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Research Article

Mathematics Teachers' Perceptions and Practices in the Implementation of Problem-Based Learning for Developing Math Literacy: A Case Study

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ABSTRACT

This study aimed to understand educators' perceptions of Problem-Based Learning (PBL) and its application in instructional settings to enhance mathematical literacy at Maximo L. Gatlabayan Memorial National High School during the school year 2023-2024. The research focused on the following objectives: to explore mathematics teachers' perceptions of PBL for enhancing math literacy, to assess how teachers evaluate the outcomes of PBL initiatives in relation to math literacy development, to identify challenges encountered during PBL implementation, to examine the strategies employed by teachers in implementing PBL, and to propose a model to support PBL implementation. Utilizing a qualitative research design, the study involved semi-structured interviews with twelve purposively selected mathematics teachers from junior and senior high school levels. Data were analyzed through reflexive thematic analysis, following Braun and Clarke's six-phase framework. Trustworthiness was ensured through credibility, transferability, dependability, confirmability, and reflexivity. Key findings include: (1) teachers view PBL as a tool that significantly improves learners' mathematical literacy by engaging them in real-world problem scenarios; (2) structured assessments, such as rubrics, were utilized to evaluate student learning, demonstrating strong links between PBL and mastery of mathematical concepts; (3) barriers to successful PBL implementation included time constraints and varying student preparedness; (4) varied strategies, including Think-Pair-Share and Real-life Math Modeling, were employed to enhance student participation and critical thinking; and (5) a proposed model for PBL emphasizes collaborative experiential learning, focusing on time allocation for projects and structured assessments. In conclusion, the study highlights the potential of PBL to enhance mathematical literacy while addressing challenges and proposing a model for effective implementation.

Keywords: *Problem-Based Learning, Mathematical literacy, Qualitative research, Education, Teaching strategies*

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Introduction

Today's learners often struggle to understand mathematics and apply their knowledge to complex problems that require more than rote memorization. This challenge is particularly evident in the Philippines, where the Program for International Student Assessment (PISA) results from 2018 and 2022 showed the country ranking near the bottom in mathematics, with mean scores of 353 and 355, respectively. These findings highlight the urgent need to improve mathematical literacy, defined as the ability to apply mathematical concepts in everyday life.

Problem-Based Learning (PBL) has emerged as an effective instructional strategy that engages students in real-world problem-solving, fostering critical thinking and communication skills. Research indicates that PBL can enhance student outcomes, making it a viable approach to address the gaps in mathematical learning. According to the Center for International Development and Research in Reconstruction (CIDRR, 2004), PBL utilizes questions and problems to initiate meaningful learning experiences, positively impacting students' critical thinking and problem-solving abilities.

Moreover, studies show that PBL aligns well with constructivist learning principles, as highlighted by theorists like Vygotsky and Piaget, who emphasize the importance of active participation in the learning process. This approach not only helps students connect mathematical concepts to real-life situations but also promotes higher-order thinking skills (Azucena et al., 2022).

Despite these benefits, there remains a gap in understanding how mathematics teachers navigate the implementation of PBL in their classrooms and the challenges they face. Maximo L. Gatlabayan Memorial National High School has reported low learning outcomes, with a Mean Percentage Score of 43.2 in the School Year 2022-2023, indicating a need for instructional strategies that promote resiliency and flexibility in learning. PBL aligns with the goals of the Department of Education's MATATAG framework, which emphasizes holistic development and the cultivation of essential skills like literacy and numeracy.

This study aims to explore the experiences and perspectives of athematics teachers regarding PBL, focusing on its implementation, challenges, and impact on student outcomes. Understanding these dynamics is crucial for enhancing teaching strategies and improving mathematical literacy among students.

Statement of the Problem

The study aimed to understand educators' perceptions of Problem-Based Learning (PBL) and its application in instructional settings to enhance mathematical literacy at Maximo L. Gatlabayan Memorial National High School during the 2023-2024 school year. Developing mathematical literacy is crucial in the current educational context, as it prepares students for 21st-century skills and STEM readiness.

Specifically, the study sought answers to the following questions:

1. What are the mathematics teachers' perceptions of using Problem-Based Learning (PBL) to enhance math literacy skills?
2. How do mathematics teachers assess and evaluate the outcomes of PBL initiatives in relation to math literacy development?
3. What challenges do mathematics teachers encounter during the implementation of PBL to enhance math literacy?
4. How do mathematics teachers implement the Problem-Based Learning (PBL) approach?
5. Based on the study, what model can be proposed to support the implementation of Problem-Based Learning?

Methods of Research

This study employed descriptive case study, which fell under the umbrella of qualitative research methodologies. Ho & Limpaechaer (2022), explained that phenomenology conducts a thorough investigation into personal experiences. According to Girardin (2023), good research focuses on individuals and their perspectives or the situations in which they participate as subjects and/or players in a social context. Qualitative research is created to develop an insight into the values, thoughts, and emotions of individuals. Additionally, Creswell and Poth (2018) mentioned that using a qualitative method enables

researchers to delve into the perspectives and experiences of participants, uncovering the reasons behind them, ultimately leading to a deeper comprehension of the research subject.

In order to address this goal, the study utilized the interview technique to acquire understanding of participants' perspectives. More specifically, the interviews involved participants sharing their experiences, issues, and strategies for problem-based teaching in math classrooms. The researcher deemed that the qualitative research method was the most appropriate to use because the results were more comprehensive than just using either the quantitative and qualitative alone.

By utilizing inputs from educational stakeholders, the researcher's ontological perspective aligns with an epistemological one focused on investigating optimal approaches to Problem-Based Learning (PBL) in mathematics. This vision puts into action the study on policy and policy implementation at Maximo L. Gatlabayan Memorial National High School. Nevertheless, its main focus lies on the effects of these practices on students, including those with special needs, and the potential for enhancing these effects.

The approach utilized in the research was strategically selected to enable administrators, faculty, and students to freely share their opinions without any constraints. The researcher valued the significance of a qualitative approach that centers on subject experiences and that also ensures bias is minimized. Therefore, qualitative methods particularly interview was utilized to gather information on the status of PBL in mathematics and suggest a comprehensive educational framework.

Data Gathering Instruments

The data gathering instrument used in this study was a semi-structured interview guide, which was submitted for validation to a panel of experts, including Education Program Supervisors in Mathematics, distinguished Master Teachers, and Head Teachers responsible for curriculum development, before being utilized in the data collection phase.

The semi-structured interview guide was designed to explore the perspectives and experiences of mathematics teachers regarding the enhancement of mathematical literacy through Problem-Based Learning (PBL). The guide included a series of questions that encompassed both closed-ended and open-ended formats, allowing for a conversational approach that encouraged in-depth responses. Key questions included:

1. What are your views regarding the ability of Problem-Based Learning to promote mathematical literacy among students?
2. Do you think Problem-Based Learning efficiently leads to the improvement of learners' literacy skills in mathematics?
3. How do mathematics teachers assess and evaluate the outcomes of Problem-Based Learning initiatives in relation to math literacy development?

This validation process ensured that the interview guide was effectively tailored to elicit rich insights from mathematics teachers about PBL and its impact on mathematical literacy.

Data Gathering Procedure

The Superintendent of the Antipolo Schools Division, the President of Marikina Polytechnic College, and the head of a public school are among the authorities from whom the researcher needed authorization to carry out the study. A form for informed consent was provided to participants and the researcher ensured that the contents of the letter meet the requirements specified in R.A. Data Privacy Act of 2012, Public Law 10173. This measure was undertaken to avoid potential issues and safeguard individual privacy.

After receiving the permit to conduct the study, participants were selected for data collection and were interviewed using semi-structured interview. The inclusion criteria for participants included being a mathematics teacher with at least two years of teaching experience and actively engaged in implementing PBL in their classrooms. The purpose of the research was clearly explained to the participants, and they were given a copy of the questionnaire in advance. Interviews lasted approximately 45 to 60 minutes, were recorded, and transcribed verbatim for accurate analysis. Interviews were recorded using a voice recorder, and the

researcher also took notes during the interviews.

Qualitative interviews were held for teachers to get insights about their experiences and perceptions regarding PBL. A semi-structured interview schedule was developed to facilitate the respondents' freedom of expression and reactions while at the same time pricking their thoughts and experiences about PBL implementation in mathematics. This method is most in line with Creswell's (2018) suggestion on phenomenological research that it be a foolproof approach to collect nuanced perspectives. In addition to the interviews, participants provided lesson plans which served as further support that demonstrated how PBL was implemented in the classrooms.

Result and Discussion

This chapter shows the findings concerning the complexities that accompany the implementation of Problem-Based Learning in mathematics education at Maximo L. Gatlabayan Memorial National High School. Through analyzing teachers' perspectives, this study explores possible advantages and obstacles when using PBL as a model to enhance students' mathematical literacy.

In this light, the chapter discusses the narrative around the themes developed from the analysis of the data collected through interviews with mathematics teachers. These observations have set the groundwork for any future practice and improvement operation concerning the application of Problem-Based Learning in classroom settings.

This qualitative analysis sought to discover and uncover the impressions, concerns, and strategies of teachers toward the implementation of Problem-Based Learning or PBL in mathematics classrooms at Maximo L. Gatlabayan Memorial National High School during School Year 2023-2024.

Table 1. Mathematics teachers' viewpoints on the effectiveness of PBL in enhancing students' mathematical literacy

Themes	Codes	Responses
Enhancement of students Skills and Character	Engages students, enhances understanding, improves literacy	"*The role of Problem-Based Learning is significant because when we give students word problems, their literacy skills are already being enhanced just by reading the problem*." – Teacher 1
Development of Analytical and Independent Thinking Skills	Fosters analysis, encourages independent thought	"*PBL lets students control their own learning, leading them to become more self-directed*." - Teacher 4

Table 2. Mathematics Teachers' Assessment and Evaluation on the Outcomes of Problem-Based Learning Initiatives in Relation to Math Literacy Development

Themes	Codes	Responses
Use of Rubrics	Easy assessment, criteria-based evaluation	"S*pecifically, I assess students primarily through group performance. The contents of the rubrics include criteria such as problem-solving, creativity, illustration, organization, and time management, with a specific time limit for task completion.*" – Teacher 2
Engagement Indicators	Active participation, peer collaboration	"*I follow a teaching ideology called gradual release of responsibility. In most of my lessons, I first model the lesson or skill. After providing input, I shift to a fifty-fifty guidance approach, allowing students to*

Themes	Codes	Responses
		engage in activities and solve problems while still being able to ask questions. This transition minimizes my role to that of a facilitator." – Teacher 3

Table 3. Challenges in Implementing Problem-Based Learning

Themes	Codes	Responses
Time Management Issues	Insufficient lesson time, pressure to cover curriculum	"*We have only 45 minutes, so it's not enough*." – Teacher 7
Diverse Skill Levels	Need for differentiated instruction, varying comprehension	"*Some common challenges are students who struggle with open-ended problems*." – Teacher 10

Table 4. Implementation Strategies of Mathematics Teachers in using PBL

Themes	Codes	Responses
Group Activities	Peer collaboration, team-based learning	"*I actively use Problem-Based Learning (PBL) to foster peer collaboration and team-based learning among students. For every competency, I incorporate at least one PBL activity, which we refer to as integration. This approach allows students to apply the topics they've learned to real-life scenarios."* – Teacher 5
Real-World Applications	Contextual learning, relevance to everyday life	"*Creating projects that relate the mathematics subject with students' lives..."* – Teacher 12

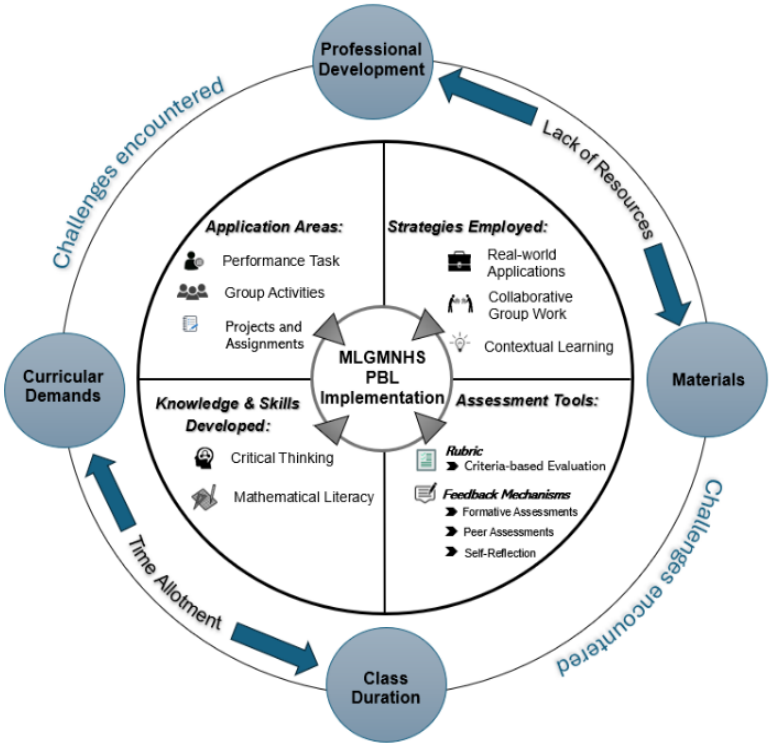
Table 1 summarizes teachers' points of view on the effectiveness of PBL, highlighting a great deal of agreement that it can develop students' thinking and literacy skills. Educators also observe that exposing students to word problems would help improve their reading comprehension and at the same time develop independence in their learning processes. Then they would be thrust into developing very important analytical skills by way of real-world scenarios. Direct quotes from the teachers enhance these findings, grounding them in their lived experiences. For example, Teacher 1 emphasized, "the role of Problem-Based Learning is significant..." illustrating the perceived impact on students' literacy. **Table 2** outlines the evaluation methods applied, particularly the use of structured assessments such as rubrics for evaluating student performance. Teachers reported that clear problem-solving and creative criteria not only ensure transparent assessment but also encourage active participation through a gradual release of responsibility. This approach enables students to take on more responsibility for their own learning, fostering a more collaborative classroom environment. **Table 3** highlights the challenges teachers face, including significant barriers like time constraints and varying skill levels among students. These challenges necessitate differentiated instruction to engage all students meaningfully. Teacher 10 noted, "some common challenges are students who struggle with open-ended problems," emphasizing the need for tailored support. **Table 4** showcases various strategies employed by teachers, such as group activities and real-world applications, aimed at enhancing student engagement. Educators observed that by connecting mathematical concepts to everyday life, they create a more relevant and impactful learning experience. As Teacher 12 stated, "creating projects that relate the mathematics subject with students' lives" reinforces understanding beyond the classroom.

Comments:

The participants commented that PBL effectively engages students in real-world problem-solving scenarios, enhancing their comprehension, reasoning, and critical thinking skills. Additionally, they noted that the integration of practical applications makes mathematical concepts relatable and engaging which leads to better retention of knowledge and deeper understanding of the subject matter. Therefore, collaborative and interactive nature of PBL builds teamwork, communication, and independent exploration, making it a valuable approach for both teachers and students.

Suggestions:

The following suggestions were also given by the participants. Firstly, incorporating more visual aids such as charts, diagrams, and real-life images will improve visualization and comprehension, it will make mathematical concepts accessible and engaging. On top of that, expanding the scope of real-world scenarios performance tasks will provide students with more opportunities to apply their knowledge in diverse contexts as it will strengthen their problem-solving abilities. Secondly, adding video demonstrations that showcases practical application of mathematical concepts in real-life situations will offer students practical insights and reinforce their understanding. Lastly, inviting professionals from various industries to share their experiences and demonstrate how mathematical skills are applied in their fields will provide valuable context and inspire students to see the relevance of mathematics in everyday life. These enhancements will enrich the PBL approach, cultivating a broader understanding and facilitating meaningful connections between theoretical knowledge and its practical applications.



Implementation Model of PBL in Maximo L. Gatlabayan Memorial National High School

The preceding diagram is the suggested model for PBL implementation at Maximo L. Gatlabayan Memorial National High School. This Framework outlines four (4) areas of how PBL works in the teaching-learning process namely: (1) Application Areas, (2) Strategies Employed, (3) Knowledge and Skills Developed, and (4) Assessment tools. Elements

around the implementation process represents the challenges or barriers encountered during the application of PBL model.

This model depicts the whole process of how Problem-Based Learning (PBL) was applied at Maximo L. Gatlabayan Memorial National High School (MLGMNHS); thus, locating PBL principle at the core of the instruction in this school, around which essential elements contribute in some way to effective PBL. This model is unique compared to existing PBL frameworks because it specifically addresses the contextual challenges faced by MLGMNHS, such as resource limitations and time constraints, while emphasizing the development of critical thinking and mathematical literacy within a collaborative learning environment. Lack of Resources puts on the critical challenge of available teaching materials and professional development, defining these inadequacies as obstacles toward implementation. Time Allotment dwells on short classroom periods which hinder students in engaging real-time thinking with such complex issues. What is basically covered under Knowledge and Skills encompasses problem understanding. With respect to PBL, both teachers and students should be well equipped with the right competencies, which also include good critical thinking abilities. Then, on the bottom of the model, Assessment Tools come into play. Their role is fulfilled through rubrics and formative assessments designed to provide essential parameters for assessing students' performance and, thus, encourage self-reflection within the context of PBL. Skills and Processes also include performance tasks, group activities, and projects, emphasizing collaborative and applied learning. These interconnected components create a solid and sound framework for PBL, enabling students to develop better mathematical literacy within reality.

Conclusion

The study's findings lead to several important conclusions. First, improving mathematical literacy through Problem-Based Learning will be effectively realized because of the actual lessons and applications of learning that bring favorable learning outcomes among students. Hence, it is already affirmed that engagement of students in real-life problem scenarios is the key role of Problem-Based Learning in developing mathematical literacy as it promotes their understanding and internalization of mathematical concepts and develops critical thinking and problem-solving skills. Additionally, the teachers cited a wide variety of application strategies like hook problems and cooperative group work, which has managed to meet a multitude of different learning styles and encourage collaboration of classmates. Structured assessment formats, rubrics, and formative assessments were habited to monitor the growth of students during the comprehension process in the PBL environment, and the success of the strategy can be viewed from the students consistently attaining high levels of mastery. Finally, there has been a strong request for continuous professional development as it possesses the necessary skills to equip teachers in applying PBL for the enhancement of mathematics education at large.

Recommendations

Drawing on the study's findings and conclusions, the following recommendations arise:

1 The schools should have continued education for their teachers in the areas of PBL strategies and forms of assessments to deepen their understanding and strengthen their application.
2 Educational institutions need to allocate funds to integrate learning materials and train staff, leading to the effective development and provision of the most engaging learning experience.
3 Curriculum designs of the future should anchor PBL principles so that students may encounter hands-on, collaborative engagements to make mathematics relevant within their worlds.
4 Clear instruction about what is expected will reduce misunderstanding for educators, and the provision of learning materials in the students' mother tongue should facilitate effective comprehension and learning performance.
5 School heads and curriculum planners should advocate for policies that support the integration of PBL into the curriculum,

ensuring adequate resources and professional development opportunities are available for teachers.

6 Future research should be directed toward the long-term effects of PBL on outcome measures for students, as well as understanding students' and parents' perceptions as part of a more comprehensive understanding of PBL's impact on enhancing mathematical literacy. Additionally, longitudinal studies or mixed-method approaches could provide deeper insights into the sustained effects and implementation challenges of PBL in diverse educational contexts.

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