schools and play a role in students' learning advanced mathematics topics. Thus, mastery of linear equation lessons is essential (Wati et al., 2019). However, a study by Fatio et al. (2020) found that 71 percent of 118 junior high school (JHS) students in Indonesia had difficulty solving systems of linear equations in two variables. The study indicated that students struggled to use, apply, and select appropriate procedures to solve such problems in algebraic form. Similarly, an assessment conducted by Samuel et al. (2016) in one of the public schools in Zambia, Africa, showed that 80 grade 11 students achieved a mean percentage score of only 13.8 percent, indicating a very low level of achievement in solving both symbolic and word-form linear equations.

Moreover, in Nueva Vizcaya, Philippines, a study by Lopez and Gurat (2024) found that 50 percent of Grade 8 students in one section of a public high school scored low on a graphing linear equations assessment, indicating difficulties with related problems. Additionally, Tilos et al. (2023) revealed that grade 8 students perform poorly in solving linear equation word problems. Students often struggle to understand and analyze word problems, conceptualize equations, and create correct algebraic representations. Common errors include negligence, incorrect equation formation, computational mistakes, and misinterpretation of problem statements. According to the study by Saraswati et al. (2016), linear equations are often difficult for students transitioning from a concrete to an abstract mathematical concept. So, a learning that bridges the students' thinking from abstract to real is needed

The constructivist approach has been recognized as an effective pedagogical strategy for enhancing students' understanding of complex mathematical concepts. An experimental study by Andam et al. (2015) in Kumasi, Ghana, demonstrated that the constructivist approach significantly improved students' competence in solving word problems involving algebraic linear equations. Similarly, Cañete et al. (2020) found that the constructivist approach was more effective than traditional methods in enhancing students' achievement in polynomial functions. Specifically, their intervention utilized the Social Interactive Constructivist Approach in teaching mathematics to Grade 10 learners in one of the schools in Bayawan City, Philippines, during the school year 2017–2018. Additionally, Yakubu (2020) found, in a study conducted in Ghana showed that the constructivist approach was more effective than the traditional method for teaching linear equations in one variable. The findings indicated that guiding students to solve problems independently through structured learning led to better outcomes compared to traditional instruction. Students exposed to the constructivist approach achieved a mean gain score of 30.34.

While the studies by Andam et al. (2015), Cañete et al. (2020), and Yakubu (2020) support the effectiveness of the constructivist approach in improving students' performance in mathematics, they focused on overall performance or word problem-solving at different junior high school levels. However, few studies have specifically examined how a constructivist approach can be applied to address the difficulties Grade 8 students face in solving systems of linear equations in two variables. This research aims to bridge this gap by employing a quasi-experimental design to examine the effect of a constructivist approach in teaching linear equations in two variables.

The findings of this research can benefit junior high school students, teachers, and curriculum developers by highlighting how a constructivist approach may boost students' mathematics achievement. These insights can be shared with policymakers, educators, and academic conferences, as well as through digital platforms, to promote the benefits of constructivist teaching of linear equations.

Statement of the Problem

1. What is the pretest mean scores of the students in the experimental and control group before the conduct of the constructivist approach?
2. Is there a significant difference between the pretest mean scores of the experimental and control group before the conduct of the constructivist approach?
3. What is the post-test mean scores of the students in the experimental and control group after the conduct of the constructivist approach?
4. Is there a significant difference between the posttest mean scores of the experimental and control group after the conduct of the constructivist approach?
5. Is there a significant difference between the pretest and post-test mean scores of the control group?
6. Is there a significant difference between the pretest and post-test mean scores of the experimental group?
7. What are the mean gain scores of the experimental and control group?
8. Is there a significant difference between the mean gain scores of the experimental and control group?

Theoretical Lens

This study is anchored in the social constructivist theory of Lev Vygotsky (1978) and the cognitive constructivist theory of Jean Piaget (1968).

Vygotsky's social constructivism emphasizes learning through social interaction, with the Zone of Proximal Development (ZPD) highlighting the gap between independent and supported learning. Strategies like scaffolding, guided discovery, and group activities help students work within their ZPD. Jean Piaget's cognitive constructivism theory also supports this approach by suggesting that students learn best when they can connect new ideas to what they already know. In a constructivist classroom, teachers are encouraged to recognize students' different starting points and provide time to bridge any gaps in understanding. Piaget believed that learning occurs gradually through real experiences, which help students actively participate, explore, and develop their understanding of the world around them.

METHODOLOGY

Research Design. This study employed a quantitative research approach with a quasi-experimental design. As stated by Bhandari (2023), quantitative research involves collecting and analyzing numerical data to identify patterns, test hypotheses, establish causal relationships, and generalize findings to broader populations. This particularly suits educational research that assesses measurable changes in academic performance. Moreover, a quasi-experimental design was used in this study to examine the impact of the teaching method on students' mathematics achievement, despite the absence of random participant assignment. According to Thomas (2023), this design establishes cause-and-effect relationships by applying an intervention to existing groups, often organized by non-random factors like class sections. Participants were split into two groups: the experimental group, which experienced the constructivist teaching approach, and the control group, which followed the traditional approach. Both groups took a pre-test before the intervention and a post-test afterward, following the pretest-posttest design outlined by Chiang (2015). This method strengthens internal validity by enabling clear comparisons of changes within and between groups.

It is important to acknowledge the potential for researcher bias, as the researcher also served as the instructor in this study. To mitigate this concern, the researcher maintained a consistent lesson plan for the control group and ensured that the constructivist strategies for the experimental group were implemented according to the designed protocol. Additionally, all assessments (pre-test and post-test) were standardized to minimize subjective influence on the results.

Research Locale. The researcher conducted the study at one of the schools in Davao City. Davao City is a major urban center in the southern Philippines. It is the largest city in the country in terms of land area and is known for its diverse culture, natural beauty, and economic significance. The school has three campuses, but the researcher chose to conduct the study at the campus in Cabantian, Davao City. The school started as the Day Care Learning

Center. The school envisions itself as the leading provider of Christian education. The selected school is the most suitable for the research because students enrolled in this institution implemented the traditional approach. The school leads and directs the learning process, imparts knowledge through lectures, and ensures that students listen, take notes, and follow instructions. However, the constructivist approach is one of the best strategies for the school to achieve its mission of promoting an effective multi-modal teaching system, diversifying the learning process, and improving the quality of instruction.

Research Respondents. The respondents of this study were 50 Grade 8 students, with 25 participants in each section, from one of the private schools in Davao City. The chosen school has 2 grade 8 sections. These two sections are heterogeneous groups with diverse students. The researcher chose section A as the control group, which used a traditional approach, and section B as the experimental group, which used a constructivist approach. Students from the other junior high school levels were excluded from the study.

Purposive sampling was used to select the study respondents. It is a nonprobability sample selected based on a population's characteristics and the study's objective. When sampling for proportionality is not the primary concern and you need to obtain a desired sample immediately, this sampling method can be quite helpful (Crossman, 2020).

Ethical Considerations. This study adhered to ethical standards for research involving human participants. The research protocol was reviewed and approved by the school's Institutional Research Ethics Committee (REC). Informed consent was obtained from the school administration and the parents or guardians of the student participants prior to data collection, ensuring that participation was voluntary and that student data was kept confidential.

Statistical Tools. The researcher used the mean, standard deviation, independent-samples t-test, dependent-samples t-test, and effect size for data analysis to produce a valid and reliable study and interpretation of the data. The mean was used to determine students' mathematics achievement. Standard deviation indicates how much each group's data deviates from the mean and how spread out the group's scores are. Furthermore, a paired t-test was used to determine whether respondents' scores differed significantly between the pre-test and post-test within the experimental and control groups. It measures how much the scores changed within each group. Lastly, the effect size was used to determine the intervention's effect on scores, based on pre-test and post-test results.

RESULTS AND DISCUSSION

Pre-test Mean Scores of the Experimental and Control Groups

Table 1 shows the descriptive statistics for the pretest scores of both groups. The control group (n = 25) achieved a mean score of 12.24, indicating that 20.4 percent of the correct answers were at a very low level of achievement. In contrast, the experimental group (n = 25) recorded a lower mean of 8.44, with 14.07 percent of correct answers at a very low level of achievement.

This result shows that respondents in both the control and experimental groups rated their performance as very low. This outcome indicates that the students' academic achievement did not meet expectations. The analysis demonstrates that students at this level struggle with their understanding of prerequisite knowledge and skills, which have not been acquired or adequately developed to support learning. Additionally, the overall standard deviation for the control and experimental groups is 6.39 and 8.35, respectively, indicating that the experimental group has greater homogeneity in their scores than the control group.

Table 1
Pre-Test Mean Scores of the Experimental and Control Groups

Group	Mean	Percent of Correct Answer	SD	Description
Control	12.24	20.4	6.39	Very Low
Experimental	8.44	14.07	8.35	Very Low

The results align with the research conducted by Fisher et al. (2019), which revealed that the mathematical reasoning ability of junior high school students in systems of linear equations and application topics is at a very low level. These findings reinforce the results of the study by Tilos et al. (2023); the results imply that grade 8 students perform low in solving linear equation word problems. Furthermore, a study by Sujadi and Subanti (2021) found that factors contributing to students' learning difficulties in systems of linear equations include misconceptions, calculation errors, and low problem-solving skills. Addressing these requires targeted instructional strategies and supportive learning environments.

Significance of the Difference between the Pre-test Scores of Experimental and Control Groups

The difference between the pretest mean scores of the experimental and control groups was tested at the 0.05 significance level. The p-value of 0.077 in Table 2 is greater than 0.05, indicating that there is no significant difference in students' prior knowledge in solving systems of linear equations using graphical, elimination, and substitution methods. Further, this analysis demonstrates that the control group (M = 12.24, SD = 6.39) and the experimental group (M = 8.44, SD = 8.35) have comparable levels of understanding of solving systems of linear equations using graphical, elimination, and substitution methods.

Table 2 presents the results of the independent-samples t-test that compared the pretest means. The test yielded a t-value of 1.81 and a p-value of 0.077. Although the p-value exceeds the conventional α = 0.05 threshold—indicating that the observed 3.76‑point difference is not statistically significant—the medium effect size suggests a nontrivial practical difference in favor of the control group.

Table 2
Significance of the Difference between the Pretests of Experimental and Control Groups

Groups	t	p-value	Remarks
Control (Traditional Approach) Experimental (Constructivist Approach)	1.81	0.077	Not significant

The findings of this study are consistent with those of Sekgoma (2024), who examined the comparative effects of the constructivist approach and traditional teaching methods on students' performance in linear equations. Sekgoma reported no significant difference in pre-test scores between the experimental and control groups, indicating that both groups had comparable levels of prior knowledge. Similarly, Galia (2016) conducted a quasi-experimental study on the use of a constructivist-based approach in teaching mathematics and found no significant difference in pre-test mean scores between the control and experimental groups. These results reinforce the validity of using pre-test scores to establish baseline equivalence between groups prior to implementing different teaching interventions.

Post-Test Mean Scores of the Experimental and Control Groups

Table 3 shows the post-test mean scores for the experimental and control groups. The post-test mean score in the control group was 31.81 (SD = 7.15), corresponding to 53.07% correct, which is considered very low.

In contrast, the experimental group had a mean score of 37.80 (SD = 8.08), corresponding to 62.93% correct answers and considered low, suggesting that the academic achievement of the students in this group is fairly satisfactory. This implication suggests that the students in both groups at this level exceed the core knowledge, skills, and understanding requirements and can transfer them automatically and flexibly through authentic performance tasks. The results imply that the mean

Scores of the experimental and control groups increased after implementing the constructivist and traditional approaches, respectively.

Table 3

Post-test Mean Scores of the Experimental and Control Groups

Group	Mean	Percent of Correct Answer	SD	Description
Control	31.81	53.07	7.15	Very low
Experimental	37.80	62.93	8.08	Low

The post-test results of this study align with those of Beura et al. (2021). In their quasi-experimental study, the mean post-test scores of the experimental and control groups were 22.16 and 16.2, respectively. Similarly, in the present study, students in the experimental group, who were taught using the constructivist approach, performed better than those in the control group, who were taught using traditional methods. This suggests that engaging learners through active, student-centered instruction can enhance understanding and retention of mathematical concepts.

However, it is also notable that the control group achieved a relatively high mean score, consistent with Pradhan's (2015) findings. Pradhan emphasized the value of traditional teaching in shaping student learning and development. Traditional approaches remain vital in providing structured learning experiences, cultivating discipline, and supporting the gradual acquisition of foundational skills. These results suggest that while innovative teaching strategies, such as constructivism, can significantly enhance learning outcomes, traditional methods still play an important role in educational settings.

Significance of the Difference in the Post-test of Experimental and Control Groups

The difference between the post-test mean scores of the experimental and control groups was tested at the 0.05 significance level. The p-value of 0.009 in Table 4 is less than 0.05, indicating a significant difference between the mathematics achievement of the control group (M=31.84, SD=7.15) and the experimental group (M=37.76, SD=8.08) in solving simultaneous linear equations using graphical, elimination, and substitution methods.

Table 4 shows the independent-samples t-test results for post-test scores. The analysis produced $t = –2.74$; a negative t implies that the first group (control) mean is less than the second group (experimental) mean, $p = 0.009$, and Cohen’s $d = 0.776$ indicates a medium effect size. This suggests that the difference between the groups being compared is substantial and practically significant. This combination of statistical and practical significance provides strong evidence that the constructivist approach outperforms traditional instruction in enhancing mathematics achievement at the junior high level.

Table 4
Significance of the Difference in the Post-test of Experimental and Control Groups

Groups	t	p-value	Remarks
Control (Traditional Approach) Experimental (Constructivist Approach)	-2.74	0.009	Significant

The results of this study support those of Cañete et al. (2020) and reveal a significant difference in post-test scores between the experimental and control groups. The control group, which was taught using the traditional approach, generally received a fairly satisfactory rating, while the experimental group, taught through the social interactive–constructivist approach, achieved a satisfactory rating. These findings suggest that the social interactive–constructivist approach is more effective than traditional teaching methods in enhancing students' mathematical performance. Additionally, the study conducted by Abdelkarim and Abuiyada (2015) found a significant difference in the post-test scores between the experimental and control groups. The findings indicate that peer teaching—a strategy grounded in social interaction—positively influences students' academic performance in mathematics.

Moreover, the results of the present study align with Vygotsky's (1978) social constructivism theory, which emphasizes the critical role of social interaction in cognitive development. According to this theory, learning occurs as students engage in dialogue, share knowledge, and construct meaning collaboratively. By integrating Vygotsky's principles into the constructivist approach, teachers can foster a learning environment that values cooperation, provides scaffolding, and considers learners' cultural and contextual backgrounds. This approach promotes a more interactive, student-centered classroom that fosters more profound understanding and active participation.

Significance of the Difference between the Pre-test and Post-test Mean Scores of the Control Group

Table 5 shows the difference between the pre-test and post-test means. scores of the control group. The obtained p-value of 0.001 was less than the 0.05 level of significance, indicating a significant difference in achievement in solving simultaneous linear equations using graphical, elimination, and substitution methods between the pretest and posttest of the control group. Further, although the percentages of the correct answer of the pre-test and post-test are 20.4 percent and 53.07 percent, respectively, and the control group is described as very low, an increase of 32.67 percent and the t-value of -20.2 show that the post-test mean score of the control group is higher than the pre-test mean score.

Table 5 presents the paired-samples t-test for the control group's pretest and posttest scores. The control group shows a Cohen's d of 4.04; this result indicates a large effect size, with the difference between the pre-test and post-test indicating a practically significant difference in the test's mean outcomes. This result shows that the traditional method used by the control group to discuss specific topics in linear equations has improved students' mathematics achievement.

Table 5

Significance of the Difference between the Pre-test and Posttest Mean Scores of the Control Group

Control Group	Mean	t	p-value	Remarks
Pre-test	12.24	-20.20	<0.001	Significant
Post-test	31.84			

The findings of this study indicate a significant improvement in the post-test scores of the control group, supporting the quasi-experimental study by Galia (2016) on a constructivist-based approach to teaching mathematics. In Galia’s study, although the focus was on the constructivist method, students taught through the traditional lecture method in calculus also demonstrated significant improvement, from fair to good, indicating the effectiveness of structured, teacher-led instruction. Similarly, the results align with the experimental study by Benning and Agyei (2018), which found a significant difference between pre-test and post-test scores for Grade 7 students taught quadratic equations using the traditional approach. Their study emphasized that when properly designed and delivered, traditional teaching methods can lead to measurable gains in student achievement. These findings affirm that even within traditional instructional settings, students can make meaningful academic progress when teaching is clear, organized, and aligned with learning objectives.

Significance of the Difference between the Pre-test and Post-test Mean Scores of the Experimental Group

Table 6 shows the difference between the pre-test and post-test mean scores of the experimental group. The level of achievement in linear equations on the pretest and posttest for the experimental group indicates that the obtained p-value of 0.001 was less than the 0.05 level of significance. Although the percent of the correct answer of the pre-test, indicating 14.07, is described as very low, and the percent of the correct answer of the post-test, indicating 62.83, is described as low, the result still indicated a significant difference between the level of achievement in linear equations in the pre-test and post-test of the experimental group, which increased by 48.76 percent. The t-value of -35.5 means that the post-test mean score of students from the experimental group is higher than their pre-test mean score.

Table 6 shows the paired-samples t-test for the experimental group's pretest versus post-test scores. The experimental group's shows a $t = –35.5$, $p < .001$, and Cohen's $d = 7.10$, indicating an extremely large effect size; it means the difference between the pre-test and post-test being compared is very strong and practically has a significant difference in the mean outcomes of the test. This result implies that the constructivist approach generated learning gains far exceeding those achieved through traditional methods alone.

Table 6

Significance of the Difference between the Pre-test and Post-test Mean Scores of the Experimental Group

Experimental Group	Mean	t	p-value	Remarks
Pre-test	8.44	-35.50	<0.001	Significant
Post-test	37.76			

The findings of this study support the research of Yakubu (2020), which demonstrated the effectiveness of the constructivist approach in enhancing students' competence in solving word problems involving linear equations in one variable. Similarly, the experimental study by Andam et al. (2015) in Kumasi, Ghana, confirmed that students taught using constructivist strategies showed significant improvement in solving linear algebraic equations, highlighting the approach's potential to enhance mathematical understanding.

Furthermore, Vintere (2018) emphasized that constructivism not only enhances mathematical competencies but also fosters creativity and analytical thinking. These skills are essential for preparing students to solve complex and real-world problems effectively.

The consistent findings across these studies reinforce the constructivist approach's significant contribution to students' academic growth, as evidenced by the experimental group's notable increase in post-test scores.

Mean Gain Scores of the Control and Experimental Groups

Table 7 displays the mean gain scores of both the experimental and control groups. The mean gain scores indicate the average improvement in mathematics achievement observed from the pre-test to the post-test for both the experimental and control groups. The control group had a mean gain score of 19.600, while the experimental group had a mean gain score of 29.320, as shown in the descriptive statistics for gain scores (post-test minus pre-test). The control group's average gain was 19.6 points (SD = 4.85), whereas the experimental group averaged a gain of 29.3 points (SD = 4.13).

The nearly 10‑point differential in mean gains, combined with relatively low variability, suggests a consistently larger benefit of the constructivist approach across individual students. This result indicates an improvement in students' achievement across both groups.

Table 7
Mean Gain Scores of the Experimental and Control Groups

Groups	Mean	Standard Deviation
Control (Traditional Approach)	19.60	4.85
Experimental (Constructivist Approach)	29.32	4.13

The findings of this study revealed that the experimental group achieved a higher mean gain score compared to the control group, indicating the greater effectiveness of the constructivist approach over traditional methods. This result is consistent with the study by Samsudin et al. (2016), which demonstrated that students taught through a constructivist approach significantly improved their scores—from a pre-test mean of 60.28 to a post-test mean of 76.39—suggesting a substantial learning gain. Although the study focused solely on the experimental group, the substantial increase supports the effectiveness of constructivist teaching.

Likewise, Nair (2019) emphasized that students who underwent constructivist instruction outperformed their counterparts taught using traditional strategies, with both male and female students benefiting equally from the approach. Collectively, these findings reinforce that the constructivist method leads to greater academic gains, as reflected in higher mean gain scores compared to traditional instruction.

Significance of the Difference between the Mean Gain Scores of the Experimental and Control Groups

Table 8 shows the difference in mean gain scores between the experimental and control groups. Table 8 presents the independent-samples t-test comparing gain scores between groups. The comparison yielded t = –7.63; a negative t means the first group (control) mean is less than the second group (experimental) mean, p < 0. 0.01, and Cohen's d = -2.16; a negative Cohen's d means the effect of the experimental group is bigger than the control group. This result confirms that the experimental group's improvement is highly unlikely to be due to chance, providing conclusive evidence of the constructivist approach's enhanced efficacy in boosting junior high students' mathematics achievement.

Table 8

Significance of the Difference between the Mean Gain Scores of the Experimental and Control Groups

Groups	t	p-value	Remarks
Control Experimental	-7.63	<0.001	Significant
Effect Size (Cohen's d)	-2.16		Very Large

The significant difference in the mean gain scores between the experimental group, which used the constructivist teaching method, and the control group, which followed traditional methods, supports previous research on the effectiveness of constructivist teaching in enhancing students' mathematical achievement. Studies by Aydisheh and Gharibi (2015) consistently show that constructivist approaches, characterized by active, student-centered learning, lead to better academic performance than traditional, teacher-centered instruction. Similarly, Kaur and Kaur (2022) found that students taught through constructivist methods showed significantly greater achievement gains than those taught traditionally, highlighting a clear difference in gain scores between the two groups.

The findings align with Vygotsky's social constructivism and Piaget's cognitive constructivism, both of which highlight the importance of social interaction and active problem-solving in learning. These theories suggest that constructivist methods, such as collaboration and hands-on learning, promote deeper understanding and retention of math concepts, thereby improving academic outcomes.

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