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Benefits of Peer Tutoring in Enhancing Students' Academic Performance in Mathematics

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Abstract — This study investigates the impact of peer tutoring on the academic performance of secondary school students in mathematics, focusing specifically on topics such as sequences, polynomials, and polynomial equations. The research includes 60 students from Nancalobasaan National High School and employs a descriptive correlational method, utilizing pretests, posttests, and quantitative data collection throughout the 3rd quarter. The results indicate a significant improvement in students' understanding of math and problem-solving skills following the peer tutoring intervention. A strong positive correlation ($r = 0.85$) is found between students' perceived benefits from peer tutoring and their academic performance, suggesting that students who value the tutoring program more highly tend to achieve higher grades in mathematics. Based on these findings, a proposed learning development plan is recommended to enhance learning outcomes through structured peer tutoring programs in secondary math education. However, the study acknowledges the limitations of its sample size and the specific school setting, which may impact the broader applicability of the results.

Nonetheless, the study contributes valuable insights into the benefits of peer tutoring in mathematics education, highlighting its potential to improve student learning outcomes and engagement in the subject. Further research is recommended to explore the effectiveness of peer tutoring in different educational settings and with larger sample sizes to enhance the generalizability of the findings. Overall, this study underscores the importance of peer tutoring as an effective educational intervention that can significantly impact students' academic performance and attitudes toward mathematics.

Keywords — Peer Tutoring, Perceived Benefits, Educational Intervention, Critical Thinking, Problem-Solving, Communication, Social Skills, Academic Skills, Academic Performance

I. Introduction

Peer tutoring is widely recognized for its positive impact on students' academic achievement, enhancing attitudes toward learning, critical thinking, problem-solving, communication, social skills, and academic skills (Barahona et al., 2023). Studies have demonstrated significant academic improvements in various subjects, including mathematics, particularly benefiting students with emotional and behavioral (Osei-Himah et al., 2022; Bowman-Perrott et al., 2022). Meta-analyses further support its effectiveness, with medium to significant gains in academic performance, averaging effect sizes around 0.75 (Zhang, 2023).

This study focuses on implementing peer tutoring in secondary school mathematics, aiming to enhance comprehension, retention, and interest in the subject, thereby transforming it from a challenging task into an engaging activity. Based on the well-established benefits of peer tutoring, this technique aims to increase students' self-efficacy and confidence in their mathematical ability (Gan & Hong, 2020). Furthermore, peer tutoring has been connected to the development of critical social skills, including communication, teamwork, and motivation, all of which are necessary for academic and personal development (Dada et al., 2023).

Despite extensive research demonstrating the benefits of peer tutoring, gaps remain in understanding its effectiveness compared to other peer-assisted strategies and its impact on reducing math anxiety and improving attitudes toward learning math. Addressing these gaps will provide a comprehensive understanding of peer tutoring's advantages in mathematics education. Furthermore, the Programme for International Student Assessment (PISA) 2018 results revealed that over half of Filipino students scored below the minimum proficiency level in mathematics, highlighting the need for effective interventions like peer tutoring to improve math achievement (Dinglasan et al., 2023; Lopez, 2023).

In response to these challenges, the Department of Education (DepEd) issued DepEd Order No. 025, s. 2022, allowing schools to conduct remedial classes, including peer tutoring, for learners needing to meet the Most Essential Learning Competencies (MELCs) in mathematics. This study will explore a learning development plan focusing on training teachers to use peer tutoring strategies effectively, aiming to maximize the benefits of peer tutoring in diverse educational settings. This research seeks to address the urgent need for improved educational practices and provide valuable insights for global educational strategies.

Literature Review

Studies highlight peer tutoring's potential as a flexible pedagogical technique that benefits both tutees and tutors, creating a win-win situation for all parties involved (Thurston et al., 2021). Moreover, the advent of online peer tutoring has expanded the reach of this educational approach, offering benefits beyond traditional face-to-face interactions, such as enhanced study skills, self-confidence, and communication abilities (Tan et al., 2022; Kim, 2022).

The perceived benefits of peer tutoring among high school students encompass social support, trust, attitudes toward school, and overall well-being. Martinot et al. (2022) and Sarosa and Setyowati (2022) emphasized the role of peer support and collaborative interactions in enhancing school engagement and eLearning participation during the COVID-19 pandemic. Furthermore, studies indicate that perceived benefits significantly impact students' engagement, motivation, and overall academic experience (Elzainy et al., 2020; Tai et al., 2022). Inclusion attitudes toward students with intellectual disabilities and autism spectrum disorders also show positive effects, highlighting the broader educational advantages of peer tutoring (Rueda et al., 2022).

Educational interventions, ranging from multiple-choice question assessments to social and emotional learning programs, significantly enhance learning outcomes. Employing multiple-choice questions to measure the efficacy of educational interventions offers critical insights into knowledge acquisition and retention (Gottlieb et al., 2023). These strategies underscore the importance of evidence-based practices and overcoming implementation challenges to enhance learning outcomes across diverse educational contexts. Researchers have also discovered that peer tutoring improves student comprehension and learning outcomes, especially when students study in small groups and participate in cooperative learning and peer teaching. (Anditiasari et al., 2023; Rahmadhanty et al., 2022; Thomas & Mansfield, 2022). Peer assessment fosters student autonomy, participation, and teamwork, contributing to positive social and personal outcomes such as cooperation and communication skills (Carvalho & Santos, 2020; Tenenbaum et al., 2020). Additionally, to improve students' critical thinking skills, educators are essential in creating instructional pedagogy with meaningful learning activities (Ridzal & Haswan, 2023). It has been discovered that a variety of learning approaches, including problem-based learning and think-pair-share cooperative learning, are beneficial in helping students develop their critical thinking abilities across a range of subject areas (Alberida et al., 2022; Pasandaran et al., 2023). The literature underscores the advantages of peer tutoring in facilitating collaborative learning and enhancing academic achievement through increased student engagement and motivation.

II. Methodology

This study utilized a descriptive correlational research design to examine the impact of peer tutoring on the academic performance of secondary school students in mathematics, focusing on topics such as sequences, polynomials, and polynomial equations. The research involved 60 students from Mathematics 10 classes at Nancalobasaan National High School, selected using purposive sampling based on their first-quarter math exam scores. The study design allowed for a detailed analysis of the relationships between variables without establishing causality, aligning with the research objectives.

Data was collected using quantitative methods, including pretests, posttests, and standardized survey questionnaires with 4-point Likert-scale items to measure students' math attitudes and the perceived benefits of peer tutoring. These tools were validated using the Survey/Interview Validation Rubric for Expert Panel. Before the study commenced, consent was obtained from the Superintendent of the City Schools Division Office of Urdaneta City and parental consent for student participation. Pretests were administered before the 25-day peer tutoring intervention, followed by posttests and questionnaires. The collected data was analyzed using statistical tools such as paired T-tests and correlation analysis to evaluate the effectiveness of the peer tutoring program, ensuring a structured and ethical approach to data collection.

III. Results and Discussion

Respondents Profile

Table 1 presents the demographic profile of Grade 10 students involved in peer tutoring for mathematics at Nancalobasaan National High School. It highlights the gender distribution, family income, parental education levels, and available learning resources, providing insights into the background characteristics of the participants.

Table 1: Respondents Profile

Profile	Category	Frequency	Percent
Sex	Male	30	50
	Female	30	50
Monthly Family Income	Below 10,000	36	60
	10,000 - 19,999	12	20
	20,000 - 29,999	6	10
	30,000 - 39,999	4	7
	40,000 and above	2	3
Highest Education Attainment of Father	Elementary	6	10
	High School	40	67
	Vocational	3	5
	Bachelor's Degree	10	17
	Master's Degree	1	2
	Doctoral Degree	0	0
Highest Education Attainment of Mother	Elementary	10	17
	High School	36	60
	Vocational	5	8
	Bachelor's Degree	8	14
	Master's Degree	1	2
	Doctoral Degree	0	0
Available Learning Resources (Printed)	Textbooks	60	100
	Workbooks	60	100
	Magazines/Journals	32	53
	Self-learning Module	60	100
	Flashcards	60	100
Available Learning Resources (Digital)	Textbooks	45	75
	Workbooks	0	0
	Magazines/Journals	30	50
	Self-learning Module	45	75
	Flashcards	45	75

The study at Nancalobasaan National High School focused on the demographic characteristics and resource availability of Grade 10 students involved in peer tutoring for mathematics. Forty-five students below 75% in the First Quarter Examination were identified as tutees, while fifteen students scoring 75% and above were designated as tutors. The study's demographic analysis revealed a balanced gender ratio among respondents and a majority (60%) from low-income families. Most parents had a high school education, indicating varied academic support at home. While students had access to comprehensive learning resources, online courses were not utilized, suggesting a gap in digital learning. These findings underscore the importance

of considering economic, educational, and resource-related factors in academic interventions, helping teachers tailor interventions like peer tutoring to meet students' diverse needs effectively.

Perceived Attitude of Students towards Mathematics

Table 2 examines the perceived attitudes of Grade 10 students towards mathematics in the context of peer tutoring. It provides an overview of students' positive attitude towards learning mathematics through peer tutoring, offering valuable insights into their motivation and engagement.

Table 2: Perceived Attitude of the Respondents Towards Mathematics

Indicators As a math student…	WM	DE	TR
1. mathematics is perceived as enjoyable.	3.55	SA	VP
2. confidence in understanding and solving mathematical problems is felt.	3.35	A	P
3. mathematics is found interesting when discussed in peer tutoring sessions.	3.45	A	P
4. a positive attitude toward learning mathematics through peer tutoring is maintained.	3.50	SA	VP
5. seeking help from peers when struggling with mathematics is comfortable.	3.40	SA	VP
6. an improved understanding of mathematical concepts through peer tutoring is gained.	3.65	A	P
7. enjoyment in collaborating with peers to solve mathematical problems is experienced.	3.55	SA	VP
8. peer tutoring is believed to be an effective way to enhance learning in mathematics.	3.60	SA	VP
9. active participation in mathematics discussions during peer tutoring is engaged.	3.40	A	P
10. a more positive attitude towards mathematics is developed due to peer tutoring.	3.50	SA	VP
Overall Weighted Mean	3.50	SA	VP

Understanding students' attitudes toward mathematics is crucial in evaluating the effectiveness of peer tutoring programs, as it significantly influences their engagement, motivation, and academic performance. The table presents the perceived attitude of Grade 10 students towards mathematics in the context of peer tutoring. The overall weighted mean of 3.50, falling within the 'Very Positive' range, underscores the program's success in enhancing students' attitudes. However, item no. 2 ("confidence in understanding and solving mathematical problems is felt") received a lower score of 3.35, indicating a need to address challenges in problem-solving skills and confidence. These findings align with existing literature, highlighting the positive impact of peer tutoring on students' attitudes and academic outcomes in mathematics. Overall, the results suggest that peer tutoring is an effective way to enhance students' perceptions of mathematics, potentially leading to improved academic performance.

Perceived Benefits of Peer Tutoring in Mathematics

Table 3 showcases the perceived benefits of peer tutoring on critical thinking, problem-solving, communication, social, and academic skills in mathematics among Grade 10 students. It reveals the students' perspectives on how peer tutoring enhances various aspects of their mathematical education.

Table 3: Perceived Benefits of Peer Tutoring in Mathematics

Indicators Peer tutoring in mathematics has...	WM	DE	TR
Perceived Benefits of Peer Tutoring on Critical Thinking in Mathematics	3.70	SA	HP
Perceived Benefits of Peer Tutoring on Problem-Solving in Mathematics	3.70	SA	HP
Perceived Benefits of Peer Tutoring on Communication in Mathematics	3.76	SA	HP
Perceived Benefits of Peer Tutoring on Social Skills in Mathematics	3.73	SA	HP
Perceived Benefits of Peer Tutoring on Academic Skills in Mathematics	3.88	SA	HP

Based on the survey results, Grade 10 students at Nancalobasaan National High School perceive peer tutoring to have substantial benefits on their critical thinking, problem-solving, communication, social, and academic skills in mathematics. The data revealed a strong agreement among students regarding the positive impact of peer tutoring across various aspects of their mathematical education. Specifically, peer tutoring was found to enhance students' critical thinking skills by helping them understand, analyze, evaluate, and think creatively about mathematical concepts. It also improved their problem-solving abilities, including defining problems, generating solutions, and assessing their effectiveness. Moreover, peer tutoring was instrumental in improving students' communication skills, as they became more adept at explaining concepts, listening actively to peers, and providing constructive feedback. Socially, peer tutoring helped students develop stronger relationships, practice empathy, and enhance their leadership skills. Academically, peer tutoring contributed to improved understanding, application, and communication of mathematical concepts, as well as fostering a sense of ownership of learning and effective study habits. Overall, these findings highlight the significant positive impact of peer tutoring on students' mathematical education, supporting its continued use as an effective pedagogical tool.

Performance of the Respondents in the Posttest

Table 4 presents the performance of students in the posttest after participating in peer tutoring. It highlights the improvement in academic performance, indicating the effectiveness of peer tutoring in enhancing students' understanding and skills in mathematics.

Table 4: Performance of the Respondents in the Posttest

Statistical Measures	Pretest	Posttest
Mean	16.77	25.48
Median	16.00	26.00
Standard Deviation	3.98	2.65
Minimum	11	18
Maximum	24	30
Skewness	0.33	- 0.42
Paired Sample t-test		
t-statistic	-23.817	
p-value	1.15e-31	

Based on the results of the study, the peer tutoring intervention significantly improved the performance of students in the posttest, particularly in the competencies identified as the least mastered. Descriptive statistics revealed a notable increase in the mean score from 16.77 before tutoring to 25.48 after tutoring. This improvement was further supported by a paired sample t-test, which showed a significant increase in scores (t-statistic = -23.52, $p < 0.05$). The distribution of scores also shifted from positively skewed before tutoring to negatively skewed after tutoring, indicating more high scores than low scores post-intervention. Additionally, the decrease in standard deviation after tutoring suggests a narrower range of variability, reflecting the effectiveness of tutoring in reducing score disparities. These findings underscore the effectiveness of peer tutoring in enhancing student understanding and skills in specific areas of weakness, supporting its continued implementation as an effective educational strategy.

Correlation Between Student Profiles and Academic Performance

Table 5 examines the correlation between academic performance and profile variables, this table sheds light on the influence of gender, family income, parental education, and access to learning resources on students' academic achievements. It provides valuable insights into the factors that impact students' educational outcomes.

Table 5: Correlation Between Academic Performance and Profile Variables

Profile Variables	Academic Performance	Interpretation
Sex (S)	Point-biserial - 0.335074 P-value - p = 0.008870	*Significant Positive Correlation*
Monthly Family Income (MFI)	Spearman Rho - 0.815058 P-value - p < 0.00001	*Significant Positive Correlation*
Father Education (FE)	Spearman Rho - 0.617962 P-value - p < 0.00001	*Significant Positive Correlation*
Mother Education (ME	Spearman Rho - 0.703550 P-value - p < 0.00001	*Significant Positive Correlation*
Printed Materials (PM)	Spearman Rho - 0.392965 P-value - p = 0.001897	*Significant Positive Correlation*
Digital Resources (DR)	Spearman Rho - 0.794222 P-value - p < 0.00001	*Significant Positive Correlation*

The results reveal significant correlations between various student profile variables and academic performance. While gender shows a moderate yet considerable correlation with educational outcomes ($r = -0.335$, $p = 0.0089$), family income and parental education exhibit stronger correlations ($r = 0.815$, $p < 0.00001$ for monthly family income; $r = 0.618$, $p < 0.00001$ for father's education; $r = 0.704$, $p < 0.00001$ for mother's education), indicating the pivotal role of family support and financial stability in educational attainment. Moreover, access to learning resources also influences academic performance, with digital resources showing a robust correlation ($r = 0.794$, $p < 0.00001$) compared to printed materials ($r = 0.393$, $p = 0.0019$). These findings underscore the importance of addressing socioeconomic disparities and integrating technology into educational practices to enhance student learning outcomes and adapt to the evolving digital landscape.

Impact of Attitudes Toward Math on Academic Performance

Table 6 explores the relationship between students' perceived benefits of peer tutoring and their academic performance. It demonstrates the positive impact of peer tutoring on critical competencies such as critical thinking, problem-solving, communication, and social skills, indicating its effectiveness as an educational strategy.

Table 6: Correlation between Academic Performance and Students' Attitudes Toward Mathematics

Aspect of Attitude	Academic Performance	Interpretation
Overall Attitude	Spearman Rho - 0.742548 P-value - $p < 0.00001$	*Significant Positive Correlation*
Enjoyable subject	Spearman Rho - 0.519674 P-value - $p = 0.00020$	*Significant Positive Correlation*
Confident in solving	Spearman Rho - 0.745089 P-value - $p < 0.00001$	*Significant Positive Correlation*
Interesting when discussed	Spearman Rho - 0.644890 P-value - $p < 0.000001$	*Significant Positive Correlation*
Positive about learning	Spearman Rho - 0.560019 P-value - $p = 0.00003$	*Significant Positive Correlation*
Comfortable seeking help	Spearman Rho - 0.649143 P-value - $p < 0.00001$	*Significant Positive Correlation*
Better Understanding	Spearman Rho - 0.448719 P-value - $p = 0.000323$	*Significant Positive Correlation*
Enjoy Collaborating	Spearman Rho - 0.567189 P-value - $p = 0.00002$	*Significant Positive Correlation*
Effective Tutoring	Spearman Rho - 0.501297 P-value - $p = 0.00045$	*Significant Positive Correlation*
Motivated to participate	Spearman Rho - 0.573991 P-value - $p = 0.00002$	*Significant Positive Correlation*
Positive about Math	Spearman Rho - 0.519160 P-value - $p = 0.000021$	*Significant Positive Correlation*

The results reveal significant correlations between students' attitudes toward mathematics and their academic performance, shedding light on the profound impact of psychological factors on educational outcomes. Confidence in mathematical abilities, comfort in seeking help, interest

in discussing math, and positive attitudes towards learning and collaboration all show strong positive correlations with academic performance. These findings support Bandura's Social Cognitive Theory, emphasizing the role of self-efficacy and engagement in learning processes. However, while peer tutoring shows a positive correlation with improved understanding of mathematical concepts, the correlation is relatively lower compared to other attitude aspects assessed. The result suggests the need for more tailored approaches in peer tutoring programs to enhance students' comprehension and academic performance further. Overall, the study underscores the importance of cultivating positive attitudes toward mathematics to foster academic success in the subject.

Relationship Between Perceived Tutoring Benefit and Performance

Table 7 examines the correlation between students' attitudes toward mathematics and their academic performance. It highlights the importance of positive attitudes in enhancing academic outcomes, emphasizing the role of psychological factors in educational success.

Table 7: Correlation Between Academic Performance and Perceived Benefits of Peer Tutoring

Aspects of Benefits	Academic Performance	Interpretation
Overall Benefits	Spearman Rho - 0.851583 P-value - $p < 0.00001$	*Strong Positive Correlation*
Critical Thinking	Spearman Rho - 0.768776413 P-value - $p < 0.00001$	*Significant Positive Correlation*
Problem-solving	Spearman Rho - 0.800187615 P-value - $p < 0.00001$	*Significant Positive Correlation*
Communication	Spearman Rho - 0.725350588 P-value - $p < 0.00001$	*Significant Positive Correlation*
Social Skills	Spearman Rho - 0.832199277 P-value - $p < 0.00001$	*Significant Positive Correlation*
Academic Skills	Spearman Rho - 0.718003871 P-value - $p < 0.00001$	*Significant Positive Correlation*

The results demonstrate significant positive relationships between peer tutoring and academic performance across all assessed dimensions of perceived benefits. Spearman's rank correlation, being appropriate for ordinal data, allowed for robust measurement of these relationships without assuming a normal distribution. The study revealed strong positive correlations between academic performance and various benefits of peer tutoring, including critical thinking, problem-solving, communication, social skills, and academic skills. The overall strong positive correlation between students' perceived benefits from peer tutoring and their academic performance underscores the effectiveness of peer tutoring in educational settings. Such a substantial link highlights peer tutoring as a key strategy for enhancing academic and critical educational competencies, aligning with theories stressing social interaction's significance in learning. These results emphasize the value of peer tutoring as a comprehensive educational strategy for enhancing critical competencies and academic outcomes.

Learning Development Plan for Enhancing Math Performance

The study's findings indicate significant improvements in students' mathematics scores post-intervention, affirming the effectiveness of the peer tutoring program in addressing the least mastered competencies. Correlation analyses further revealed relationships between academic performance and profile variables, attitudes toward mathematics, and perceived benefits of peer tutoring. The paired t-test results provided statistical evidence of the program's impact on academic performance, validating the proposed Learning Development Plan as an effective strategy for improving mathematics education. The development of this plan, based on research findings, shows promise for enhancing students' academic performance in mathematics through structured peer tutoring, metacognitive strategies, and a collaborative learning environment. Future initiatives should focus on implementing and evaluating the plan's effectiveness, expanding it to other subject areas, and providing continuous support for teachers' professional development to ensure sustained positive outcomes.

IV. Conclusion

In conclusion, this study demonstrates the significant impact of peer tutoring on Grade 10 students' mathematics education, enhancing critical skills, attitudes, and academic performance. Despite challenges such as limited parental educational attainment and low-income backgrounds, students have access to comprehensive learning resources. The positive correlations between students' attitudes, academic performance, and the benefits of peer tutoring highlight the need for strategies that promote engaging learning environments and support systems. The proposed Learning Development Plan for peer tutoring in Mathematics 10 shows promise in further enhancing student understanding and performance. Recommendations include implementing targeted teacher training programs, strengthening peer tutoring programs, developing a comprehensive tutoring curriculum, and integrating socioeconomic considerations into teaching strategies to improve overall educational outcomes.

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