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Effectiveness of the Phenomenon-Based Approach in Enhancing Senior High School Students' Mathematical Achievement and Problem-Solving Skills

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ABSTRACT

This study investigates the effectiveness of the Phenomenon-Based Approach (PBA) compared to the Traditional Approach (TA) in teaching mathematics to Senior High School students at Polonuling National High School, Philippines. Employing a quasi-experimental design, pre-tests and post-tests were administered to measure students' mathematical performance, particularly their problem-solving and critical thinking skills. The pretest scores showed no significant difference between the two groups, indicating comparable initial proficiency levels. However, post-test results revealed a statistically significant improvement in the PBA group, highlighting the approach's effectiveness in enhancing conceptual understanding and academic achievement. Statistical analysis confirmed the superior impact of PBA on student learning outcomes. The findings support the integration of PBA into classroom instruction to foster real-world application of mathematics and strengthen 21st-century competencies. The study recommends curriculum enhancement, teacher training, and interdisciplinary collaboration to facilitate effective implementation of the Phenomenon-Based Approach in the Philippine educational context.

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1. INTRODUCTION

Mathematics plays a foundational role in shaping learners' analytical and problem-solving skills, which are essential for success in both academic and real-life contexts. It cultivates logical reasoning, critical thinking, and precision, making it indispensable in the 21st-century skill set (Agbata *et al.,* 2024). In recent decades, global educational systems have sought innovative strategies to improve mathematics instruction and student engagement (Van den Broeck *et al*., 2019). One such innovation is the Phenomenon-Based Approach (PBA), a learner-centered, interdisciplinary method that contextualizes instruction around real-world phenomena to promote deeper understanding (Sølvi & Glenna., 2022).

PBA moves away from rote memorization and isolated subject learning, encouraging students to explore complex issues through inquiry, collaboration, and critical reflection (Serkan, 2019). Countries such as Finland and South Korea have pioneered PBA in their curricula, yielding positive results in students' motivation and academic performance (Lee & Cuthbert, 2016; Ryan *et al*., 2022). In these contexts, PBA has shown promise in fostering transferable skills like communication, adaptability, and creativity. It qualities essential in modern, rapidly changing societies (Bottery, 2008; Kováčiková *et al*., 2016).

In the Philippine education system, the Department of Education (DepEd) has promoted context-based and problem-based learning under the K to 12 curriculum, especially through Republic Act No. 10533, which emphasizes learner-centered approaches and real-world applications (Worawong, 2017). In mathematics, this aligns with efforts to enhance conceptual understanding and relevance, particularly among Senior High School students. (Leonard, 2018). Teachers are now expected to serve as facilitators of knowledge, guiding students through collaborative exploration and problem-solving processes (Lotter *et al.,* 2007; Capps & Crawford, 2013).

Despite the theoretical appeal and policy support for PBA, empirical studies examining its local implementation and outcomes in the Philippines remain limited (Gartlehner et al, 2006). While international research provides encouraging insights, localized evidence is necessary to validate its efficacy and inform curriculum integration (Asahid & Lomibao, 2020; Rebecca & Bercasio, 2023). Moreover, the educational disruptions caused by the COVID-19 pandemic have highlighted the urgency of adopting flexible, student-centered methodologies that can adapt to diverse learning contexts (Chris & Joanna, 2022).

This study seeks to address this gap by comparing the effectiveness of the Phenomenon-Based Approach with the Traditional Approach (TA) in teaching mathematics at Polonuling National High School. Specifically, it evaluates their impact on students' problem-solving skills and academic performance. The study aims to contribute empirical data to support the integration of PBA into local classroom practices and to align mathematics instruction with both global trends and national educational goals (peSalendab, 2021).

2. METHODS

This study employed a quasi-experimental quantitative research design to evaluate the effectiveness of the PBA in teaching mathematics. The objective was to assess how PBA influences instructional practices and enhances students' problem-solving skills. A quasi-experimental approach was chosen because it enables structured comparisons between different teaching methodologies, specifically PBA and the TA. We conducted without requiring full randomization (Daniel *et al*, 20212).

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Pretests and posttests were administered to both the experimental group (as PBA) and the control group (as TA) to measure changes in students' mathematical performance (Koné, 2021). The assessment tools focused on key competencies such as problem-solving, analytical reasoning, and critical thinking. Validated test instruments were used to ensure the reliability and accuracy of the data collected (Abualrob,2021).

Statistical analyses were conducted to compare pretest and posttest results and to determine whether the PBA led to significant improvements in learning outcomes. The study was conducted at Polonuling National High School, and the participants were Senior High School students. Ethical considerations, including informed consent and confidentiality, were strictly observed. The study also accounted for local challenges in implementing the PBA to contribute to a broader understanding of how innovative teaching strategies can enhance mathematics education in the Philippine context (Helsel, 2022).

3. RESULTS AND DISCUSSION

The results of this study provide clear evidence supporting the effectiveness of the PBA in enhancing the academic achievement of Senior High School students in mathematics. Before the intervention, students from both the PBA and TA groups demonstrated comparable performance levels, as evidenced by the pretest scores. The independent t-test result ($p = 0.238$) indicated no statistically significant difference between the two groups, thereby establishing a balanced baseline in terms of mathematical proficiency. This parity was essential in ensuring that any observed post-test differences could be attributed to the instructional approach rather than pre-existing disparities (Scott & Husain, 2021).

After the implementation of the intervention, the posttest results revealed a statistically significant difference in favor of the PBA group ($p = 0.005$). The PBA group achieved a higher mean post-test score ($M = 75.26$) compared to the TA group ($M = 73.01$). Additionally, the mean gain in scores from pretest to posttest was greater for the PBA group (6.16) than for the TA group (4.80), highlighting the superior learning gains under the PBA method (Julius, 2022). These findings support earlier research suggesting that phenomenon-based learning approaches contribute to improved comprehension, retention, and application of knowledge across various disciplines (Lee & Cuthbert, 2016; Vainio, 2020).

Furthermore, a qualitative analysis of score distribution indicated that a higher proportion of students in the PBA group achieved performance levels classified as "Good" or "Very Good." This suggests not only improvement in average performance but also a broader uplift across the student population (Pagès, 2021). These outcomes echo the findings of Capps and Crawford (2013), who observed that student-centered and inquiry-based strategies like PBA result in more consistent academic gains and foster deeper engagement (Wang e*t al*., 2016; Uhlig, 2015).

The PBA's effectiveness can be attributed to its interdisciplinary and real-world focus, which enables students to understand mathematical concepts in context. Unlike traditional methods, which often emphasize rote memorization and procedural drills, PBA encourages students to explore real-life phenomena through collaborative and investigative tasks (Asahid & Lomibao, 2020). This approach promotes critical thinking and nurtures problem-solving skills by situating learning within authentic, meaningful scenarios, which are vital competencies for the 21st century (Bybee, 2013).

Moreover, the results align with the theoretical frameworks, who emphasized the importance of social interaction and contextual learning in cognitive development, who advocated for experiential and inquiry-based learning environments (Eklund & Helmefalk, 2022). The success

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of the PBA also resonates work, which asserts that students develop a stronger mathematical mindset when they are engaged in exploratory, creative, and real-world problem-solving tasks.

Despite the encouraging outcomes, the study also recognizes potential challenges in the widespread implementation of PBA. Successful adoption requires comprehensive teacher training, curricular adaptation, and access to instructional resources. Teachers must be equipped not only with content knowledge but also with pedagogical strategies to facilitate interdisciplinary learning effectively (Lotter *et al.*, 2007). Additionally, institutional support and policy alignment are necessary to sustain the use of innovative instructional methods like PBA in mainstream classrooms (DepEd Order No. 32, s. 2015).

The findings strongly advocate for the integration of Phenomenon-Based Learning in the teaching of mathematics. This approach has been shown to enhance students' academic performance, foster critical thinking, and provide them with practical problem-solving skills essential for their academic and future professional endeavors. These results underscore the importance of shifting from traditional to more dynamic and student-centered learning frameworks in the Philippine educational system and beyond.

The study compared the effectiveness of the Phenomenon-Based Approach (PBA) and the TA in teaching mathematics. Pretest results showed no significant difference between the two groups, confirming that both started with similar levels of mathematical knowledge (Ricciutti, 2024). However, post-test results indicated that while both approaches improved student performance, the PBA led to significantly better outcomes, as demonstrated by a higher mean score and a statistically significant difference in performance ($p = 0.005$). The findings suggest that the PBA is a more effective teaching method as it enhances students' understanding by emphasizing real-world applications and interdisciplinary learning. This approach fosters critical thinking, problem-solving, and deeper engagement with mathematical concepts, unlike the TA, which relies more on rote learning. The study highlights the potential of the PBA to improve mathematics education and better equip students for academic and future success.

Based on the study's findings, which demonstrated the effectiveness of the PBA in enhancing students' academic achievement in mathematics, the following recommendations are proposed:

(i) Integration of PBA into the Mathematics Curriculum. Educational policymakers and curriculum developers should consider formally incorporating PBA into the Senior High School mathematics curriculum. Doing so would promote the real-world application of mathematical concepts and foster interdisciplinary learning, consistent with the goals of Republic Act No. 10533.

(ii) Capacity Building for Mathematics Teachers. Regular training, seminars, and workshops should be organized for mathematics teachers to familiarize them with the principles, implementation strategies, and classroom management techniques required for effective PBA instruction. Empowering teachers with practical skills and theoretical knowledge will increase their confidence and competence in using innovative teaching approaches (Capps & Crawford, 2013).

(iii) Development of Instructional Materials. Schools and education departments should collaborate in the development of teaching aids, modules, and digital resources aligned with PBA. These materials should be contextually relevant, culturally responsive, and designed to encourage student inquiry and collaboration (Bell *et al*., 2010)

(iv) Pilot Testing and Scaling. The implementation of PBA should begin with pilot testing in selected schools to gather data and feedback on its effectiveness. Successful models can then be used as benchmarks for broader scaling across regions, especially in public schools where innovation in pedagogy is greatly needed.

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(v) Collaboration Across Disciplines. Teachers from various subject areas should be encouraged to work collaboratively in designing interdisciplinary lessons that connect mathematics to science, technology, arts, and social studies. This promotes holistic learning and aligns with the integrative goals of PBA (Lee & Cuthbert, 2016; Nguyen *et al*., 2024).

(vi) Further Research. Future studies should explore the long-term effects of PBA on learners' academic performance, motivation, and attitudes toward mathematics (Levatino, 2024). Research may also investigate its applicability across different grade levels and learning environments, including remote and blended learning settings.

By taking these steps, educational stakeholders can ensure that PBA becomes a sustainable and impactful part of teaching practice, ultimately leading to improved student outcomes and a stronger foundation in mathematics education.

4. CONCLUSION

This study assessed the comparative effectiveness of the PBA and the TA in teaching mathematics to Senior High School students. The findings revealed that while both instructional methods contributed to improved student performance, PBA produced significantly better learning outcomes. Pretest results confirmed that the two groups had similar levels of mathematical understanding at the outset. However, post-test scores demonstrated that students taught using PBA achieved higher mean scores and greater gains in mathematical achievement than their peers in the TA group, with statistical significance.

These results affirm that the PBA is a more effective pedagogical strategy, particularly in enhancing students' problem-solving abilities, critical thinking, and conceptual understanding of mathematics. By anchoring instruction in real-world phenomena and encouraging interdisciplinary exploration, PBA supports deeper cognitive engagement and helps learners make meaningful connections between mathematical concepts and everyday life. This is consistent with prior research emphasizing the benefits of inquiry-based and student-centered approaches in STEM education.

The study also highlights the alignment of PBA with national educational reforms such as Republic Act No. 10533, which advocates for learner-centered, contextualized, and integrative teaching practices. The findings suggest that integrating PBA into the standard mathematics curriculum can address persistent challenges in engagement and comprehension, especially in post-pandemic classrooms where students may need more interactive and holistic learning experiences.

However, the successful adoption of PBA requires strategic planning. This includes curriculum redesign, teacher capacity-building programs, availability of interdisciplinary materials, and institutional support to overcome implementation challenges. With proper infrastructure and professional development, PBA holds great promise for transforming mathematics education in the Philippines and preparing students with the 21st-century competencies necessary for academic and life success.

In conclusion, the Phenomenon-Based Approach not only enhances academic achievement but also cultivates a deeper, more enduring appreciation for mathematics. It is a forward-thinking instructional strategy that should be embraced and scaled to foster meaningful learning across diverse educational settings.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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