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# The Effects of Peer Tutoring Strategy On Student-Teachers' Academic Performance in Linear Equations in Algebra

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doi: <https://doi.org/10.37745/ijeld.2013/vol14n14656>

Published February 21, 2026

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**Citation:** Adokoh E., Tatsi S., Yeng E. & Asemani E. (2026) The Effects of Peer Tutoring Strategy On Student-Teachers' Academic Performance in Linear Equations in Algebra, *International Journal of Education, Learning and Development*, 14 (1),46-56

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**Abstract:** *Peer tutoring in recent times has garnered significant academic attention within education as a cornerstone of cooperative learning and a pivotal instructional method for inclusive education. This study specifically investigated the impact of peer tutoring on mathematics academic performance among student-teachers. Grounded in positivist philosophy, the study employed a pre-test, post-test quasi-experimental design with two intact classes: fifty student-teachers in the control group (receiving traditional instruction) and sixty in the experimental group (engaged in peer tutoring). Academic achievement was evaluated using the Linear Equation in Algebra Test (LEAT), a 30-item multiple-choice objective test designed to measure proficiency in algebraic concepts. The results indicated that student-teachers in the peer tutoring group achieved higher scores on the LEAT compared to those in the traditional instruction group. This outcome underscored the efficacy of peer tutoring in enhancing academic performance in mathematics. Based on these findings, it is recommended that teachers adopt peer tutoring instructional strategies in their classrooms to improve student-teachers' academic outcomes. Peer tutoring not only facilitates deeper learning through collaborative interaction but also promotes a supportive learning environment conducive to academic growth and achievement. This approach aligns with inclusive education principles by fostering peer support and active student engagement in the learning process.*

**Keywords:** academic performance, instructional strategy, peer tutoring, student-teachers, Algebraic Linear Equations.

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## INTRODUCTION

Enabling student-teachers to engage in collaborative and communicative learning as well as inclusive education is one of the key competencies of the common core curriculum (NaCCA, 2019). As part of the attempt to reverse the trend of declining motivation to study among student-teachers, various attempts, such as problem solving, professional guidance, and support, are being made (Gal, 2020). One of the attempts to resolve the shortage of good teachers (Karamaroudis et al., 2020) and draw student-teachers to the discipline is through social learning, such as activating peer tutoring. Peer tutoring serves as a strategy for learning knowledge and skills in a collaborative way in which student-teachers teach each other, and is an example of a teaching method that is based on Vygotsky's theory (Engels et al., 2018; Nind et al., 2020). For it to be successful, it is not enough to focus on the cognitive aspect, as the social aspect plays a

significant role in the success of peer tutoring (Engels et al., 2018; Raisanen et al., 2020). Cockerill et al. (2018) attest that student-teachers can communicate verbally with their classmates while also leveraging shared cultural and linguistic references while they are learning, and they can aid a classmate in their learning. The core of peer tutoring in a study conducted by Seery et al. (2021), reveals that helping your peers to learn will develop your academic and interpersonal abilities. Moreover, Peer tutoring improves student-teachers' inclusion and collaborative learning (Clarence, 2018).

Furthermore, peer tutoring, according to Nzekwe-ujunwa (2018), is a comparative learning strategy based on the pairing up of students with equal academic backgrounds (tutor and tutee). Duran et al. (2018) states that many times student-teachers can be better mediators than teachers or adults in academic environments. The study supports that student-teachers have just learned the contents, so they know better the areas in which their peers might need more help. Research study reveals that peer tutoring increases student-teachers' motivation to learn. However, the study also reveals that peer tutoring increased student-teachers' enthusiasm to learn (Somers & Llinares, 2021). One of the goals of Bachelor of Education programmes for the College of Education and other tertiary institutions demands that student-teachers develop collaboration and communication, personal development, critical thinking, problem solving, and other core competencies. However, peer tutoring forms part of the instructional strategies to ensure these competencies in student-teachers (NaCCA, 2019). Cooperative learning is generally defined as a teaching arrangement that refers to a small, heterogeneous group of students working together to achieve a common goal (Dotson, 2001). Cooperative learning enables student-teachers' learn from their colleagues and may feel more comfortable asking questions to colleagues rather than a teacher.

Daly-Smith et al. (2021) regard instructional strategies and materials as all the things the teacher utilizes to interactively enhance, motivate, and facilitate teaching and learning in an attempt to ensure the achievement of a set of objectives. The concept of algebra is the major component of the mathematics curriculum in all countries around the world (Kieran, 2020). Arcavi et al. (2017) define the aims of school algebra as including expressing generalizations, establishing relationships, solving problems, exploring properties, proving theorems, and calculating. Evidence from researchers showed that students' ability to solve algebraic linear equation problems has not yet attained the desired expectations because of their semester's low performance (Zongo et al., 2023). Similarly, evidence from researchers shows that student achievement in linear equations in algebra is impaired because of the pedagogy applied in courses that appear to be largely teacher-centered (Hazmi, 2023; Nyaikamba-Kamau, 2022). Nyaikamba-Kamau (2022) attests that the lack of instructional strategies that give students the opportunity to interact with each other and formulate their own ideas is one of the sources of minimal understanding of basic concepts of linear equations in algebra. This form of learning strategy must be implemented by moving towards a student-centered approach, in which learners are actively involved in their own learning rather than as passive recipients of information. Lectures need to be content-rich and focus on pedagogy that will incorporate learner interaction. According to Chan et al. (2023), what is needed today in pedagogy is a learning strategy that places more emphasis on student participation in knowledge construction rather than knowledge transformation. For learners to understand and have meaningful experiences when learning linear equations in algebra, they must have the opportunity to work in groups and use the concepts they have learned to interpret, explain, algebraic analysis, and evaluation, structure, among others. This study examines the effect of peer tutoring strategies on student-teachers' performance in linear equations in an algebra classroom.

### **Problem Statement**

The effective cultivation of core pedagogical and content competencies in mathematics, particularly in algebra, is essential for student-teachers to meet the objectives of the common core curriculum. These objectives include critical thinking, problem-solving, and collaboration (NaCCA, 2019; Arcavi et al., 2017). However, documented evidence consistently shows that student-teachers' academic performance in algebraic linear equations falls below acceptable standards (Zongo et al., 2023). This ongoing achievement gap is often attributed to the dominant use of teacher-centered instructional approaches (Hazmi, 2023; Nyaikamba-Kamau, 2022). Such traditional methods frequently restrict student-teacher interaction and engagement in the conceptual development of knowledge (Chan et al., 2023; Nyaikamba-Kamau, 2022), resulting in a limited understanding of fundamental algebraic principles. While peer tutoring is widely recognized as an effective student-centered and collaborative learning strategy (Engels et al., 2018; Nind et al., 2020), known for enhancing student-teacher motivation (Somers & Llinares, 2021), improving inclusion (Clarence, 2018), and fostering interpersonal skills (Seery et al., 2021; Cockerill et al., 2018), a significant gap in the literature remains. Specifically, the direct, measurable impact of peer tutoring on significantly improving academic performance in the specific area of linear equations in algebra among student-teachers within the local context has yet to be empirically established. As a result, this study addresses the urgent need for an empirically validated, student-centered instructional intervention to bridge the documented gap in algebraic performance. This research aims to assess the effectiveness of implementing the peer tutoring strategy as an instructional method for enhancing student-teachers' academic performance in linear equations within algebra classrooms.

### **Research Objective**

The objective of this study was to determine the effect of a peer tutoring strategy on student-teachers' academic performance in a mathematics linear equation in an algebra classroom.

### **Null Hypothesis**

H<sub>0</sub>1: There is no significant difference in student-teachers' academic performance in the mathematics linear equation in the algebra classroom of the experimental group and the control group.

## **THEORETICAL FRAMEWORK**

The study is anchored in Vygotsky's Sociocultural Theory (1978), which posits that learning is fundamentally social and occurs through interaction with others and cultural artifacts. According to Vygotsky, the learning process involves the learner (student-teachers), the subject matter (linear equations in algebra), and mediating artifacts (social tools) that facilitate learning and problem-solving abilities. Social mediation, facilitated by these artifacts, plays a crucial role in the development of high-level mental functions, such as drawing conclusions and solving complex problems. In addition to Sociocultural Theory, the study integrates principles of social-emotional learning (SEL), which emphasize creating a positive social and emotional environment conducive to learning (Neth et al., 2020). SEL encompasses the acquisition of attitudes and skills essential for student-teachers to manage their emotions effectively, handle uncertainty, engage in problem-solving, empathize with others, maintain positive relationships, and make responsible decisions (Omasta et al., 2020; Pinchumphongsang & Chanchalor, 2020). It also involves

developing cognitive abilities related to processing and responding to emotions in ways that promote productive and empowering behaviors.

In this study, Vygotsky's Sociocultural Theory informs the implementation of peer tutoring as an instructional strategy. By engaging student-teachers in collaborative learning activities, such as peer tutoring sessions focused on linear equations in algebra, the study leverages social interaction and cultural tools to enhance learning outcomes. The mediating artifacts, in this case, include peer interactions and collaborative problem-solving, which are designed to scaffold student-teachers' understanding and application of algebraic concepts. Furthermore, integrating principles of SEL ensure that the learning environment is not only academically enriching but also emotionally supportive. The study emphasizes the development of socio-emotional competencies among student-teachers, which are essential for their holistic growth and future professional effectiveness. By fostering a positive learning climate that addresses emotional intelligence and interpersonal skills, the study aims to enhance student-teachers' overall academic achievement and well-being. Thus, by synthesizing Sociocultural Theory with SEL principles, the study seeks to provide a comprehensive framework that supports both cognitive and socio-emotional development among student-teachers. This theoretical foundation guides the implementation of peer tutoring as a pedagogical approach aimed at improving academic performance in algebra while nurturing essential life skills and emotional resilience.

## METHODOLOGY

This study adopted the research philosophy of positivism. To Cohen et al. (2008), the objective of positivism is to measure, control, predict, constrict laws, and ascribe causality. A pre-test, post-test quasi-experimental design was adopted in this study using two groups (experimental and control), to determine the students' understanding of the topics. In this type of design, the group was observed and measured not only after being exposed to treatment but also before (Fraenkel & Wallen, 2008; Johnson & Christensen, 2008; McBurney & White, 2010; Kaplan & Garner, 2020). The research design illustration is presented in Figure 1:



**Figure 1:** Research Design Illustration

EG	= Experimental group,	CG	= Control group
01	= Pre-test	X1	= Treatment using peer tutoring
X2	= Treatment using conventional method	02	= Post-test

This study targeted all second-year student-teachers' offered the course Linear Equation in Algebra. It is assumed that the student-teachers have gone through their first year, where they have the basic prerequisite knowledge of linear equations in the Algebra course. The research samples of this study were identified through a purposive sampling of dividing the student-teachers into two main groups. The first group was the experimental while the second was the control group. The reason behind dividing the student-teachers into two groups is that all the student-teachers offer Linear Equations in Algebra as a compulsory course in the second year. Table 1 shows the sample selected for the study.

**Table 1: Sample Selected for the Study**

Division	Groups	Total Number of Students
A	Experimental	60
B	Control	50
<b>Total</b>		<b>110</b>

### Intervention Process

The experimental group was exposed to a peer tutoring strategy during the intervention process, whereas the control group was subjected to conventional methods. Two mathematics lectures with similar competence and experience from the Basic Education Department teaching mathematics specialism instructed both groups. The groups were instructed separately, meeting once a week for at least two hours for a period of 4 weeks. In the peer tutoring intervention, student-teachers tutored each other in a face-to-face setting and in a small group of five tutees per tutor; and it was found that none of the students had previously been in a peer tutoring setting. The intervention consisted of 4 consecutive sessions in a row, including a training session. At the end of each session, the tutor's role is exchanged among the students, giving all the student-teachers equal opportunities to benefit during the implementation of peer-tutoring (Alegre et al., 2019). The same post-test was given to both groups at the end of the intervention process to see the effect of the intervention and to compare their performance in linear algebra.

The researchers constructed a self-developed Linear Equation in Algebra Test 1 (LEAT 1) as a pre-test and Linear Equation in Algebra Test 2 (LEAT 2) as a post-test; both tests were parallel to the same level of difficulty. The research instruments were validated by experts, and adjustments have been taken into consideration to ensure the instruments and their content are valid. A pilot test of the instruments was conducted among student-teachers who were not part of the study, but part of the population. 78 student-teachers were pilot tested. The data obtained from the pilot study were used to determine the reliability coefficient of the instruments. The instruments were found to be reliable for the study, as the reliability coefficient of 0.78 was achieved using Spearman Brown equal length value reliability. There are a variety of factors that may impact internal validity that can be related to the researchers (test administrator), research participant (test taker), and the environment in which the research (test) is conducted. These threats to internal validity basically decrease the likelihood that the results of the experiment are due to relationships among/between independent and dependent variables. These threats to internal validity, such as testing threat, instrumentation threat, regression to the mean, differential selection, etc., were minimized.

The instruments were divided into Linear Equation in Algebra Test 1 (LEAT 1) and Linear Equation in Algebra Test 2 (LEAT 2). The LEAT 1 was administered to the student-teachers before the treatment process, while the LEAT 2 was administered to the student-teachers after the treatment process. The tests were carried out at the time allocated to the student-teachers, and both groups completed the test at the appropriate time (3 hours). The test was collected and marked by the research assistants according to the rubric. Scores obtained from the tests were statistically analyzed using Mean, Standard Deviation, and an independent sample t-test at  $\alpha = 0.05$ . Effect size statistics were also computed to determine the magnitude of the effect of the intervention. The following ethical considerations were considered for the study: informed consent, confidentiality, harm to participants, etc.

**RESULTS AND DISCUSSIONS****Pre-Test**

Before the intervention process, both groups were given the same Pre-Test to determine their level of homogeneity (group equivalence), understanding the subject area, and serving as a basis for pairing experimental group student-teachers in their various groups. The Pre-Test scores mean and Standard Deviation are shown in Table 2.

**Table 2: Pre-Test Results**

	Group	N	Mean	Std. Deviation
	Experimental	60	23.60	1.520
<b>Pre-Test</b>	Control	50	23.40	1.578

**Source: Field Work (2024)**

The Pre-Test results presented in Table 2 indicate that the mean scores for the experimental group and the control group were 23.60 and 23.40, respectively. The small mean difference of 0.2 points suggests that both groups had similar levels of understanding and proficiency in linear equations in algebra before the intervention. This similarity in Pre-Test scores is crucial as it establishes the initial equivalence between the groups, ensuring that any differences observed in the Post-Test scores can be attributed to the intervention rather than pre-existing disparities in knowledge or skills. To statistically confirm whether the mean scores of the Pre-Test are significantly different, a t-test was conducted. The t-test results, presented in Table 3, will help determine if the initial performance levels of the experimental and control groups were indeed comparable. By verifying the homogeneity of the groups, the validity of the intervention's impact on the Post-Test scores is strengthened. This ensures that the improvements seen in the experimental group's Post-Test scores are a result of the peer tutoring strategy rather than any inherent differences between the groups at the start of the study. This initial step of administering the Pre-Test and analyzing its results is a critical part of experimental design. It helps in confirming that the groups are starting from a similar baseline, thus making the subsequent comparison of Post-Test results more robust and meaningful. By establishing this equivalence, the study can more confidently attribute any observed differences in learning outcomes to the peer tutoring intervention, providing stronger evidence for its effectiveness.

**Table 3: Pre-Test Comparison between Experimental and Control Groups**

	Group	Mean	Std. Deviation	t	df	Sig.
	Experimental	23.60	1.520			
Scores				0.675	108	0.501
	Control	23.40	1.578			

**Source: Field Work (2024)**

Results from Table 3 show that the mean scores of the experimental group ( $M = 23.60$ ,  $SD = 1.520$ ) and the control group ( $M = 23.40$ ,  $SD = 1.578$ ) are not significantly different in their Pre-Test scores;  $t(108) = 0.675$ ,  $p = 0.501$  at  $\alpha = 0.05$ . This indicates that the difference in mean scores is not statistically significant, confirming that both groups are equivalent at the start of the study. The statistical analysis confirms that the groups are homogenous, meaning there were no significant pre-existing differences between them. This homogeneity is important for the validity of the study, as it ensures that any differences in the Post-Test scores can be attributed to the peer tutoring intervention rather than initial disparities. The eta square value of 0.185, although noted as large in the provided text, suggests a negligible effect size in the context of this comparison, further reinforcing the equivalence of the two groups. Establishing this initial equivalence ensures that any observed differences in learning outcomes post-intervention are due to the peer tutoring strategy, thereby providing stronger evidence for its effectiveness.

### Hypothesis

There is no significant difference in the academic performance of student-teachers in mathematics linear equations in the algebra classroom between the experimental group and the control group.

**Table 4: Post-Test Comparison between Experimental and Control Groups**

	Group	Mean	Std. Deviation	t	df	Sig.
Scores	Experimental	38.50	1.112	43.694	108	0.000
	Control	27.20	1.591			

**Source: Field Work (2024)**

The findings presented in Table 4 reveal that the post-test scores are statistically significant with respect to the experimental group ( $M = 38.50$ ,  $SD = 1.112$ ) and the control group ( $M = 27.20$ ,  $SD = 1.591$ );  $t(108) = 43.694$ ,  $p = .000$  at  $\alpha = 0.05$ . This statistical outcome indicates that the null hypothesis, which states that there is no significant difference in student-teachers' academic performance in a linear equation in an algebra classroom between the experimental group and the control group, is rejected. Consequently, the alternative hypothesis is accepted, asserting that there is a significant difference in students' academic performance in the linear algebra classroom due to the peer tutoring strategy. The magnitude of the difference in the means, measured by eta square, is 0.946, indicating a very moderate effect size. This substantial eta square value suggests that the peer tutoring strategy had a considerable positive impact on the academic performance of student-teachers in the linear equation in the algebra classroom. These findings confirm that the peer tutoring strategy among Basic Education Mathematics Student-Teachers is effective in producing academic gains in the Linear Equation in Algebra classroom. The significant statistical difference at  $\alpha = 0.05$  supports the conclusion that peer tutoring enhances understanding and performance in this subject area. This study's findings align with previous research. Studies conducted by Tsuei (2012), Ke (2013), and Toh and Kaur (2019) also demonstrated improvements in the mathematics self-concepts of student-teachers following peer tutoring interventions. Additionally, this study concurs with the observations of Philip and Council (2010) and Romano and Walker (2010), who noted that peer tutoring positively affects student-teachers' performance. The evidence from this study strongly supports

the effectiveness of peer tutoring in enhancing student-teachers' academic performance in linear equations in algebra classrooms. The peer tutoring strategy not only improves scores but also fosters better comprehension and confidence in algebraic concepts among student-teachers.

## CONCLUSION AND RECOMMENDATIONS

This study investigated the impact of peer tutoring on the learning outcomes of student-teachers in a Linear Equation in Algebra classroom. The peer tutoring strategy, which involved students working in pairs or small groups to tutor each other, led to a significant increase in the scores of those who participated compared to those who did not. This was evidenced by the post-test results, where the experimental group outperformed the control group, suggesting that peer tutoring was highly effective in enhancing student-teachers' understanding of algebraic concepts related to linear equations. The statistical analysis confirmed that the differences in scores between the two groups were not due to chance, with a very low p-value ( $p = .000$ ) indicating a high level of statistical significance. Furthermore, the eta square value of 0.946 indicated a substantial impact of peer tutoring on student-teachers' performance.

These findings imply that peer tutoring promotes active engagement, allowing student-teachers to participate in the learning process by asking questions, explaining concepts, and solving problems collaboratively. This active engagement is crucial for deeper learning and retention of knowledge. Additionally, peer tutoring provides immediate feedback, helping student-teachers correct mistakes and misunderstandings in real-time, leading to a more accurate understanding of algebraic concepts. The personalized nature of peer tutoring also allows student-teachers to work at their own pace and receive tailored explanations suited to their learning styles, which is often not possible in large classroom settings. Moreover, peer tutoring boosts motivation and confidence by creating a supportive learning environment where student-teachers can rely on and help each other. This positive atmosphere likely contributed to their improved performance. For the tutors, the process of explaining concepts and solving problems reinforced their own understanding of the material, demonstrating the reciprocal benefits of peer tutoring. The study shows that peer tutoring significantly improves student-teachers' academic performance and comprehension of linear equations in algebra. By fostering a collaborative, engaging, and supportive learning environment, peer tutoring proves to be an effective educational strategy that enhances learning outcomes and promotes a deeper understanding of complex subjects like algebra. Based on these findings, it is recommended among others that:

1. Peer tutoring as a teaching technique in algebra classrooms should be implemented to boost student confidence and understanding of linear equations through face-to-face interaction, leading to improved engagement, academic achievement, and problem-solving skills.
2. NaCCA and GES should promote peer tutoring strategies among teachers to standardize effective teaching practices, improve student performance, and create a collaborative learning culture, ultimately raising educational standards and reducing achievement gaps.
3. Regular in-service training for mathematics teachers should be organized to enhance their skills in using peer tutoring strategies, leading to more effective teaching, better student outcomes, and innovative approaches to education.

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