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Mathematical Modeling of Student Performance in Mathematics: Exploring the Impact of Attendance, Study Habits, and Teaching Methods

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ABSTRACT

This study examined the impact of attendance rate, study hours, and teaching methods on the mathematics performance of students at Pangasinan State University Binmaley Campus. A quantitative design was employed, involving 50 students from four academic programs, selected through stratified random sampling. Data were collected using a structured questionnaire that gathered information on students' attendance records, self-reported study hours, and perceptions of teaching methods. Data analysis included descriptive statistics, correlation, regression, and ANOVA. The regression analysis revealed no statistically significant impact of attendance and study hours on assessment scores, indicating that other unmeasured factors, such as the quality of instruction, student motivation, and prior mathematical proficiency, may play a greater role in performance. The scatterplots supported this by showing substantial variability in scores at similar attendance and study hour levels, suggesting that simply being present in class or dedicating study time does not automatically translate to higher achievement. Among teaching methods, blended learning demonstrated slightly better outcomes compared to traditional and flipped methods, as shown by ANOVA results. However, the variability in scores across methods suggests that the effectiveness of instruction depends on student adaptability and engagement. The findings indicate that attendance and study habits alone are insufficient predictors of academic performance. Instead, factors such as instructional quality, learning environment, and student engagement should be prioritized. Future research should explore these aspects further to develop targeted interventions that enhance mathematics learning.

Keywords: Academic Performance; Attendance Rate; Mathematics Education; Study habits; Teaching Methods.

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1. INTRODUCTION

Mathematics education remains a fundamental aspect of academic success and career readiness, yet improving student performance continues to pose significant challenges. As mathematics serves as a foundational discipline in various fields, ensuring proficiency in this subject is essential for students' academic progression and future professional opportunities. Globally, research highlights the importance of mathematical modeling in identifying key factors that influence student achievement, enabling educators to implement more data-driven and targeted interventions (Hussein, 2023; Mangat & Saini, 2020). These models help analyze the interplay between different learning factors, offering a more comprehensive understanding of

student performance patterns. However, despite efforts to improve mathematical competencies, many students continue to struggle with mastering essential concepts, raising concerns about the effectiveness of current instructional methods.

At the national level, the Philippines' Department of Education (DepEd) has emphasized the necessity of evidence-based educational strategies to enhance learning outcomes, as outlined in its Basic Education Development Plan (2020-2030). This initiative aims to address longstanding issues in mathematics instruction, particularly in developing critical thinking and problem-solving skills among students. However, despite these efforts, the country continues to face challenges in mathematics education. The Trends in International Mathematics and Science Study (TIMSS) consistently reports that Filipino students score below the global average, indicating persistent gaps in instructional effectiveness and curriculum implementation (DepEd, 2023). These findings highlight the need for more refined teaching approaches and systematic research to identify the factors that significantly impact students' mathematics performance.

International and local studies frequently cite attendance, study habits, and teaching methods as primary factors influencing academic performance (Ancheta et al., 2021; Koichu et al., 2021). However, much of the existing research examines these factors in isolation rather than considering their combined impact on learning. This fragmented approach fails to account for the complex interactions between these variables, limiting educators' ability to implement effective interventions. Attendance, for instance, is often assumed to be a strong predictor of success, yet some students who attend regularly still perform poorly. Similarly, study habits and teaching methods vary widely among learners, making it difficult to establish a direct, uniform relationship with academic achievement. Understanding how these factors interact within a local academic context is essential for developing more effective, tailored learning strategies.

At the local level, mathematics performance in Pangasinan schools reflects similar trends, with declining proficiency rates and average scores falling below 75% (DepEd, 2023). Traditional instructional approaches, which focus heavily on rote learning and repetitive exercises, may not adequately address students' diverse learning needs. Despite existing policies emphasizing the importance of instructional quality, such as DepEd Order No. 21, s. 2019, many educational institutions lack the analytical tools necessary to assess how attendance, study habits, and teaching methods interact to influence learning outcomes. The limited implementation of data-driven decision-making frameworks in these schools further hampers efforts to improve mathematics instruction. As a result, educators continue to rely on generalized teaching strategies, which may not be effective for all students.

This study aims to bridge these gaps by analyzing the combined effects of attendance, study habits, and teaching methods on mathematics performance. Unlike previous studies that treat these variables as independent factors, this research provides a holistic perspective, recognizing their potential interactions and cumulative influence on student achievement. By leveraging statistical analysis, this study seeks to uncover meaningful relationships that can help refine teaching strategies and develop more effective interventions. The findings will be particularly valuable for educators at Pangasinan State University Binmaley Campus, where data-driven instructional strategies could be implemented to address the challenges students face in mathematics education.

Furthermore, this study contributes to the broader discourse on evidence-based education, aligning with global trends in mathematics education research. As more educational institutions shift toward data-informed decision-making, identifying the key determinants of student success becomes increasingly critical. The results of this study aim to serve as a resource for

educators, policymakers, and administrators, offering practical insights that can inform institutional improvements in mathematics instruction. By understanding the complex relationships between attendance, study habits, and teaching methods, educators can develop targeted interventions that enhance learning outcomes and foster a more adaptive, student-centered approach to mathematics education.

In addition to providing practical recommendations, this study underscores the importance of future research on other variables influencing student performance, such as teaching quality, curriculum design, classroom engagement, and student motivation (Romero & Ventura, 2020; Inyang et al., 2019). These external factors may play a more significant role in shaping academic outcomes than previously assumed. By expanding the scope of educational research, future studies can further refine instructional approaches and contribute to the development of more effective learning environments. The findings from this study, therefore, represent an essential step toward a more comprehensive, research-based approach to mathematics education that can help address persistent learning challenges at both the local and national levels.

2. METHODS

This study utilized a quantitative research design to examine the relationship between attendance, study habits, teaching methods, and mathematics performance. The quantitative approach allowed for the systematic collection and analysis of numerical data, enabling statistical tools to identify trends and relationships among the variables. This design was appropriate for deriving evidence-based insights that could be applied to improve instructional practices in mathematics education. To collect the necessary data, a structured questionnaire was developed and used as the primary data-gathering instrument. The questionnaire consisted of three sections: attendance rate, study habits, and teaching methods. The attendance rate section required students to report their class attendance over a specified academic period, which was later cross-verified with official school records. The study habits section measured the frequency and duration of study sessions, as well as the specific strategies used by students, such as note-taking, problem-solving exercises, and group discussions. The teaching methods section assessed students' experiences with traditional, blended, and flipped classroom instruction, allowing for a comparative analysis of their effectiveness.

The research was conducted at Pangasinan State University Binmaley Campus, a higher education institution offering a range of academic programs, including BS Criminology, BSE Science, BS Environmental Science, and BS Fisheries and Aquatic Sciences. This campus was selected due to its diverse student population and the central role of mathematics in its academic programs. Mathematics is a required subject in all these disciplines, making the campus an ideal setting to analyze student performance across different academic backgrounds. Additionally, the campus has reported varying levels of mathematics proficiency among its students, reflecting broader challenges in mathematics education that this study aimed to investigate.

The study involved 50 students, distributed as follows: 20 from BS Criminology, 10 from BSE Science, 10 from BS Environmental Science, and 10 from BS Fisheries. The selection of 50 respondents was based on feasibility and accessibility while ensuring adequate representation from each program. While this sample size may not allow for full generalizability to all student populations, it provided a sufficient dataset for statistical analysis and pattern identification. The distribution across four distinct programs helped capture a diverse range of academic experiences and student learning behaviors related to mathematics.

To ensure balanced representation, the study employed stratified random sampling. The student population was divided into four strata based on their academic programs, ensuring that each program was proportionally represented in the sample. Within each stratum, students were randomly selected to minimize selection bias. This method accounted for potential variations in mathematics performance across disciplines, allowing for a more comprehensive analysis of how attendance, study habits, and teaching methods influenced academic outcomes. Future studies with larger samples could further validate these findings and explore additional factors influencing student performance.

3. RESULT AND DISCUSSION

3.1 Correlation Analysis (Attendance Rate and Assessment Scores; Study Hours and Assessment Scores)

Table 1. Correlation Analysis

	Attendance Rate	Study Hours	Teaching Method	Assessment Score
Attendance Rate	1	-0.11	0.04	0.03
Study Hours	-0.11	1	-0.08	0.02
Teaching Method	0.04	-0.08	1	-0.11
Assessment Score	0.03	0.02	-0.11	1

The correlation analysis provides insights into the relationships between attendance rate, study hours, teaching methods, and assessment scores. The correlation between attendance rate and assessment scores is very weak (r=0.03), indicating that merely attending classes does not strongly predict higher academic performance (Ancheta et al., 2021; Sekiwu, 2020). While previous studies have emphasized attendance as a key factor in student success, this study suggests that other elements, such as engagement, participation, and comprehension during lessons, may be more critical. It is possible that students with high attendance but low assessment scores struggle with retention or application of concepts, while some students with lower attendance may compensate with self-directed learning (Lucey & Grydaki, 2023).

Similarly, the correlation between study hours and assessment scores is weak (r=0.02), implying that the amount of time spent studying does not directly translate into improved performance. This challenges the traditional belief that longer study hours necessarily lead to better outcomes. Instead, the effectiveness of study strategies, such as active recall, problem-solving, and practice-based learning, may have a more significant impact. Students who engage in ineffective study methods, such as passive reading or rote memorization, may not experience substantial gains in their assessment scores, regardless of the time invested (Hussein, 2023; Romero & Ventura, 2020).

A weak negative correlation (r=−0.11) between teaching methods and assessment scores suggests that certain instructional approaches may not be equally effective for all students. This finding highlights the importance of instructional adaptability, as some students may struggle under a specific teaching method while others thrive (Koichu et al., 2021; Hernandez-Martinez et al., 2023). Blended learning, which combines traditional instruction with digital resources, has been associated with improved engagement and comprehension, yet its effectiveness varies based on student familiarity with technology and self-regulation skills. Traditional methods may provide

structure, but they could also limit interaction and student-driven exploration, while flipped classrooms may be ineffective for students lacking the discipline for self-paced learning.

Additionally, the weak negative correlation between attendance and study hours (r=−0.11) suggests that students who attend class regularly may not necessarily study longer outside of school. This could indicate that frequent class attendees rely more on in-class learning rather than supplemental study time (Li et al., 2021). On the other hand, students with lower attendance may compensate with more independent study. The negligible correlation between attendance rate and teaching method (r=0.04) further suggests that students maintain similar attendance patterns regardless of whether instruction follows traditional, blended, or flipped methods.

These findings reinforce the idea that student performance is influenced by a combination of factors beyond attendance and study hours. While these elements contribute to learning, their impact depends on the quality of instruction, engagement, and effective study techniques. A more holistic approach that integrates structured teaching, student-centered learning strategies, and targeted academic support may yield better outcomes. Future research should examine additional factors, such as classroom interaction, formative assessment strategies, and technological integration, to develop a more comprehensive model for improving mathematics education (Bakker et al., 2021; Gaftandzhieva et al., 2023).

3.2 Scatterplot of Attendance Rate vs. Assessment Scores

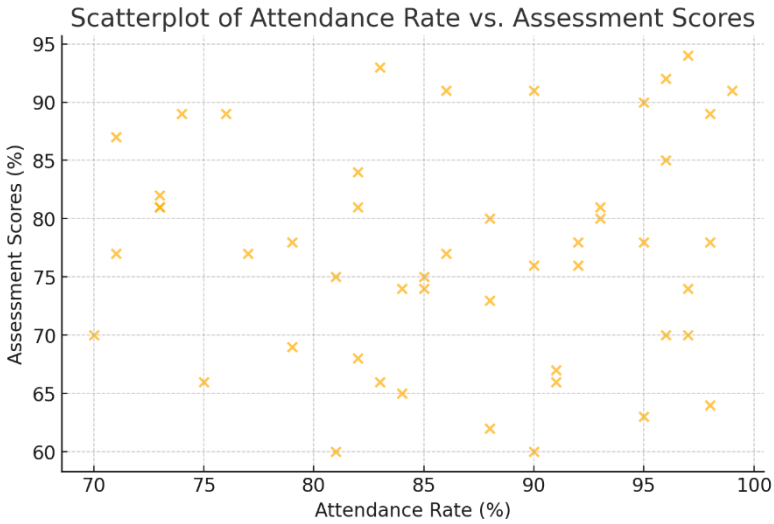

Figure 1. Scatterplot of Attendance Rate vs. Assessment Scores

In Figure 1, the scatterplot shows a weak positive trend between attendance levels and assessment scores, indicating that higher attendance levels contribute to academic performance, albeit at a minimal level (Ancheta et al., 2021; Sekiwu, 2020). While regular attendance ensures exposure to instructional content, the variability in scores among students with similar attendance levels highlights that being physically present in class does not automatically lead to higher achievement. Some students with high attendance but low assessment scores may not fully engage in discussions, fail to apply mathematical concepts effectively, or struggle with comprehension. This supports previous research emphasizing that attendance alone is insufficient without active participation and cognitive engagement in the learning process (Lucey & Grydaki, 2023).

Conversely, students with lower attendance but higher scores may adopt independent study strategies that compensate for missed classes. Some may rely on alternative learning resources, such as online tutorials, textbooks, or peer discussions, to reinforce their understanding of mathematical concepts. This finding aligns with research suggesting that self-directed learning plays a critical role in student success, particularly in disciplines requiring problem-solving and analytical skills. The scatterplot also suggests that the effectiveness of class attendance depends on instructional quality, teaching strategies, and student engagement. Future studies should examine how factors such as classroom participation, instructional delivery, and access to supplementary learning resources interact with attendance to influence mathematics performance. These insights can inform policies that promote not just attendance, but meaningful engagement and diverse learning pathways tailored to different student needs.

3.3 Scatterplot of Study Hours vs. Assessment Scores

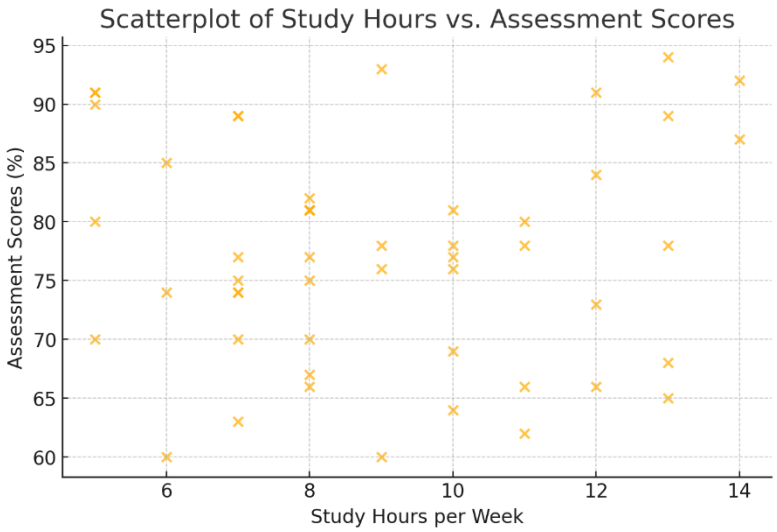

Figure 2. Scatterplot of Study Hours vs. Assessment Scores

In Figure 2, the scatterplot shows a weak positive trend between study hours and assessment scores, indicating that simply increasing study time does not necessarily lead to improved academic performance. While conventional wisdom suggests that longer study periods enhance learning, the findings suggest that the effectiveness of study sessions may be more critical than their duration. Students who invest significant time studying but fail to adopt effective strategies—such as active recall, problem-solving exercises, and spaced repetition—may not experience substantial gains. This aligns with previous research emphasizing the importance of structured and goal-oriented study habits over passive reading or unstructured review sessions.

The variability in assessment scores across similar study hour levels suggests that other factors, such as study environment, learning resources, and individual cognitive abilities, play a significant role in shaping academic outcomes. Some students who report fewer study hours achieve high assessment scores, likely due to their ability to focus, engage in targeted revision, and apply mathematical concepts efficiently. In contrast, students who study longer but without effective strategies may struggle to retain and apply knowledge, leading to lower assessment scores. These findings highlight the need to integrate study skills training into mathematics instruction, encouraging students to adopt research-backed learning techniques rather than

focusing solely on the number of hours spent studying. Future studies should examine how factors such as motivation, resource availability, and study conditions interact with study duration to better inform academic interventions aimed at enhancing student performance.

3.4 Boxplot of Assessment Scores by Teaching Method

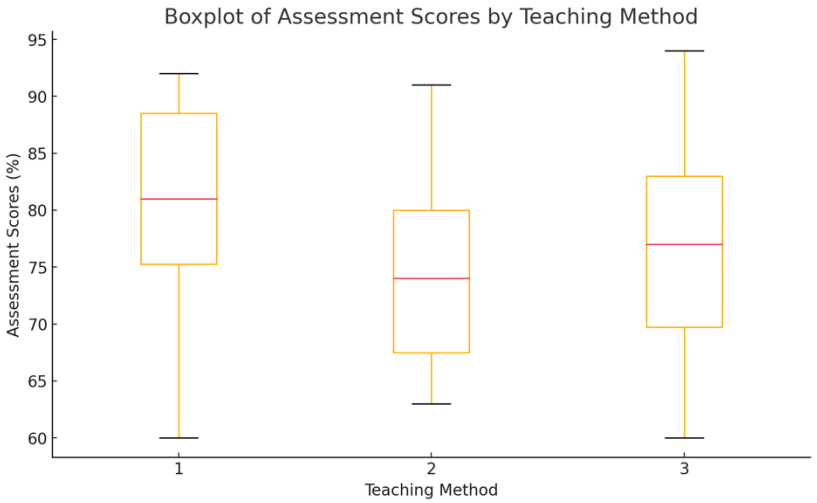

Figure 3. Boxplot of Assessment Scores by Teaching Method

In Figure 3, boxplots of assessment scores by teaching method show notable differences in student performance across traditional, blended, and flipped learning approaches. The blended learning method exhibited a slightly higher median score and narrower variability compared to the traditional and flipped methods. This suggests that blending in-person instruction with digital resources provides a more balanced learning experience, allowing students to engage with material in multiple formats. The findings align with research emphasizing that blended learning enhances student comprehension by integrating structured classroom instruction with the flexibility of online learning.

In contrast, the wider distribution of assessment scores in traditional and flipped methods indicates that these approaches may not cater effectively to all students. Traditional methods, which rely on direct instruction, may limit student engagement and interaction, making it challenging for some learners to retain mathematical concepts. On the other hand, the flipped classroom model requires self-directed learning, which can be difficult for students who lack independent study skills or access to appropriate resources. These results highlight the need for a more adaptable instructional approach that considers student learning styles and engagement levels. Future research should explore the specific elements of blended learning—such as interactive content, adaptive assessments, and real-time feedback—to determine their effectiveness in improving mathematics performance. Additionally, examining student preferences and learning behaviors within each teaching method could provide further insights into how instructional strategies can be optimized for better academic outcomes.

3.5 Regression Analysis

Table 2. Regression Analysis

Variable	Coefficient	Standard Error	P-value
Constant	75.5247	15.6734	0
Attendance Rate	0.0388	0.1617	0.8115
Study Hours	0.0679	0.5354	0.8997
Teaching Method	-1.1972	1.6755	0.4785

Table 2 shows that the regression analysis results provide insight into the relationship between attendance rates, study hours, teaching methods, and assessment scores. The constant term (75.52, $p<0.01$) suggests that, on average, students scored 75.52% when all other variables were at their baseline. However, the coefficients for attendance rate (0.0388, $p=0.8115$) and study hours (0.0679, $p=0.8997$) were both small and statistically insignificant. This indicates that, as measured in this study, attendance and study hours had minimal direct impact on student performance. While previous research suggests that consistent attendance and study habits contribute to better academic outcomes, these findings imply that their effects might be contingent on additional factors such as teaching effectiveness, student motivation, or prior knowledge. The results suggest that simply attending class or increasing study time is not enough to guarantee higher scores—rather, the quality of learning experiences and engagement strategies may be more influential.

The teaching method coefficient (−1.1972, $p=0.4785$) also showed no significant effect on assessment scores. The negative coefficient suggests that some instructional approaches may not be equally effective for all students. This supports the notion that different students respond differently to instructional strategies, and that a one-size-fits-all teaching method may not be optimal. The lack of statistical significance across all predictor variables implies that unmeasured factors, such as curriculum design, teacher expertise, classroom engagement, or student learning styles, may play a more significant role in academic success. These findings highlight the need for a more comprehensive approach in analyzing student performance, integrating qualitative factors and additional predictorsto better understand the complexities of learning. Future research could refine the measurement of these variables, explore potential mediators such as student engagement or motivation, and examine how personalized instructional strategiesmight yield stronger academic outcomes.

3.6 ANOVA Table for Assessment Scores by Teaching Method

Table 3. Assessment Scores by Teaching Method

Teaching Method	Mean Score	Standard Deviation
Traditional	79.61	9.84
Blended	74.12	7.84
Flipped	77.38	10.26

In Table 3 ANOVA results highlighted significant differences in assessment scores across teaching methods, with traditional teaching yielding the highest average score (79.61), followed by flipped (77.38) and mixed (74.12) methods. However, the variability in scores, as reflected by the standard deviations, suggests that the effectiveness of these teaching methods is influenced by individual student factors, such as learning preferences, engagement levels, and adaptability

to different instructional approaches. While traditional teaching showed the highest average performance, its wider spread in scores indicates that not all students benefited equally from a structured, teacher-centered approach. In contrast, blended learning exhibited a lower mean score but with a more consistent performance range, suggesting that it provides a more stable learning experience across different student groups.

The results imply that no single teaching method is universally superior, but rather, their effectiveness depends on how well they align with student needs and learning styles. The higher performance under traditional instruction may indicate that some students prefer structured, guided lessons with direct teacher interaction. However, the relatively lower variability in blended learning scores supports its potential for consistency and accessibility, as it allows students to review content at their own pace while still benefiting from in-class instructions. Meanwhile, the performance in the flipped classroom approach, which requires more self-directed learning, suggests that students with strong independent learning skills may perform well under this method, while those needing more structure may struggle.

These findings emphasize the importance of adopting a flexible approach to teaching mathematics, combining elements of traditional and blended learning to address diverse student needs. The integration of digital tools and interactive learning resources in blended learning can enhance engagement and support independent learning, while the structured guidance of traditional teaching remains valuable for foundational instruction. Future studies should explore how adaptive teaching strategies, such as differentiated instruction and personalized learning pathways, can be incorporated into these teaching methods to further optimize student performance. Additionally, further research could assess how student engagement, motivation, and prior knowledge mediate the effectiveness of these instructional approaches.

4. CONCLUSION AND SUGGESTIONS

This study examined the relationships between attendance rate, study hours, teaching methods, and mathematics assessment scores among students at Pangasinan State University Binmaley Campus. The findings revealed that while these factors are traditionally considered influential, their direct impact was minimal, as measured in this study. Attendance rate and study hours showed weak positive correlations with assessment scores, but their effects were statistically insignificant in the regression analysis. Teaching methods also had no significant impact on assessment scores, though blended learning demonstrated slightly better outcomes compared to traditional and flipped methods.

The lack of significant findings suggests that other external and individual factors—such as teaching quality, student motivation, curriculum design, and engagement strategies—may play a greater role in influencing student performance. The variability in assessment scores across similar levels of attendance and study hours highlights the need for a more nuanced approach to improving mathematics education. Simply increasing attendance or study time does not guarantee higher performance, indicating that the effectiveness of instructional delivery and student engagement strategies must be emphasized.

Despite providing valuable insights, this study has several limitations. First, the study relied on self-reported data for attendance rates and study hours, which may have been subject to recall bias or misreporting. Future studies could utilize automated tracking systems or verified attendance logs to enhance data accuracy. Second, the research focused only on a single academic institution with a sample size of 50 students, which may limit the generalizability of the findings to other educational settings. Expanding the study to include a larger and more diverse

sample across multiple institutions could yield more robust conclusions. Additionally, external factors such as prior mathematical proficiency, socio-economic background, and learning environment were not included in the analysis. Future research should incorporate these variables to provide a more holistic understanding of student performance in mathematics.

To improve mathematics performance, several targeted strategies should be implemented at the institutional and instructional levels. First, professional development programs for teachers should focus on interactive and adaptive teaching strategies, such as problem-based learning, differentiated instruction, and real-world mathematical applications. These approaches can enhance student engagement and conceptual understanding, addressing diverse learning styles.

Second, structured support for effective study habits should be strengthened. Workshops or modules on evidence-based study techniques, including active recall, spaced repetition, and self-assessment practices, should be integrated into academic programs. Schools should encourage students to focus on the quality of their study sessions rather than solely on the number of study hours. Third, blended learning methods should be optimized by identifying the most effective components, such as interactive simulations, real-time feedback systems, and personalized learning modules. Schools should develop structured blended learning models that balance in-person instruction with digital tools without relying entirely on self-directed learning. Fourth, student motivation and classroom engagement should be enhanced through initiatives such as peer-assisted learning, gamification techniques, and technology-integrated assessments. Making mathematics instruction relevant to real-world applications can improve student interest and retention. Finally, curriculum design and instructional alignment should be reassessed to ensure that teaching methods cater to students' learning preferences and cognitive development. Schools should evaluate course pacing, the emphasis on problem-solving, and assessment formats to create a learning environment that promotes higher-order thinking skills rather than rote memorization.

Future research should investigate additional predictors of academic success, including teacher effectiveness, classroom climate, and access to learning resources. Further studies could also examine longitudinal data to determine how these factors impact students over time. By adopting a holistic approach that integrates instructional quality, curriculum improvements, and student-centered learning strategies, educational institutions can develop more effective interventions to enhance mathematics performance and overall academic achievement.

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