

Assessing the Numeracy Gaps among Junior High School Students through Project PEMDAS

Catador, Jose Jr. A.; Fernando, Heidee G.

Kapayapaan Integrated School, Calamba City, Laguna, Philippines

DOI: <https://doi.org/10.51584/IJRIAS.2024.909057>

Received: 17 September 2024; Accepted: 25 September 2024; Published: 22 October 2024

ABSTRACT

This study sought to understand and address the numeracy challenges faced by Junior High School students at Kapayapaan Integrated School. The goal was to develop and implement effective interventions to improve basic arithmetic skills. A comprehensive assessment of all 2,303 Junior High School students enrolled in the 2022-2023 school year revealed a concerning reality. An overwhelming majority of students, approximately 86%, exhibited poor numeracy skills. This finding underscores a significant gap in foundational mathematical knowledge. While a small group excelled, the urgent need for targeted support to strengthen the arithmetic abilities of the majority of students was evident. To bridge this numeracy gap, teachers employed a diverse range of instructional strategies focused on strengthening the four fundamental arithmetic operations: addition, subtraction, multiplication, and division. The positive impact of these interventions is reflected in the posttest results, which showed a dramatic improvement in numeracy levels. The percentage of students demonstrating high numeracy skills increased significantly to 63%, while the number of students with below-numerate levels dropped to just 1%. These findings highlight the effectiveness of the Project PEMDAS in enhancing students' mathematical proficiency. The study's outcomes provide valuable insights for developing an action plan to sustain and expand these improvements, ensuring that all students at Kapayapaan Integrated School have a solid foundation in numeracy.

Keywords: Project PEMDAS, numeracy gaps, below numerate, interventions

INTRODUCTION

Assessments in mathematics must be carefully designed to effectively evaluate student learning and inform instructional decisions. Determining which aspects of mathematical proficiency to assess, and how and why to do so, is crucial. The ultimate goal is to gather evidence that can be used to enhance mathematics education. As Nortvedt and Buchholtz (2018) emphasized, assessment is a critical tool for improving teaching and learning.

The COVID-19 pandemic profoundly disrupted global education, with over a hundred countries implementing school closures affecting more than half the world's student population (UNESCO, 2022). The World Bank (2022) reported significant learning losses resulting from these closures.

To address this crisis, the Department of Education (DepEd) introduced DepEd Order No. 24, s. 2022, outlining the Basic Education Development Plan 2030. This plan aims to bridge access gaps, improve education quality, prepare for future challenges, foster resilience, and uphold children's rights, including addressing learning loss. In alignment with this, the DepEd Calamba City through Division Memorandum No. 185, s. 2022, established Project DREAM as a key component of the Basic Education-Learning Recovery and Continuity Plan (BE-LRCP). The memorandum mandated a two-week initial period for schools to identify and assess learning gaps across subjects. This data-driven approach would inform the subsequent implementation of targeted interventions and remediation efforts.

In the case of Kapayapaan Integrated School (KIS), teacher absence during the pandemic exacerbated these challenges, leading to a pronounced decline in students' numeracy skills. The challenges encountered in assessing student numeracy during remote learning were primarily attributed to limitations in student-teacher interaction and the reliance on traditional assessment methods. The reduced opportunities for real-time feedback

and clarification hindered students' ability to verify their understanding and address learning gaps promptly. Additionally, the absence of in-person assessments limited the evaluation of diverse mathematical skills, as written works and performance tasks alone may not fully capture the range of student abilities.

To address these challenges and ensure that students receive the necessary support, it is imperative to implement targeted interventions focused on strengthening foundational mathematical skills. By providing opportunities for regular feedback, interactive learning experiences, and a variety of assessment methods, teachers can effectively identify and address learning gaps, fostering student success in mathematics.

To assess the extent of this decline, mathematics teachers at KIS administered a pre-test focusing on arithmetic skills. While no students were classified as "non-numerate," a substantial number (86%) fell below numeracy standards. Subsequent classroom observations revealed that students struggled with basic arithmetic operations involving whole numbers, fractions, integers, and decimals. Moreover, their inability to comprehend and visualize word problems hindered their problem-solving abilities. As a result, teachers found it difficult to progress to higher-order concepts due to these persistent foundational gaps.

Thus, the mathematics department will implement Project PEMDAS (Practical Evaluation and Measurement through Developed Activities for Students) to bridge the significant learning gaps identified among students. This initiative will focus on enhancing numeracy skills through a comprehensive range of activities. These will include foundational drills, individualized instruction, collaborative learning, vocabulary development, real-world problem-solving, and formative assessments. By integrating these strategies into daily instruction and meticulously documenting them in lesson logs, teachers will be able to provide targeted support to students struggling with basic arithmetic operations. This data-driven approach will ensure that interventions are aligned with students' specific needs and contribute to overall numeracy improvement.

Research Question

This study aims to significantly improve the basic numeracy skills of Junior High School students at Kapayapaan Integrated School by designing and implementing effective intervention strategies. The ultimate goal is to develop a comprehensive action plan to address identified numeracy gaps. Specifically, this sought answers to the following questions.

1. What is the numeracy level of the respondents based on their pretest and posttest scores?
2. What are the specific intervention strategies employed by the teachers to address the numeracy gaps of the participants.?
3. Is there a difference in the numeracy level of the students after the implementation of Project PEMDAS based on their pretest and posttest scores?

Scope and Limitation of the Study

This study focuses on enhancing the basic numeracy skills of Junior High School students at Kapayapaan Integrated School through the development and implementation of effective intervention strategies. It aims to identify specific numeracy gaps among these students and proposes an action plan to address them. The study is delimited to the school year 2022-2023 and involves a comprehensive assessment of 2,303 Junior High School students using a researcher-made pretest and posttest.

The study is limited to the specific context of Kapayapaan Integrated School and may not be generalizable to other schools with different demographics or educational settings. Additionally, the research instrument, while validated by school authorities, may have limitations in its ability to comprehensively assess all aspects of numeracy. Furthermore, the study's duration is limited to one school year, which may not be sufficient to evaluate the long-term impact of the intervention strategies.

To ensure the focus of the study, the following delimitations are in place. Firstly, the study is confined to the basic numeracy skills of Junior High School students, excluding advanced mathematical concepts. Secondly, the

intervention strategies are primarily focused on addressing the identified numeracy gaps and do not include other academic areas. Thirdly, the data collection is limited to the school year 2022-2023, and no follow-up assessments are conducted beyond this period. Lastly, the study does not explore the factors influencing students' numeracy performance outside of the school environment.

Framework

The present study utilized the Input-Process-Output (IPO) model in figure 1, to provide a visual representation of the research workflow. The IPO model offers a clear structure to depict the relationships between the study's **inputs** (independent variables), **processes** (data processing), and **outputs** (dependent variables and expected outcomes).

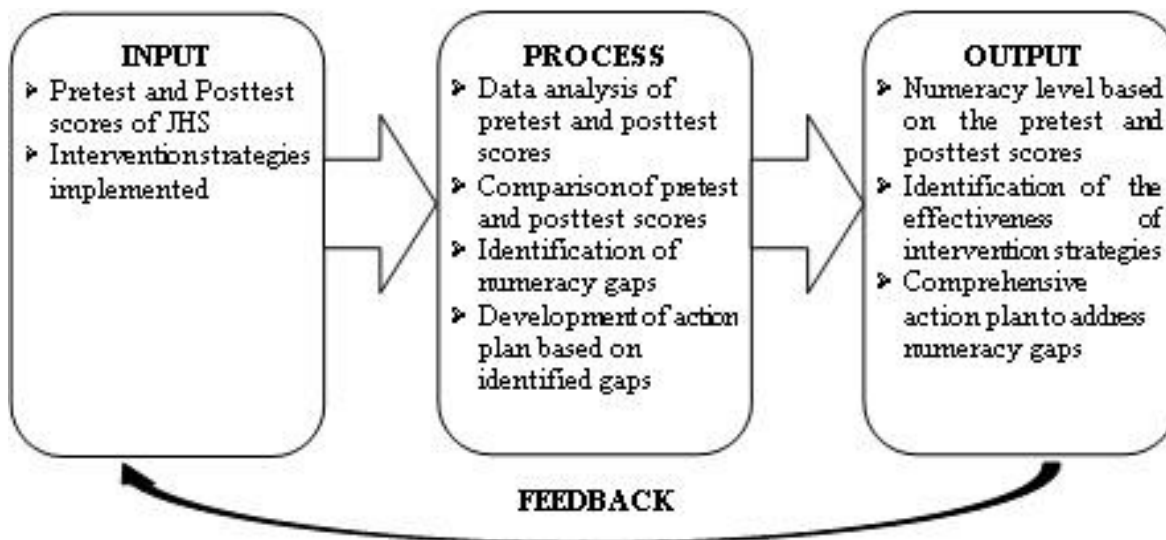


Figure 1: Conceptual Paradigm of the Study

The input component of the IPO model encompasses the pretest and posttest scores of the Junior High School students, as well as the instructional strategies implemented by teachers. These elements serve as the independent variables of the study. The process component involves data management and analysis, including comparing pretest and posttest results, identifying specific numeracy gaps, and formulating an action plan based on these findings. The output component presents the dependent variables and desired outcomes, such as determining students' numeracy levels, evaluating the efficacy of intervention strategies and producing a comprehensive action plan to address identified numeracy challenges.

By explicitly outlining the conceptual framework, researchers established a clear roadmap for the study. This blueprint guided the research process, ensuring coherence, focus, and a logical progression from problem identification to solution proposal. The conceptual framework served as a foundational structure, informing data collection, analysis, and interpretation while maintaining alignment with the study's objectives.

METHODOLOGY

This chapter outlines the research methodology, including the study design, participant characteristics, data collection instruments, data analysis procedures, and ethical considerations.

Research Design

This study employed a descriptive research design. As outlined by Creswell and Creswell (2018), descriptive research aims to accurately portray the characteristics of a population or phenomenon without manipulating variables. By utilizing surveys, interviews, or observations, researchers sought to provide a detailed account of students' numeracy proficiencies. Given its non-experimental nature, this design allowed for the exploration of the "who," "what," "when," "where," "why," and "how" of the research question without introducing external

influences. This approach is commonly adopted in educational research to establish a foundational understanding of a particular group or issue, thereby informing subsequent studies and interventions.

A descriptive research design was optimally suited for this study as it aimed to provide a comprehensive overview of the numeracy levels among Junior High School students at Kapayapaan Integrated School. Furthermore, the design facilitated the description of instructional strategies employed by teachers, offering valuable insights into potential factors influencing students' numeracy performance. By accurately portraying the current state of numeracy within the school, the study established a solid foundation for understanding the challenges and opportunities for improvement.

Respondents of the Study

The study population encompassed all 2,303 Junior High School students enrolled at Kapayapaan Integrated School during the 2022-2023 academic year. This constituted a complete census of the target population, allowing for a comprehensive examination of numeracy levels within the school.

Research Instrument

The primary research instrument consisted of a researcher-developed pretest and posttest. Designed to assess basic numeracy skills, the instrument comprised twenty items that evaluated proficiency in the four fundamental arithmetic operations: addition, subtraction, multiplication, and division. Of these, fifteen items focused on computational accuracy, while the remaining five delved into problem-solving abilities, requiring students to apply arithmetic operations to real-world scenarios. To ensure age-appropriate content, the test was aligned with the grade level standards of the participating students.

The research instrument, a pretest and posttest, was subsequently subjected to a rigorous validation process. A panel of experts, comprising a head teacher and two master teachers in mathematics, provided critical feedback on the instrument's content validity. Their valuable insights and suggestions were carefully incorporated to enhance the instrument's alignment with the study's objectives and its capacity to accurately measure students' numeracy levels.

Table 1 below presents the arbitrary scale for students' numeracy level based on the SDO Calamba City guidelines. **Highly numerate** students exhibit a strong grasp of mathematical fundamentals, including the four basic operations. They are proficient in applying these skills to solve problems and demonstrate a deep understanding of mathematical concepts. Meanwhile, **average numerate** students possess a moderate understanding of the fundamental operations but may require additional support to solidify their knowledge and skills. While they can perform basic calculations, they may struggle with more complex problems or applications. Further, **below numerate** students have limited proficiency in the four basic operations and require significant intervention to develop the foundational skills necessary for mathematical success. These students may struggle with basic calculations and lack the confidence and understanding needed to progress in mathematics. On the other hand, **non-numerate** students demonstrate a lack of basic proficiency in the fundamental operations, indicating a severe deficiency in mathematical skills. These students require immediate and intensive support to develop the foundational knowledge necessary for future learning.

Table 1. Arbitrary Scale for the Students' Numeracy Level

Description	Interpretation	Classification
75%-100% of the score	If the learner got 15-20 correct answers	Highly Numerates
50%-74% of the score	If the learner got 10-14 correct answers	Average Numerates
25%-49% of the score	If the learner got 5-9 correct answers	Below Numerates
0%-24% of the score	If the learner got 0-4 correct answers	Non-Numerates

Source: DepEd Calamba City, 2022

Data Gathering

Upon finalizing the research instrument through rigorous validation, data collection commenced. To facilitate the research process, a formal request for permission was submitted to the school head. Upon securing approval, informed consent was obtained from participating students. This ethical imperative ensured voluntary participation and upheld the rights of research participants.

To establish a baseline for numeracy skills, a pretest was administered to all participants at the commencement of the academic year. Subsequently, teachers implemented the designed intervention strategies within their respective grade levels. As the school year drew to a close, a posttest was conducted to assess the impact of the interventions. Upon completion of data collection, rigorous statistical analysis was employed to interpret the results and determine the effectiveness of the implemented strategies.

Statistical Treatment

After retrieving the questionnaires, the researchers made the tabulation of the responses and appropriate statistical tools applied to the study.

To ascertain the numeracy levels of participants, researchers employed frequency counts and percentages to analyze pretest and posttest data. Teachers provided detailed descriptions of the instructional interventions implemented in their respective classrooms. The efficacy of Project PEMDAS was evaluated by comparing pretest and posttest scores, with particular emphasis on the reduction in the number and percentage of students classified as below numerate.

Research Ethics

To ensure ethical integrity, researchers adhered strictly to ethical guidelines. Participants provided voluntary informed consent, fully understanding the study's purpose, procedures, and potential implications. Respect for participants was paramount, with all data handled confidentially and used solely for academic purposes. Researchers meticulously cited and acknowledged all sources, avoiding plagiarism and copyright infringement. Moreover, the study was conducted in full compliance with the Data Privacy Act of 2012, safeguarding participant information.

RESULTS

This section presents a comparative analysis of pretest and posttest scores to assess changes in students' numeracy levels across grade levels. Furthermore, it provides a detailed overview of the intervention strategies implemented to address identified numeracy gaps in each grade.

Students Numeracy Level

Numeracy level refers to a person's ability to understand and use mathematics in everyday life. It encompasses a range of skills, including basic arithmetic such as addition, subtraction, multiplication, and division. By identifying students' numeracy levels and providing targeted support, teachers can address learning gaps and empower students to achieve their full potential in mathematics.

Table 2. Numeracy levels of students based on their pretest scores.

Description	Grade 7	Grade 8	Grade 9	Grade 10	Total
Highly Numerates	0	4	0	18	22
Average Numerates	37	45	81	146	309
Below Numerates	524	513	482	453	1972

Non-Numerates	0	0	0	0	0
Total	561	562	563	617	2303

Table 2 presents a concerning overview of numeracy levels among 2,303 Junior High School students based on their pretest results. A significant majority, 86% of students, demonstrated a below-numerate level, indicating a substantial gap in foundational mathematical skills. This means that students have limited proficiency in the four basic operations and require significant intervention to develop the foundational skills necessary for mathematical success. These students may struggle with basic calculations and lack the confidence and understanding needed to progress in mathematics. While a small percentage (1%) excelled, the predominance of students requiring numeracy intervention underscores the urgent need for targeted support to enhance proficiency in basic arithmetic operations.

Research consistently demonstrates that a strong foundation in basic operations is essential for sustained mathematical success (Svane et al., 2023). Gafoor and Kurukkan (2022) highlight the significant challenges faced by students who struggle with these foundational skills, often leading to difficulties in higher-level mathematics. Further, Aguhayon, Tingson, and Pentang (2023) emphasize the critical role of fundamental operations in building a solid mathematical base. Students who master addition, subtraction, multiplication, and division are better equipped to handle complex math problems. Difficulty with these core skills can lead to ongoing struggles and a dislike of math. Research supports the idea that strong foundational skills are essential for learning new math concepts.

Additionally, Jain and Rogers (2019) stated that math should be taught in a way that connects to real-world situations to improve understanding and problem-solving abilities. Building student confidence in math is key to their overall success. By focusing on basic arithmetic and tailoring instruction to individual students, teachers can create a positive learning environment that prepares students for future challenges.

Thus, addressing numeracy gaps at an early stage is crucial to prevent a cycle of frustration and disengagement that can hinder students' academic progress. Addressing students' numeracy gaps in the four fundamental operations is vital for their academic success, the development of critical thinking skills, and the promotion of confidence in mathematics. By implementing targeted instructional strategies, teachers can help bridge these gaps, ensuring that all students are equipped with the necessary skills to thrive in their educational journeys and beyond.

Table 3. Numeracy levels of students based on their posttest scores.

Description	Grade 7	Grade 8	Grade 9	Grade 10	Total
Highly Numerates	360	217	373	505	1455
Average Numerates	201	324	189	112	826
Below Numerates	0	21	1	0	22
Non-Numerates	0	0	0	0	0
Total	561	562	563	617	2303

Table 3 presents the numeracy levels of the learners based on their posttest scores. Results revealed that a substantial improvement in numeracy levels is evident in the posttest results. The proportion of students classified as "highly numerate" surged to 63%, indicating a significant enhancement in mathematical proficiency. This means that students exhibit a strong grasp of mathematical fundamentals, including the four basic operations. They are proficient in applying these skills to solve problems and demonstrate a deep understanding of mathematical concepts. While a considerable number (36%) achieved an average numeracy level, the percentage of students categorized as "below numerate" declined dramatically to only 1%. Notably,

no students were identified as "non-numerate" in the posttest.

The significant improvement in student numeracy levels as evidenced by the posttest results can be attributed to the effectiveness of the targeted intervention strategies implemented by teachers. These strategies, which likely included traditional methods such as flashcards and worksheets, as well as individualized support for students requiring additional assistance. By focusing on core arithmetic competencies and providing targeted practice, the intervention aimed to bridge knowledge gaps and enhance student proficiency. To create a more engaging and effective learning environment, teachers employed game-based strategies and emphasized the development of mathematical vocabulary. By integrating real-world word problems with reading comprehension activities, teachers strengthened students' understanding of mathematical concepts and their ability to apply them to real-world scenarios.

Intervention Strategies Employed by the Teachers

To effectively address the deficiencies in students' numeracy skills, teachers implemented a variety of instructional approaches. These strategies were specifically designed to enhance students' proficiency in the fundamental mathematical operations of addition, subtraction, multiplication, and division.

The Grade 7 teachers employed a multifaceted approach to enhance students' mastery of the four fundamental operations. This included traditional methods such as flashcard drills, worksheet exercises, and interactive board work to reinforce basic arithmetic skills. To address the diverse learning needs within the classroom, teachers implemented individualized instruction for students who exhibited difficulties with fundamental operations. By providing one-on-one support, these students received tailored guidance and practice, allowing them to gradually close the proficiency gap. This combination of whole-class and individualized instruction aimed to create a comprehensive learning environment where all students had the opportunity to develop a solid foundation in arithmetic.

The Grade 8 teachers implemented the Project MATHEC (Mathematics Enhancement and Comprehension for Grade 8 Students under below numerates) to provide targeted support for students struggling with foundational mathematical skills. This intervention focused on remediating core arithmetic competencies to bridge the knowledge gap before progressing to the Grade 8 curriculum's most essential learning competencies (MELCs). The project incorporated regular practice through drills and exercises, combined with weekly word problems to enhance problem-solving abilities and deepen conceptual understanding. By addressing these fundamental weaknesses, the project aimed to equip students with a solid mathematical foundation, thereby increasing their chances of success in subsequent learning.

The Grade 9 teachers concentrated their intervention efforts on strengthening students' foundational mathematical skills. By emphasizing the mastery of the four fundamental operations, teachers aimed to create a solid arithmetic base. Additionally, the curriculum incorporated explicit vocabulary development to enhance students' comprehension of mathematical terms, particularly within the context of word problems. To bridge the gap between mathematics and language arts, teachers integrated contextualized, real-world word problems into the curriculum. This approach not only reinforced mathematical concepts but also developed students' ability to extract relevant information from text, thereby strengthening their reading comprehension skills.

The Grade 10 teachers prioritized reinforcing foundational mathematical concepts by focusing on the application of the four fundamental operations. To enhance engagement and active learning, teachers incorporated game-based strategies such as class point systems and Bingo concept into their instruction. Similar to previous grade levels, building mathematical vocabulary and contextual understanding was emphasized through the integration of real-world word problems with reading comprehension activities. To provide additional support, teachers offered supplementary lessons and remedial activities, with a particular focus on the correct spelling of mathematical terms and phrases. This comprehensive approach aimed to improve students' overall mathematical proficiency and literacy.

Teachers strategically implemented a variety of instructional approaches both before and after formal lesson delivery to address students' numeracy needs. These interventions were meticulously documented in daily lesson

logs, providing a detailed record of the strategies employed. This systematic approach facilitated a comprehensive evaluation of the implemented teaching practices and their impact on student learning outcomes.

Effectiveness of Project PEMDAS

Following the findings of the pretest and posttest scores, the data was tallied, and an appropriate statistical tool was applied to determine the effectiveness of Project PEMDAS. The efficacy of Project PEMDAS was evaluated by comparing pretest and posttest scores, with particular emphasis on the reduction in the number of students classified as below numerate.

Table 4. Comparison of the pretest and posttest scores after the implementation of Project PEMDAS.

Description	Pretest		Posttest	
	frequency	percentage	frequency	percentage
Highly Numerates	22	1%	1455	63%
Average Numerates	309	13%	826	36%
Below Numerates	1972	86%	22	1%
Non-Numerates	0	0%	0	0
Total	2303	100%	2303	100%

Table 4 presents the comparative analysis on the numeracy levels of the learners based on their pretest and posttest scores. A more in-depth analysis of posttest results reveals a substantial decrease in the proportion of students classified as "below numerates" from 86% to approximately 1%. Conversely, a significant increase in students attaining the "highly numerates" level is observed, rising from 1% to 63%. These marked changes in numeracy levels suggest that the instructional strategies and interventions implemented by teachers within their respective classrooms have had a positive impact on student outcomes. This further explain that the substantial improvement in students' numeracy levels as evidenced by the posttest results strongly suggests that Project PEMDAS was effective in addressing the identified gaps. The implementation of the project appears to have had a positive impact on students' mathematical proficiency.

Aligned with the Philippine Professional Standards for Teachers (PPST), this study emphasizes the importance of employing a variety of instructional strategies to promote literacy and numeracy skills. The PPST underscores the need for teachers to create a supportive learning environment that fosters lifelong learning. Providing timely and constructive feedback is a key component of effective teaching, as it informs students of their progress and guides their development. By offering feedback on classroom performance and specific tasks, teachers empower students to integrate new knowledge and refine their understanding and skills.

As Hattie (2009) suggests, by utilizing data gleaned from feedback, teachers can tailor instruction to meet the specific needs of their students. This, in turn, empowers students to adjust their learning strategies and goals, creating a continuous cycle of improvement. Furthermore, Selvaraj et al. (2021) highlight the growing recognition of the art of providing effective feedback on student learning and achievement. Feedback has evolved from a simple tool to a cornerstone of effective teaching, driving improvement and propelling students towards success.

Moreover, according to educational research, effective teaching methodologies not only enhance academic performance but also cultivate student engagement. Active learning approaches, such as cooperative learning and hands-on activities, can foster positive attitudes towards mathematics and motivate students to persist in the subject (Cardino and Ortega-Dela Cruz, 2020). The long-term implications of quality mathematics instruction extend beyond immediate academic success, preparing students for higher education and future challenges.

Furthermore, effective teaching strategies have the potential to mitigate achievement disparities, particularly among marginalized student populations (Shafiq, Hashmi and Zafar, 2023).

DISCUSSION

The Project PEMDAS or Practical Evaluation and Measurement through Developed Activities for Students was a flagship project of the mathematics department aimed at overcoming and addressing learning gaps and losses in fundamental numeracy skills among junior high school students at Kapayapaan Integrated School. The project involved the implementation of diverse intervention activities tailored to each grade level. To ensure the effective execution of these interventions, monitoring activities were implemented, including the integration of project components into teachers' daily lesson logs. The ultimate goal was to elevate all students classified as below-numerate to a higher proficiency level.

The posttest results demonstrate a dramatic transformation in students' numeracy levels. An abrupt decline in the percentage of students categorized as "below numerate," from 86% to approximately 1%, is accompanied by a corresponding surge in the proportion of students achieving "highly numerate" status, increasing from a mere 1% to an impressive 63%. These substantial shifts in numeracy proficiency provide compelling evidence of the effectiveness of the instructional strategies and interventions implemented by teachers. The pronounced impact of Project PEMDAS on students' mathematical abilities is undeniable, as the project has successfully addressed the critical numeracy gaps identified at the outset of the study.

It can be inferred that the substantial improvement in students' numeracy levels, as evidenced by the marked decrease in below-numerate students and the corresponding increase in highly numerate students, strongly indicates the effectiveness of Project PEMDAS in addressing learning gaps. The implementation of comprehensive instructional strategies by teachers, to address the identified numeracy gaps, was instrumental in achieving these positive outcomes. This study underscores the critical role of carefully designed and targeted interventions in enhancing students' mathematical proficiency. This included traditional methods such as flashcards and worksheets, as well as individualized support for students requiring additional assistance. By focusing on core arithmetic competencies and providing targeted practice, the intervention aimed to bridge knowledge gaps and enhance student proficiency. To create a more engaging and effective learning environment, teachers employed game-based strategies and emphasized the development of mathematical vocabulary. By integrating real-world word problems with reading comprehension activities, teachers strengthened students' understanding of mathematical concepts and their ability to apply them to real-world scenarios.

The findings of this study could serve as a foundation for in-depth investigations into the specific instructional strategies employed by teachers. By closely examining these strategies, it is possible to identify effective practices that can be replicated across different grade levels and potentially adapted for application in other subject areas. This knowledge can contribute to the development of school-wide or district-wide initiatives aimed at enhancing numeracy skills.

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