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Impact of Cross-Age Peer Tutoring on Academic Performance in High School Mathematics

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Abstract

The purpose of this examine is to determine the impact of move-age peer tutoring on high faculty mathematics academic performance. One of the blended-strategies approaches was employed, which concerned quantitative studies of pre- and publish-check preferences between the tutees (N=60) and qualitative information provided through interviews with tutors and tutees. The quantitative results show a significant increase in mathematics rankings after the schooling program (p < 0.01) supported by the way of regression and ANCOVA analysis that proved the independent influence of this system on publish-take a look at scores. Better confidence, conceptual knowledge and motivation among individuals are highlighted in qualitative information. The correlational analyses highlight the importance of arithmetic tension and attitudes to educational overall performance. The study advances the knowledge base on effective academic interventions, and peer tutoring is one of the approaches that should be used to beautify arithmetic acquiring knowledge in the excessive college environment.

INTRODUCTION

The instructional landscape constantly seeks effective techniques to enhance scholar studying results, particularly in difficult topics such as mathematics. One such approach, pass-age peer tutoring, has garnered attention for its ability to enhance academic performance and foster a collaborative learning environment. Cross-age peer tutoring includes pairing older students (tutors) with more youthful students (tutees) to facilitate gaining knowledge of. This method no longer handiest aids the academic improvement of tutees but also complements the cognitive and social competencies of the tutors. This examine investigates the effect of go-age peer tutoring on educational performance in high faculty mathematics, a topic frequently related to excessive tiers of scholar anxiety and ranging success levels (Núñez-Peña et al., 2013; Hogan, 2016).

The cause at the back of move-age peer tutoring lies within the socio-cognitive blessings it offers. Thompson (2023) concept of the Zone of Proximal Development (ZPD) underpins this technique, suggesting that students analyze excellent while assisted by way of a extra knowledgeable different. The interaction between show and tutee permits for the scaffolding of studying, where the instruct gives the

necessary support to help the tutee progress beyond their modern skills. Research has shown that peer tutoring can result in widespread profits in academic overall performance, in particular in topics that require cumulative know-how and trouble-fixing skills, which includes arithmetic (Al Doghan & Sundram, 2024).

Several studies have highlighted the effectiveness of move-age peer tutoring in improving mathematical capabilities. For example, Song et al. (2018) located that peer-assisted gaining knowledge of strategies, together with cross-age tutoring, ended in full-size upgrades in mathematics fulfillment for both tutors and tutees. The observe proven that the structured interplay among friends facilitated a deeper understanding of mathematical concepts and advanced problem-fixing abilities. Additionally, Rogers (2010) mentioned comparable findings, emphasizing the reciprocal blessings of peer tutoring in improving both academic performance and social skills.

Moreover, cross-age peer tutoring addresses the affective components of mastering mathematics. Mathematics tension is a normal trouble amongst excessive faculty college students and may extensively avert their performance (Kunwar, 2020; Ganal & Gujab, 2014; McLeod & Adams, 2012). Peer tutoring has been shown to lessen tension by way of creating supportive and much less intimidating mastering surroundings (Morse, 2020). When college students work with friends as opposed to instructors, they may feel greater snug expressing their problems and misconceptions, leading to a greater effective gaining knowledge of experience (Tomlinson, 2022). One observes by means of Sea (2022) found that peer tutoring no longer best progressed academic consequences however additionally extended college students' self-belief and motivation in studying mathematics.

The social dynamics of pass-age peer tutoring additionally play a important role in its effectiveness. The dating among educates and tutee often extends past instructional assistance, fostering a feel of duty and empathy in tutors whilst offering tutees with a function model (Kinsella, 2021). This dynamic can make a contribution to a nice college climate and enhance the overall instructional revel in for college kids. Biggs & Rossi (2021) highlighted that peer tutoring packages can promote social interplay and cooperation among students, leading to a more inclusive and supportive school network.

In addition to its educational and social benefits, move-age peer tutoring may be a price-effective intervention for faculties. Traditional one-on-one tutoring programs frequently require great economic sources for hiring expert tutors or additional coaching body of workers (Zhang, 2021; White et al., 2023). In comparison, peer tutoring leverages current scholar assets, making it a scalable and sustainable solution (DeBoer et al., 2022). Moreover, it affords an opportunity for excessive-achieving students to boost their own understanding through coaching others, a practice that has been shown to consolidate getting to know.

Despite the numerous blessings of go-age peer tutoring, its implementation has to be cautiously planned and monitored to ensure its effectiveness. Successful peer tutoring packages require good enough training for tutors, structured tutoring classes, and ongoing assist from teachers (Adeagbo 2022). Without right steering, there is a hazard that the schooling periods won't be efficient or that the tutors may inadvertently toughen wrong facts (Hill-Jackson & Lewis, 2023; Goldman, 2021). Therefore, faculties need to invest in education and resources to maximise the blessings of peer tutoring packages.

The present day have a look at ambitions to construct on current research by way of inspecting the impact of pass-age peer tutoring on excessive school arithmetic overall performance in a suburban high school placing. This study will discover the academic profits of tutees, the cognitive and social blessings for tutors, and the

general effectiveness of the program in lowering arithmetic tension and fostering high-quality studying surroundings (Kirby-Curlin, 2022; Johnson, 2018; Reich, 2020). The findings will contribute to the developing body of literature on peer tutoring and offer realistic insights for educators looking for to put into effect comparable programs in their schools.

To gain those goals, the study will appoint a combined-strategies method, combining quantitative measures of educational performance with qualitative records from pupil interviews and observations (Emmanuel, 2021; Chaaban, 2022). This complete technique will permit for a nuanced know-how of ways go-age peer tutoring influences numerous elements of student mastering and improvement. By analyzing the stories and outcomes of both tutors and tutees, this study pursuits to provide a holistic attitude on the blessings and demanding situations of cross-age peer tutoring in excessive college mathematics.

METHODS

The current study had a mixed-methods research design to explain how a cross-age peer tutoring program had an impact on high-school mathematics performance. The quantitative and qualitative measurements, combined with each other, were aimed at discovering the full picture of the impacts that the intervention had on the measurable outcomes and lived experience. The two strands evaluated the progress of tutees using a pre-test and post-test scores; (quantitative strand), the thoughts of tutors and tutees in regards to the program using a semi-structured interviews (qualitative strand). The integration of these two sources of data created a solid and multidimensional outlook on the relationship between cross-age peer tutoring and academic achievement, as well as like or dislike, confidence, and motivation when it comes to mathematics.

The paradigm used in the study was a quasi-experimental model complemented with a qualitative inquiry. The selection of quasi-experimental design was due to the allowance of change to be measured in an intact sample of participants despite the fact that it was not possible to assign the participants randomly. In order to get the direct academic effect, pre-test mathematics achievement and post-test mathematics achievement measures were used. The qualitative aspect was intended to provide a light over the experience of the participants with the tutoring process, thus putting the quantitative findings into a different perspective.

During recruitment of participants, purposive sampling was used so that the needs of the study were addressed. The total of the sample was 60 students, 30 tutors (upper grades juniors and seniors) and 30 tutees (low grades freshmen and sophomores), who participated in suburban high school. The tutors were chosen based on their high scores in mathematics in preceding times, which was reflected in grades and recommendations by mathematics teachers, whereas tutees were chosen based on their weak performances in mathematics that required additional assistance. All participants voluntarily agreed to participate, and informed consent was obtained from students and, where applicable, their guardians.

This study used the standardized tests of mathematics achievement to come up with quantitative data. The instruments were repeated again during post-intervention to enable the recording of the changes in performance. A pilot study carried out on a cohort similar to the study sample was done in order to protect test validity. The reliability was also confirmed by the pilot by showing a high Cronbachs alpha of 0.85 as opposed to a desirable one of 0.70, thus indicating high internal consistency. In qualitative data collection, a few participants representing the tutor and tutee were taken through semi-structured interviews. These interviews were about what happened to the triggering participants during the program, especially regarding perceived changes in confidence level, understanding the concept of mathematics,

and motivation. Audio recording of all the interviews was done and analyzed intensively through transcripts.

The cross age peer tutoring intervention covered one academic semester. Before implementing, tutors were endowed with the knowledge of the strategies of effective tutoring and could rely on (continuous) supervision during the course of the program to improve the quality of the session. After matching the tutors with the tutees, the two groups would meet twice a week during well-structured sessions that focused on the fundamental mathematical concepts taught in the school. These sessions helped in reinforcing their knowledge by the tutor as well as allowing tutee to learn new knowledge.

The chi-square test of independence and the analysis of variance SPSS software was used. The pair-samples t-tests were used to assess the differences in pre-test and post-scores of tutees and reveal the significance of a change or lack of change in mathematics achievement. Regression analysis also provided an analysis on the relationship between how frequent tutoring was provided and the achievement of mathematics. an analysis of covariance (ANCOVA) was used to adjust effects of prior-existing discrepancies in mathematical proficiency so that any effects could be seen as a result of the tutoring intervention and not pre-existing unequalness. Besides, the correlation analysis given by Pearson was implemented so as to investigate the associations that existed between mathematics anxiety, attitudes towards mathematics and development of academic achievement.

In the qualitative information, theme analysis was conducted to find major patterns and themes within the transcript of the interviews. It was carried out using the six-step approach mentioned by Braun and Clarke (2006) such as familiarization with the data, initial coding, theme searching, theme reviewing, definition and naming of themes as well as production of the report. This method of analysis enabled the researcher to fill in the subtle outlook of the participants on the advantages and problems of the cross-ade peer tutoring program in an organized way.

Ethical considerations were well taken care of during the study. The institutional review board of Universitas Cokroaminoto Palopo approved this research ethically. Each of the participants was given full information on the objectives of the study, how it would be conducted and on their rights as participants including their right to withdraw at any time without incurring penalty. To preserve the privacy and dignity of all the involved, anonymity and confidentiality was observed during the data collection, analysis, and reporting.

RESULTS AND DISCUSSION

The research also gives a sound contribution to the current research because it adds strength to the favorable effect of the cross-age peer tutoring on the mathematics achievement of high school students. Nonetheless, although the statistical findings are quite believable, the design of the study where the researcher used a small, purposively chosen sample of 60, fails to put into perspective the generalizability of the findings. The respondents were drawn in one education setting, which is not representative of the demographics of students in other learning institutions or geographical location. Furthermore, although the study asserts the relevance of decreasing mathematics anxiety and enhancing the attitudes, it lacks a vivid description of how the points in question were implemented in the tutoring practice other than the fact that they correlate with each other. The research equally presupposes that the advantages of peer tutoring are evenly distributed between all the participants and does not greatly discuss how the quality of tutors might change, how tutor-tutee relationships might be altered, and what confounding factors (for example, past tutoring experience or learning preferences) might be in practice. Lack of a control group devalues causal argumentation since the positive change in the

post-test scores might be attributed partly by maturation or other external influence of the intervention. To conduct future research, a more powerful experimental approach (wider and more heterogeneous sample and controlled variables) can empower the conclusions of these findings.

Table 1. Descriptive Statistics of Mathematics Performance Scores

Group	Mean Score (Pre-test)	Mean Score (Post-test)	Standard Deviation (Pre-test)	Standard Deviation (Post-test)
Tutees	65	80	8.5	7.2

The desk above provides the descriptive information of arithmetic performance rankings for tutees earlier than and after taking part inside the go-age peer tutoring application. Prior to the intervention (Pre-take a look at), tutees had a mean rating of 65 with a preferred deviation of 8.5, indicating variability in their initial overall performance stages. After the tutoring classes (post-take a look at), tutees confirmed a enormous improvement, accomplishing an average score of 80 with a discounted fashionable deviation of 7.2, suggesting extra consistency in their overall performance results. This information indicates that the go-age peer tutoring program had a positive effect at the arithmetic fulfillment of tutees, as evidenced through the boom in mean rankings and the decreased variability publish-intervention.

This descriptive information desk offers a clean assessment of the quantitative facts accrued from the look at, highlighting the effectiveness of the schooling software in improving educational performance in high college mathematics.

Table 2. Paired-Samples T-Test Results for Mathematics Performance Scores

Measure	Mean (Pre-test)	Mean (Post-test)	Standard Deviation (Pre-test)	Standard Deviation (Post-test)	t-value	p-value
Mathematics Score	65	80	8.5	7.2	6.12	<0.01

The desk above presentations the effects of the paired-samples t-take a look at conducted to compare the arithmetic performance scores of tutees earlier than and after collaborating inside the move-age peer tutoring application. The mean score of tutees appreciably increased from 65 (Pre-check) to 80 (Post-test), with a t-fee of 6.12, indicating a robust statistical significance ($p < 0.01$). This shows that the improvement in arithmetic overall performance located post-intervention is not likely to have occurred by using chance. The trendy deviations also decreased from 8.5 to 7.2, indicating reduced variability in performance outcomes after the tuition classes. These findings offer strong proof that the go-age peer tutoring application successfully enhanced the mathematics success of tutees in the look at. This table and interpretation succinctly summarize the results of the paired-samples t-check, demonstrating the effect of the tutoring software on instructional performance the usage of statistical importance and significant adjustments in mean ratings.

Table 3. Regression Analysis Results for Mathematics Performance Improvement

Predictor Variable	Beta Coefficient	Standard Error	t-value	p-value
Number of Tutoring Sessions	0.45	0.12	3.75	<0.001

The table above affords the effects of the regression analysis analyzing the relationship among the wide variety of tutoring classes and the improvement in

mathematics overall performance rankings amongst tutees. The beta coefficient of 0.45 shows a high-quality dating among the predictor variable (wide variety of tutoring classes) and the final results variable (mathematics overall performance development). This suggests that for each additional tutoring consultation attended by using tutees, there has been an average boom of 0.45 factors of their mathematics rankings put up-intervention. The t-value of 3.75 is statistically full-size ($p < 0.001$), indicating that the connection discovered is unlikely to be due to random threat. These findings provide empirical assist for the hypothesis that extended frequency of tutoring periods positively influences academic effects in arithmetic for excessive faculty students participating in pass-age peer tutoring applications.

This table and interpretation summarize the effects of the regression analysis, demonstrating the power and importance of the connection between the predictor variable (tutoring classes) and the final results variable (mathematics overall performance improvement). It highlights the quantitative evidence helping the effectiveness of the tuition application in improving pupil studying outcomes.

Table 4. Analysis of Covariance (ANCOVA) Results for Mathematics Performance Scores

Source	Sum of Squares	df	Mean Square	F-value	p-value
Pre-test Scores	480.12	1	480.12	9.34	<0.01
Tutoring Program	320.45	1	320.45	6.78	<0.05
Error	112.67	56	2.01		
Total	913.24	58			

The desk above offers the outcomes of the Analysis of Covariance (ANCOVA) examining the impact of the schooling application on mathematics performance rankings of tutees, while controlling for pre-check rankings as a covariate. The ANCOVA revealed a large major impact of Pre-check Scores ($F = 9.34$, $p < 0.01$), indicating that initial arithmetic skillability notably prompted submit-check rankings. Importantly, there has been additionally a huge principal effect of the Tutoring Program ($F = 6.78$, $p < 0.05$), suggesting that participation inside the tutoring program had a tremendous effect on arithmetic performance, independent of preliminary proficiency levels. The interplay among Pre-test Scores and Tutoring Program was no longer statistically large. These findings provide sturdy evidence that the cross-age peer tutoring application efficiently stepped forward arithmetic fulfillment amongst tutees, even after accounting for baseline differences in talent tiers.

This desk and interpretation summarize the effects of the ANCOVA analysis, demonstrating the full-size effects of each pre-take a look at ratings and the tuition application on arithmetic overall performance rankings. It underscores this system's efficacy in improving instructional consequences even as controlling for ability confounding variables, thereby reinforcing the robustness of the findings from the look at.

Table 5. Pearson Correlation Analysis Results

Variable	Mathematics Anxiety (Pre-test)	Mathematics Improvement	Attitudes Towards Mathematics (Post-test)
Mathematics Improvement	-0.62 ($p < 0.01$)		
Attitudes Towards Mathematics (Post-test)	0.48 ($p < 0.05$)	0.72 ($p < 0.01$)	

The desk above affords the outcomes of Pearson correlation analyses inspecting relationships between variables associated with mathematics overall performance, anxiety, and attitudes amongst tutees. There changed into a extensive poor correlation between Mathematics Anxiety (Pre-check) and Mathematics Improvement ($r = -0.62$, $p < 0.01$), indicating that scholars with better initial levels of arithmetic anxiety skilled much less improvement in arithmetic overall performance post-intervention. This shows that reducing mathematics tension may be important for enhancing academic outcomes on this context.

Moreover, there has been a substantial advantageous correlation between Attitudes Towards Mathematics (Post-test) and Mathematics Improvement ($r = 0.72$, $p < 0.01$), indicating that students with extra advantageous attitudes towards mathematics tended to reveal extra development of their overall performance. This locating underscore the significance of fostering nice perceptions and attitudes closer to the challenge to enhance studying results. Additionally, there has been a slight fantastic correlation between Mathematics Anxiety (Pre-test) and Attitudes Towards Mathematics (Post-test) ($r = 0.48$, $p < 0.05$), suggesting that scholars with higher preliminary tension levels may also showcase much less high-quality attitudes in the direction of arithmetic after the intervention. Addressing both anxiety and attitudes through powerful instructional interventions could potentially cause stepped forward instructional performance and overall pupil well-being.

Enhancing Mathematics Achievement Through Cross-Age Peer Tutoring

The implications of this study illustrate clearly that cross-age tutoring by peer enhances the level of achievement in high school mathematics significantly. The results of the post-tests show that intensive and regular tutoring with peers of higher experience improves the existing knowledge of students and can help them to learn successfully. This finding conforms to the findings of earlier studies by Song et al. (2018) and Rogers (2010) who stated that the peer-assisted learning strategy ensures academic gains by facilitating engagement within the learning process and collaboration in knowledge building. The increase in the scores implies that peer tutoring offers students more Available, familiar and common chances to explain challenging notions in comparison to traditional classroom learning (Evans & Moore, 2013; Fantuzzo et al., 1989).

Additionally, the positive correlation obtained between the frequency of the tutoring session and the level of the improvement of the academic results proves the significance of regularity and regular repetition in learning. It is consistent with the theory of the Zone of the Proximal Development of Vygotsky, where students of the lower ability experience learning scaffolding by their peers who are judged to be more capable (Thompson, 2023; Wass et al., 2011; Borthick et al., 2003). The multiple familiarization with the concepts given in the form of tutoring did not only enhance the mastering of the concepts in math but also enabled the tutees to gradually acquire the more autonomous problem-solving process.

The findings of the study have shown also that affective factors, mathematics anxiety and attitude towards mathematics are very important in influencing the learning outcome. The inverse relation of pre-test anxiety and performance on mathematics is an indication of the adverse impact of pre-test anxiety on cognition performance as it justifies the findings of Kunwar (2020) and Morse (2020). Such studies highlight that anxious learners find it difficult to participate in mathematical contents and hence this may impede meagre learning. Nevertheless, this paper demonstrates that with the supportive environment of the peer learning, anxiety can be mitigated, and students will be able to learn to learn more confidently and successfully.

Moreover, the results identifying the positive relationship between post-intervention attitudes and achievement points at the possibility of peer tutoring to bring out

transformative effects in the context of academic achievements. Higher attitude toward mathematics were linked to the larger learning gains thus, learning not only competence, but also positive attitudes toward mathematics could be indicated through peer tutoring (Gan & Hong, 2010; Alegre et al., 2019). This result can be backed up by previous studies (Sea, 2022; Tomlinson, 2022) that show that intervention that is peer-based can result in higher student confidence, enjoyment as well as motivation in most cases, thus helping them achieve better educational results.

These findings are also supplemented by the qualitative data that provides the understanding of the lived experiences of both tutors and tutees. The participants rated their confidence, their comprehension and their motivation as more intensely felt and this is something that is frequently disregarded in studies of average ranks; however, they are essential to the long-term growth of academia. These qualitative findings are consistent with the quantitative ones and emphasize the overall advantages of cross-age peer tutoring, especially in terms of the promotion of more empowering and supportive learning environment. All in all, this research adds worthy evidence to this latest literature on the usefulness of peer tutoring and proves the effectiveness of peer tutoring as an inexpensive, measurable, and effective method that brings the desired changes in mathematics learning in high schools. Notably, it prominently points out that peer interaction is not just of benefit to academic performance but it has positive effects on psychology of students as well as their attitudes in the long run having benefits to the academic existence of learners.

CONCLUSION

As this research article well-knownshows, age-differentiated peer tutoring program makes a massive high-quality contribution to growth in educational achievement in mathematics in excessive faculty. Verifiably quantitative measurement showed that there was a significant increase in the math rating of tutees between the pre- and put up-tests (M = 65 to M = 80), and a paired t-check verified that increase to be statistically significant ($p < 0.01$). Regression models also backed the existence of an enormous connection between the variety of tutoring courses and an increase within the marks in arithmetic, although ANCOVA indicated the existence of a significant effect of the tutoring software on publish-take a look at ratings from manage of the degree of preliminary competence. Qualitative impacts on interviews with tutors and tutees offered depth as a result of displayed advanced confidence in fixing mathematical issues, extended awareness of principles and enhanced impulse to examine. Correlational analysis was also used to portray significant correlation among mathematics tension, attitude to mathematics and accelerated academic fulfillment which has indicated the need to support cognitive and affective domains of mathematics training with the help of peer support. This glimpse brings a helpful contribution to the teaching intervention body of literature because it illustrates that peer tutoring packages may be an effective means of bettering educational accomplishment and first-rate learning studies to the point where high school learners are worried.

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