Strengthening Basic Mathematics Skills of Beed Students at Moncast through Project Maps (Manipulatives, Active Participation, and Peer Tutoring Strategies)

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ABSTRACT

This action research aimed to strengthen the basic mathematical skills of Bachelor of Elementary Education (BEED) students at Monkayo College of Arts, Sciences, and Technology (MonCAST) through the implementation of Project MAPS (Manipulatives, Active Participation, and Peer Tutoring Strategies). Anchored on Shulman's (1986) concept of Pedagogical Content Knowledge (PCK), the study explored how integrating subject mastery with interactive teaching strategies could help future educators overcome learning gaps in mathematics. Specifically, it sought to determine the mean scores of students before and after the intervention and to examine how the program contributed to their mathematical development. A dual-method design was employed, combining quantitative analysis of pretest and posttest results with qualitative thematic analysis of interview responses. The participants were 15 BEED students placed on academic probation due to low mathematics grades. Results showed a significant improvement in students' performance, with the mean score increasing from 24.07 (SD = 2.40) in the pretest to 50.33 (SD = 5.96) in the posttest, and a t-value of 18.27 ($p < 0.000$), confirming the effectiveness of Project MAPS. Thematic analysis revealed that the intervention built students' confidence, strengthened conceptual understanding beyond memorization, provided effective teaching strategies within a supportive learning environment, and enhanced problem-solving skills and mastery of foundational concepts. The study recommends sustaining and expanding Project MAPS, encouraging teachers and pre-service programs to adopt similar approaches, and calling on future researchers to explore its long-term impacts and adaptability in other educational settings to further improve mathematics teaching and learning.

Keywords: Project MAPS (Manipulatives, Active participation, and Peer tutoring Strategies), BEED students, action research, dual method, MonCAST, Philippines

INTRODUCTION

Mathematics is a fundamental subject that develops critical thinking, problem-solving, and analytical skills — competencies that are essential for future elementary educators. At Monkayo College of Arts, Sciences, and Technology (MonCAST), the evaluation conducted by the Dean of the BEED Program during enrollment revealed that 15 Bachelor of Elementary Education (BEED) students are struggling with basic mathematical concepts, particularly in arithmetic, algebra, and geometry. These students were found to have grades below the program's required cut-off, placing them on academic probation. This is a significant concern, as the BEED Program upholds a maintaining grade of 85 in all subjects to ensure that future teachers are academically prepared to deliver quality instruction. The identified learning gaps among these students not only affect their academic standing but also their readiness to effectively teach mathematics in elementary schools.

Addressing the basic mathematics difficulties of BEED students is vital for their academic success and their future roles as educators. When future teachers lack confidence and competence in mathematics, they may struggle to deliver effective instruction, which can negatively impact their pupils' learning outcomes. Strengthening the mathematical skills of these students will help them meet the academic standards of the BEED program and restore their good academic standing. Moreover, this intervention is crucial in preparing them to impart strong mathematical foundations to elementary learners, as emphasized in the Department of Education's K-12 curriculum, which highlights the importance of mathematical proficiency in basic education.

Educational research underscores the importance of mastering basic mathematics for teachers-in-training. Shulman's (1986) concept of pedagogical content knowledge (PCK) highlights that effective teachers must possess both subject mastery and the ability to present content in ways that make it accessible to learners. The study Parks, G. (2024) has shown that math anxiety and lack of confidence continue to be significant barriers to learning among pre-service teachers, leading to poor performance and low engagement. Furthermore, research supports the use of targeted intervention programs that incorporate hands-on activities, visual supports, and collaborative learning to strengthen mathematical understanding and reduce anxiety (Mierluş-Mazilu, I., & Yilmaz, F. 2023)

This study proposes Project MAPS (Manipulatives, Active Participation, and Peer Tutoring Strategies) as an intervention to help BEED students overcome their difficulties in basic mathematics. The program integrates interactive, student-centered strategies that aim to reinforce conceptual understanding and build confidence. Through the use of manipulatives, learners will engage with concrete tools to visualize abstract mathematical ideas. Active participation will be promoted through collaborative problem-solving and meaningful practice, while peer tutoring will allow students to learn from and support one another in a positive learning environment. Unlike traditional lecture-based instruction, Project MAPS offers a dynamic, hands-on approach that aims to bridge learning gaps, strengthen foundational skills, and empower BEED students to achieve mathematical competence essential for their future role as educators (Lee et al., 2024).

The implementation of Project MAPS is expected to result in significant improvements in the mathematical skills, confidence, and academic performance of BEED students at MonCAST. These improvements will not only help students meet the maintaining grade requirement of 85 but will also enhance their readiness to deliver effective mathematics instruction in elementary classrooms. For faculty, the study will provide insights into practical and effective strategies for addressing learning gaps among teacher trainees. Furthermore, the findings may contribute to future program improvements and institutional interventions, ultimately supporting the development of competent, confident, and effective elementary educators who can foster mathematical proficiency among their future pupils.

Action Research Questions

This action research aimed to answer the following questions:

- What are the mean scores of the students before and after the implementation of the intervention Project MAPS?
- How does the Project MAPS intervention strengthen the basic Mathematical skills of the students?

Research Hypotheses

- H_0: There is no significant difference between the pretest and posttest scores of the students before and after the intervention.
- H_1: There is a significant difference between the pretest and posttest scores of the students before and after the intervention.

Theoretical Lens

This study is anchored on Shulman's (1986) concept of Pedagogical Content Knowledge (PCK), which highlights that effective teaching requires both mastery of subject matter and the ability to design and deliver instruction that makes content accessible to learners. PCK represents the intersection of what teachers know and how they apply this knowledge in ways that address students' needs, misconceptions, and learning styles (Shulman, 1986). Recent research affirms that teachers' ability to transform subject content into meaningful learning experiences is key to improving student outcomes, particularly in mathematics (Jacob et al., 2020). For pre-service elementary educators, developing PCK ensures that they not only understand mathematical concepts but can also teach these concepts using strategies that foster understanding and engagement among young learners.

This study draws on PCK to guide both the focus and the design of Project MAPS (Manipulatives, Active Participation, and Peer Tutoring Strategies) as an intervention to strengthen the basic mathematics skills of BEED students. The intervention provides BEED students with opportunities to deepen their content knowledge while engaging with teaching approaches they can use in their future classrooms. Through manipulatives, collaborative problem-solving, and peer tutoring, the project models strategies aligned with PCK that promote conceptual understanding, active learning, and confidence in teaching mathematics (Elijah, O., 2024). By grounding the study in PCK, Project MAPS not only aims to address immediate learning gaps but also prepares future teachers to deliver mathematics instruction that is clear, engaging, and responsive to the needs of elementary learners.

METHODOLOGY

This action research utilized a dual-method approach, combining quantitative and qualitative techniques to comprehensively assess the effectiveness of the intervention, Project MAPS (Manipulatives, Active Participation, and Peer Tutoring Strategies). The quantitative component focused on analyzing the test scores of BEED students before and after the intervention to determine measurable gains in their basic mathematics skills. The qualitative component involved interviews to gather in-depth insights into how students perceived their improvement in mathematical competence and confidence. A dual-method design is appropriate for this study as it enables triangulation of findings and provides a more robust understanding of both the measurable outcomes and lived experiences of participants (Azra, H., & Zeeshan, I., 2025). Given that action research aims to solve immediate educational problems through reflection and data-driven decision-making, this design aligns well with the nature of the study and intervention (Akram et al., 2024).

The integration of quantitative and qualitative methods is especially suited to evaluating Project MAPS, as the intervention targets both academic improvement and the development of students' confidence to teach mathematics in the future. Quantitative data provide objective evidence of learning gains, while qualitative data offer rich accounts of how the intervention influenced students' engagement, attitudes, and conceptual understanding—factors not captured by test scores alone. The dual-method approach allows for a more holistic evaluation of Project MAPS, ensuring that both the cognitive and affective impacts of the intervention are examined (Salem et al., 2025). This methodology supports a deeper understanding of how interactive, student-centered strategies contribute to addressing learning gaps and enhancing teacher preparation.

Research Respondents

The respondents of this study were 15 Bachelor of Elementary Education (BEED) students at Monkayo College of Arts, Sciences, and Technology (MonCAST) who were identified as needing remediation in basic mathematics skills. These students were placed on academic probation after receiving grades below the program's maintaining grade of 85 in mathematics-related subjects, as determined during the enrollment evaluation conducted by the Dean of the BEED program. The selection of these respondents was purposive, as they represent the specific group targeted by Project MAPS (Manipulatives, Active Participation, and Peer Tutoring Strategies).

Research Instrument

This study utilized two validated instruments to gather data. For the quantitative phase, a teacher-made mathematics test questionnaire covering basic arithmetic, algebra, and geometry concepts was used to measure the pre- and post-intervention performance of the BEED students. The test was content-validated by mathematics faculty members and education experts to ensure alignment with the learning competencies targeted by Project MAPS. For the qualitative phase, a semi-structured interview guide consisting of open-ended questions was employed to explore the students' perceptions of how the intervention helped improve their mathematical skills.

Data Collection

The data collection for this study employed both quantitative and qualitative procedures to comprehensively evaluate the effectiveness of Project MAPS. For the quantitative phase, a pretest was administered to the 15 BEED students before the start of the intervention to assess their initial level of basic mathematics proficiency.

After completing the intervention, the same test was given as a posttest to measure any improvement in their skills. This approach allowed the study to generate objective data on learning gains, a common strategy in educational action research aimed at assessing the impact of interventions (Creswell & Creswell, 2022). For the qualitative phase, semi-structured interviews were conducted with the participants after the intervention to capture their experiences, reflections, and perceptions of how the program helped strengthen their mathematical abilities. This method is widely recognized for providing rich, in-depth data that complement and contextualize quantitative findings (Creswell & Creswell, 2022).

Data Analysis

This action research utilized two data analysis methods to interpret the findings. For the quantitative phase, data were analyzed using a paired t-test to compare students' pretest and posttest scores. This statistical method was appropriate as it measures the significance of differences between two related groups—in this case, the same students before and after the intervention—making it suitable for evaluating the impact of Project MAPS on improving students' basic mathematics skills (Creswell & Creswell, 2022). The paired t-test provided objective evidence of whether the intervention led to measurable learning gains.

For the qualitative phase, interview responses were examined through thematic analysis to identify common patterns, themes, and insights related to the participants' experiences with the intervention. This method was well-suited for exploring how the program influenced students' confidence, engagement, and understanding of mathematics (Jones, M., 2024). Thematic analysis enriched the study by providing in-depth perspectives that complemented and contextualized the quantitative results.

RESULTS AND DISCUSSION

This part presented the discussion of results and reflection of the study. The data presented in this part followed the arrangement set in the Research Questions. The data were described, analyzed and explicated in this section.

- RQ 1. What are the mean scores of the students before and after the implementation of the intervention Project MAPS?

Table 1. Paired Samples t-Test Results for the Pretest and Posttest Scores of the Students

Test	Mean	Standard Deviation	t-value	p-value	Interpretation
Pretest	24.07	2.40			
Posttest	50.33	5.96	18.27	< 0.000	Significant difference observed

Table 1 shows the comparison of the students' mean scores before and after the implementation of Project MAPS. The mean pretest score was 24.07 with a standard deviation of 2.40, indicating that prior to the intervention, the students demonstrated a relatively low level of performance on the assessment out of 60 items. After the intervention, the mean posttest scores significantly increased to 50.33, with a standard deviation of 5.96, reflecting a substantial improvement in the students' scores. This notable increase in the mean score suggests that Project MAPS was effective in enhancing the students' knowledge or skills as measured by the test.

The paired sample t-test yielded a t-value of 18.27 and a p-value of less than 0.000. This p-value is far below the conventional significance level of 0.05, providing very strong evidence that the difference in scores before and after the intervention did not occur by random chance. Therefore, the null hypothesis (H_0), which states that there is no significant difference between the pretest and posttest scores of the students before and after the intervention, is rejected. On the other hand, the alternative hypothesis (H_1), which posits that there is a significant difference between the pretest and posttest scores, is accepted.

In summary, the findings indicate that Project MAPS had a positive and meaningful impact on the students' academic achievement. The consistent rise in scores across the group, as reflected by the relatively low standard

deviation in both pretest and posttest, further supports the effectiveness of the intervention. These results suggest that similar strategies could be beneficial if implemented more widely to support student learning outcomes.

- RQ 2. How does the Project MAPS intervention strengthen the basic Mathematical skills of the students?

Based on the results of the interviews addressing the research question, "How does the Project MAPS intervention strengthen the basic mathematical skills of the students?", four key themes emerged. These are: Builds Confidence and Fosters a Positive Attitude Towards Mathematics, Strengthens Conceptual Understanding Beyond Memorization, Provides Effective Teaching Strategies and Supportive Learning Environment, and Enhances Problem-Solving Skills and Mastery of Foundational Concepts. These themes highlight the meaningful ways in which Project MAPS contributed to the improvement of students' mathematical abilities and overall learning experience.

Builds Confidence and Fosters a Positive Attitude Towards Mathematics. Based on the responses of the participants, it was revealed that the intervention Project MAPS builds confidence and fosters a positive attitude towards mathematics. Many students expressed that the supportive environment, encouragement from the teacher, and the structured lessons helped them overcome their fear of the subject. This positive shift in attitude enabled them to engage more actively and believe in their ability to succeed in mathematics.

"I genuinely enjoyed coming to this class, which is something I never thought I would say about math. Maybe because of the positive encouragement from the teacher. It really boosted my confidence in solving math." (IDI 2)

"I used to be scared of math classes, but this class made it less intimidating. I actually feel more confident now." (IDI 14)

"The remedial class was really helpful for me. I went from feeling lost and confused too confident and capable." (IDI 10)

Project MAPS builds students' confidence and fosters a positive attitude towards mathematics by providing a supportive and engaging learning environment. This aligns with Shulman's (1986) concept of Pedagogical Content Knowledge (PCK), which emphasizes that teachers must understand both the subject matter and how to present it in ways that promote student learning and positive engagement. Recent studies affirm that when teachers create psychologically safe spaces and use encouragement as part of their instructional practice, students develop stronger self-efficacy in mathematics (Nguyen et al., 2022). The results of this study support PCK, as the teacher's ability to combine content knowledge with strategies that boost confidence was key in transforming students' attitudes towards math.

Strengthens Conceptual Understanding Beyond Memorization**.** The responses of the participants revealed that Project MAPS strengthens conceptual understanding beyond mere memorization. Several students shared that, through the intervention, they moved from simply memorizing formulas and procedures to truly understanding how and why mathematical concepts work. This deeper comprehension allowed them to apply what they learned more effectively and with greater confidence in solving mathematical problems.

"Before attending this class, I had just memorize formulas, but now I actually understand how they work and how to use it." (IDI 3)

"This class made me realize that it is okay to struggle, as long as you are willing to put in the effort to learn. Thanks to the good teaching strategies and patience of our teacher, I finally understand decimals and percentages." (IDI 7)

The intervention effectively strengthened students' conceptual understanding by shifting the focus from memorization to meaningful learning. This is consistent with Shulman's (1986) PCK, where effective teachers are those who know how to make content accessible, connecting new ideas to students' prior knowledge and real-world contexts. Recent research highlights that students gain deeper mathematical understanding when instruction emphasizes reasoning over rote procedures (Li & Schoenfeld, 2019). Project MAPS embodies this

approach, as it helped students grasp the why behind formulas and operations, supporting the PCK view that teachers must transform subject matter into forms that are understandable for learners.

Provides Effective Teaching Strategies and Supportive Learning Environment. The participants' responses revealed that Project MAPS provides effective teaching strategies and a supportive learning environment. They highlighted how the teacher's clear explanations, use of varied methods, and patient guidance made complex topics easier to understand. The students also emphasized that the positive, encouraging atmosphere of the class helped them feel comfortable asking questions and actively participating in the learning process.

"Our teacher Ma'am Emmalyn was so patient and explained things in different ways that everyone can understand very easily. I think that made a huge difference on how I can see math now." (IDI 15)

"The pace was just right, not too fast, not too slow. We had enough time to really understand and practice each topic and concept and I could say that small class size was a big plus. It felt like I got more individual attention." (IDI 9)

"Our instructor's teaching methods were engaging and effective. The class provided a supportive and encouraging environment that helped me build confidence and achieve success." (IDI 12)

Project MAPS provided effective teaching strategies and cultivated a supportive environment that enabled students to engage meaningfully with mathematical content. According to Shulman (1986), PCK involves not just knowing the subject but knowing how to teach it in a way that meets learners' diverse needs. This finding is supported by recent studies, which emphasize that effective teaching strategies — such as differentiated instruction, formative feedback, and creating inclusive classroom climates — are central to improving student learning outcomes (Darling-Hammond et al., 2020). The results affirm, rather than challenge, the relevance of PCK in designing interventions that address both academic and emotional needs of students.

Enhances Problem-Solving Skills and Mastery of Foundational Concepts. Project MAPS enhances problem-solving skills and promotes mastery of foundational mathematical concepts. The intervention helped students learn how to break down complex problems into clear, manageable steps, making problem-solving less overwhelming. Through guided practice and targeted strategies, learners developed stronger basic math skills, enabling them to approach tasks with greater confidence and accuracy.

"My biggest challenge in math was word problems. I really struggle with those, but the strategies taught in this class made them much less intimidating." (IDI 5)

"I used to get lost in the middle of calculations, but this class taught me how to break them down into steps. And now I can confidently solve problems I used to completely avoid." (IDI 8)

"The remedial class really helps me understand math better especially fractions. The practice problems that were given in the class were really helpful." (IDI 6)

The intervention enhanced students' problem-solving skills and helped them master foundational concepts through structured guidance and practice. This supports Shulman's (1986) PCK framework, which highlights the need for teachers to anticipate difficulties and provide scaffolding that promotes independent thinking. Recent literature further reinforces that students' problem-solving abilities improve when teachers integrate content knowledge with targeted pedagogical techniques that build step-by-step reasoning (Sayers et al., 2020). The findings of this study confirm that PCK remains a valuable framework in understanding how effective instruction develops both conceptual mastery and applied mathematical skills.

CONCLUSION

Based on the findings, the following conclusions were drawn.

The study demonstrated that Project MAPS had a significant and positive impact on students' basic mathematical skills. Quantitative findings showed a substantial increase in mean scores from pretest to posttest, with the

statistical analysis confirming that this improvement was highly significant and unlikely due to chance. The intervention effectively addressed gaps in students' mathematical performance, resulting in marked gains in their test outcomes and overall mastery of fundamental concepts.

Qualitative results complemented these findings, revealing how Project MAPS strengthened students' confidence, enhanced their conceptual understanding beyond memorization, provided effective teaching strategies, and improved their problem-solving abilities. The rich reflections of learners highlighted the role of supportive instruction, engaging methods, and targeted guidance in making mathematics more accessible and less intimidating.

In summary, the study affirms the value of combining sound pedagogical practices with content expertise, as emphasized in Shulman's (1986) Pedagogical Content Knowledge (PCK). Project MAPS exemplifies how well-designed interventions that integrate both what to teach and how to teach can transform learners' mathematical abilities, attitudes, and confidence. These results provide strong evidence for adopting similar approaches to enhance mathematics education in comparable settings.

RECOMMENDATIONS

The recommendations presented aim to strengthen the gains achieved through Project MAPS and further improve students' mathematical learning. These suggestions are directed at students, math teachers, the BSED Mathematics Program, and the Project MAPS team to promote sustained progress and deeper mastery of basic math skills. Addressing these points will help ensure that the intervention continues to provide meaningful support and positive outcomes for learners.

Students. Students should actively participate in programs like Project MAPS to strengthen their mathematical skills and build confidence. They are encouraged to practice regularly and seek help whenever they encounter challenges in understanding math concepts. By applying the strategies learned, students can improve their problem-solving abilities and overall academic performance.

Math Teachers. Math teachers are encouraged to adopt the effective strategies demonstrated in Project MAPS, such as step-by-step guidance, positive reinforcement, and differentiated instruction. They should foster a supportive environment where students feel safe to ask questions and express difficulties without fear of judgment. Continuous professional development focusing on Pedagogical Content Knowledge (PCK) will help teachers deliver math content more effectively.

BSED Mathematics Program. The Mathematics Program should integrate more training on remedial strategies and PCK into its curriculum for pre-service teachers. It is important to provide opportunities for future educators to design and implement interventions like Project MAPS during their practice teaching. Encouraging reflective practice and action research will help future teachers continuously improve their teaching approaches.

Project MAPS. Project MAPS should be sustained and expanded to reach more students who need support in basic mathematics. The program can be enhanced by incorporating additional activities focused on critical thinking and real-life problem-solving. Regular monitoring and evaluation are recommended to ensure its continued effectiveness and relevance.

Future Researchers. Future researchers are encouraged to explore the long-term effects of Project MAPS on students' mathematical performance and attitudes. They may also consider examining how the intervention impacts different types of learners, including those with special educational needs. Expanding the scope to other subject areas or grade levels could provide valuable insights for further improving remedial and enrichment programs.

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