



Importance of Problem-Based Learning (PBL) Method for Enhancing Student Understanding in Mathematical Operations in the Elementary School of Mary Wilson Au-Baca, Baucau, Timor-Leste

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ABSTRACT

The problem-based learning (PBL) method is important for stimulating students' critical thinking, problem-solving skills, and autonomous learning. This research aimed to examine how teachers prioritise the use and implementation of PBL methods, as well as the changes in these methods' impact on students' knowledge and participation in the learning process. The method used in this research is qualitative with a descriptive approach. The participants of this research were one teacher and four students from EBFC Mary Wilson Au-Baca. The data was collected through interviews, observations and documentation. Interview data were analysed with thematic techniques, and observation data and documentation were analysed using the content analysis technique. This research result indicates that teachers effectively use and implement problem-based learning methods, but some students do not participate well in activities. However, the implementation of the method is satisfactory and shows a positive effect on students' understanding of mathematical operations. Consequently, the problem-based learning method is critical to implement in mathematics classes because it makes students learn content based on problems and operations that they solve. The results of this study can contribute to the development of critical thinking, supported by research to improve students' quality of understanding in mathematical operations

INTRODUCTION

Education is considered a fundamental pillar of human development, society, and the nation because, through it, individuals can transform themselves and contribute to social change. Timor-Leste educators have the role to provide quality learning for all to improve an individual's physical and intellectual, moral, and rational aspects (Ximenes, 2026). Thus, education is not only an academic activity but also a system that develops people's intellectual, affective, and social capacities to shape human beings and contribute to the welfare of society. Ximenes (2025) also reinforces that education in Timor-Leste needs to be conducted with consistency and clear objectives to ensure satisfactory results in numeracy. In this sense, education is not only a mechanism that transforms people's lives in the community but also the basis for people to live with dignity, autonomy, and responsibility. In this broader context, new instructional methods, including Problem-Based Learning (PBL), should be developed to strengthen the knowledge of students, especially in their critical areas in mathematical operations.

The role of the teacher is fundamental to using various teaching methods to stimulate students' active learning. Teachers are not only transmitters of knowledge but also guides and inspirators who guide students to determine the right path in learning (Ximenes, 2024). Effective teachers need to emphasise student participation through various activities, including group discussions and problem-solving, to stimulate critical thinking. Formal education requires teachers and students to show active collaboration to improve students' rational capacity and real problem-solving. In the context of Timor-Leste, the education system does not have well-established teaching methodologies that motivate students to learn independently. Many teachers have not implemented the new teaching paradigm because they still use traditional teacher-centered approaches (Ximenes, 2025). This research shows an urgent need to introduce teaching models that stimulate student participation, critical thinking, and creativity.

In the 21st century, the educational paradigm needs to change from the old teaching model to a new one, which is a learner-centred approach (Ximenes and da Costa, 2025). The old paradigm focuses on teaching that prioritises the teacher's role in conveying knowledge while students participate passively. This paradigm blocks students' learning autonomy because students do not receive real experience in learning. In Timor-Leste, the new teaching paradigm shift needs to promote a participatory approach that can improve the quality of education (Obe and Ximenes, 2026). Teachers need to use innovative methods that motivate students to analyse problems, learn autonomously, and apply theory to real life.

An effective learning model in the Timor-Leste context is Problem-Based Learning (PBL). According to Astria (2016), PBL is an approach that stimulates learners to learn through real problem-solving in groups, valuing collaboration, communication, and critical thinking. PBL helps learners construct context, procedural and action-based learning based on concrete experiences. PBL allows students to tackle real-life problems, apply theory in professional situations, and develop practical skills to continue learning throughout their lives (Tanna et al., 2022). In the current era of globalisation, the implementation of PBL in mathematics education is fundamental to increasing students' understanding, motivating them to solve problems, and linking academic knowledge with real-life applications. This study encourages mathematics teachers to use PBL efficiently to improve the quality of mathematics learning in Timor-Leste schools.

This research aims to understand the importance of using the PBL method to increase students' understanding of mathematical operations and learning quality in third-cycle basic education schools. The study guides itself with the three research questions. Firstly, the research explores how teachers prioritise using the PBL method for primary school learning. Secondly, the research discusses how teachers incorporate the problem-based learning method into the process of learning mathematical operations. Thirdly, how the implementation of the PBL method in the learning process of mathematical operations affects the students' understanding of the lesson content.

LITERATURE REVIEW

Problem-Based Learning: Meaning and Characteristics

Problem-based learning (PBL) is a quality learning activity that teaches students to develop their understanding of problem-solving in the subject matter. According to Rahmadani (2019), PBL is a learning model that encourages students to learn about working together in groups to identify solutions to problems they encounter. In addition, Mardliyah (2019) emphasises that PBL is a learning strategy characterised by real problems as a context for students to learn to think critically and to increase knowledge and ability to solve problems.

According to Dirgatama, Santoso & Ninghardjanti (2016), the first characteristic of the problem-based learning method is student-centred learning, where the teacher puts students at the centre of learning. The second characteristic is that the teacher organises students in groups to solve problems based on activities outlined in the lesson plan. Third, the teacher guides the students through the learning process, assisting them in completing the presented activities. Next, the teacher develops problem-solving skills by assigning exercises that include problems outlined in the lesson plan, allowing students to work in small or large groups and use their own prior knowledge to

enhance their problem-solving abilities in everyday life (Ximenes and Ximenes, 2025). Finally, the teacher discovers new information from the students by placing them in groups for activities carried out during the learning process to express their ideas to the group (Dirgatama, Santoso & Ninghardjjanti, 2016).

Thus, the PBL learning method can be applied to students at different levels as an alternative to traditional methods, which tend to prioritise the transfer of knowledge from teachers to students. PBL also has a significant impact on learning that can improve achievement, motivation, learning activities, and understanding; generate learning innovation; and improve students' critical thinking skills. According to Astria (2016), trying to identify a solution to a problem and the knowledge that accompanies it produces truly meaningful knowledge. This is a logical consequence: attempting to identify a solution to a problem independently provides concrete experience, which can be applied to similar problems, as this experience imparts its meaning to students.

Importance of Using the PBL Method

The PBL method is critical to use in the teaching and learning process to increase students' understanding so that they can have the capacity to build conceptual learning in themselves. Tortella & BorochoVICIUS (2014) present the problem-based learning method, which is essential for students as it helps them develop the conceptual, procedural, and attitudinal skills needed to tackle problems that expose them to motivating situations and prepare them for the workforce. The PBL method is important to strengthen their critical thinking skills to express ideas and express feelings during the learning process, where they are also trained to express their own opinions and respect other opinions during discussions of problems (Markula & Aksela, 2022). Using the PBL method in the teaching and learning process is very important because it facilitates logical changes, fosters critical thinking, and helps students develop their preconceptions about the subject being learnt.

PBL (problem-based learning) encourages students to build their own knowledge by solving real problems relevant to everyday life (Risandy et al., 2023). Implementing PBL in the teaching process is important because it helps students build their own knowledge to identify and solve relevant real-life problems (Peranganingin, 2025). The significance of this work lies in its ability to identify and demonstrate the benefits of the PBL approach for both teachers and students. In the 21st century, the era of globalisation in Timor-Leste makes it essential to use the PBL method in the teaching and learning process to enhance students' understanding of the material, thereby developing their critical thinking skills for problem-solving both in academic settings and in everyday life.

Effect of Using the PBL Method on Student Understanding

Understanding the PBL method is crucial for its successful implementation, as the goal of using this method is to enable students to develop conceptual learning that fosters critical thinking and helps them create their own pre-concepts. Thus, Demirel & Dağyar (2016) defined the outcome of problem-based learning as the occurrence of behaviour change in a person that can be observed and measured in the form of knowledge, attitude and skills. Effectively using this method can lead to progress for each student, as they will be actively involved in the teaching process, motivated to continue learning, and able to achieve more effective learning results. Similarly, Demirel & Dağyar (2016) stated that PBL allows students to broaden their perspectives and understand the connections between different academic fields to solve real-world problems. Student understanding can change while teachers use PBL effectively in the teaching and learning process in mathematical operations, thus allowing students to have the capacity to think critically about the material learnt.

Approaching PBL in Mathematical Operations

To implement mathematical operations using PBL, students need to be placed in pairs or groups so that they can collaboratively solve exercises. In addition, it can help them understand and practise these concepts in their daily lives and address problems related to mathematical operations, such as those involving financial needs (Ximenes, 2025). Logically, when performing any mathematical operation, you should start by solving brackets, then exponents, then multiplication and division, and finally addition and subtraction (Bártolo and Ximenes, 2025). When operations are on the same level, they should be solved from left to right. In addition, Ximenes (2025) suggested that mathematics teachers can use Artificial Intelligence to solve operations in different ways, although some teachers in the schools still face challenges of using technology. According to Perdana & Slameto (2016), the way to implement the PBL method is through student orientation, student organisation in learning, inquiry orientation (individual or group), developing and presenting solutions, and analysing and evaluating the problem-solving process.

The implementation of the PBL model as a five-phase process, according to Rahayu et al. (2024). First, teachers need to guide students to solve problems in their own way so they can develop their capacity for conceptual learning. Second, teachers need to organise their students with dignity so they can conduct their research well; consequently, they develop the capacity to solve the problems they research. Third, the teacher must observe the existing groups and guide them when they have any doubts; therefore, they can strengthen their critical thinking skills (Bártolo and Ximenes, 2025). Fourth, the teacher presents solutions when students have solved in groups and need to confirm their ideas to develop and

present solutions that exist to develop their critical thinking skills. Finally, the teacher evaluates the student's problem-solving to correct the incorrectness.

METHODOLOGY

Research Design

The qualitative research method with descriptive design was used, which guides the procedure for research on the object of study that needs to describe and analyse the phenomenon. The qualitative research method is a field of linking to reality based on human observation that is understood and experienced (Seamon & Gill, 2016). Qualitative research can easily help researchers to dig deeper into credible information related to a research topic, and the information obtained can be used to determine the purpose of the research. However, Gumilang (2021) argues that qualitative research is research conducted to achieve the objective of understanding the phenomenon experienced by the research subject. Therefore, this study was used to gather experiences and perspectives of teachers and students about the effect of problem-based learning in mathematics learning of students.

Sampling Method

Research sampling is a way to select a research subject, such as an eighth-grade teacher who teaches mathematics and eighth-grade students, to provide credible information based on the phenomenon that occurs in the school. Research subjects are informants who provide information based on the research topic in relation to the teachers' experiences in school. Participants in this research were one mathematics teacher and four students from the 8th grade at EBFC, third cycle, Mary Wilson in Baucau, Timor-Leste. Therefore, the researcher selected these participants with the purposive sampling method, where the researcher selected representatives of teachers and students to participate in the research. Purposive sampling is a technique used in qualitative research to select a specific group of individuals or units for analysis (Heath, 2023). This method is appropriate when the researcher has a clear idea of the characteristics or attributes they are interested in studying and wishes to select a representative sample of those characteristics.

Data Collection Techniques

Qualitative data collection techniques are methods used to collect data in the form of narrative, description, or non-numerical phenomena (Salsabila, 2025). This technique allows researchers to understand the experiences, meanings, and perspectives of individuals or groups in depth. Qualitative research data collection uses three data collection techniques, namely interview, observation and documentation.

An interview is a reciprocal interaction, that is, a communication between two or more people. According to Gumilang (2021), an interview is a technique that is often used to gather information or data from a person or a group of people. The direct interview was conducted with a mathematics teacher and four students to collect credible data based on the research topic. Researchers used a semi-structured interview with open-ended questions to get accurate data.

Observation is an action that occurs to observe activities that occur at the same time. Gumilang (2021) states that observation is a type of research that aims to obtain appropriate results. In qualitative research, observation is one type of credible data collection technique. The instrument that supports the observation is the observation grid to see the students' understanding of the teacher's teaching using the PBL method. The observation was conducted directly in the class during the teaching and learning of mathematics.

According to Putri (2021), the documentation method is one of the data collection methods used in social research methodology, and in essence, the documentation method is a method used to track historical data. The instrument that supports the documentation in this research is a mobile phone for taking photographs, recordings, and videos that focus on teachers and students. Furthermore, access documents that exist at the research site, such as students' exercise books and teachers' lesson plans used in the classroom.

Data Analysis Techniques

A qualitative data analysis technique is a research method that focuses on how to accumulate information obtained from informants and analyse social phenomena that occurred. Thus, Li & Zhang (2022) state that a qualitative data analysis technique is a research method that focuses on collecting and processing data, such as interviews, observations, and visual artefacts, to explore and understand social phenomena from different perspectives. The thematic analysis method was used to analyse the interview data, where themes can be determined, data codes, important ideas highlighted, and tags from the transcription data (Terry et al., 2017).

The application of thematic analysis techniques also includes processes such as data reduction, data presentation, data verification and conclusion, based on Braun and Clarke's method (Byrne, 2022). Data reduction means to summarise important and clear data based on the research results and remove information that is not important or irrelevant to the research topic. Once the data reduction is finalised, the next step is to present the data. The presentation of data must be accurate and clear based on the results obtained by the researcher and reorganised in a structured and systematic manner in a table so that people can easily understand. Finally, the validity is verified where the results of the

research in the school are concluded, which is related to the research topic (Byrne, 2022).

Data Validation Techniques

Data validation is a set of methods and processes that data teams use to ensure high-quality information (Clemens-Meyer et al., 2021). The method used by the researcher to validate the data is the source triangulation technique. Santos et al. (2020) define triangulation as a technique that combines various existing data collection techniques and data sources. The technique of triangulation is to show multiple pieces of information by examining evidence from the source and using that information to generate a coherent justification for themes. Data source triangulation is exploring the truth of information by using different data sources, such as documents, interview results, and observation results that consider different points of view (Santos et al., 2020).

Ethical Considerations

Ethical considerations are an important part of the morality and responsibility of the author through the research licence letter and the research application letter from the ICFP research ethics committee. Therefore, before conducting this research, the researcher first received a letter of permission from ICFP and then presented it to the school EBCF. Mary Wilson Aubaca, as knowledge to the school coordinator, teachers and students, that the researcher conducted the research. From this letter, it is clear that the author conducted research in a defined place. Research ethics is a moral reference that the author has to conduct research with dedication and responsibility (Pruzan, 2016). Therefore, research ethics is a guide used to perform duties with responsibility, and the author applies it to research activities in the field. After making the presentation through this permission letter, the researcher continued to communicate with the school coordinator to obtain information related to the research topic. An essential part of this research is ethical considerations, where the researcher upholds respect for the human dignity of the subjects, taking care of their privacy.

RESULT

Theme 1: The Prioritisation of Problem-Based Learning in Primary Education by Teachers

The results of the interview with the teachers and students show that problem-based learning (PBL) is an instructional strategy that teachers prioritise in mathematics education. Instead of being used on an occasional basis, PBL is systematically integrated as a daily teaching method. As the teacher states, "PBL is significant when teaching mathematics lessons through the activities, which could be either group or personal work". This statement shows the use of intentional and consistent use, which is a definite instructional commitment.

The priority of PBL is based on its perceived ability to build analytical and critical thinking skills. The teacher stressed that "the approach would help the students understand, solve, and analyse the presented problems." This implies that PBL is not only appreciated on the basis of activity-based learning but also nurturing higher cognitive processes. Students who frequently participate in group and individual problem-solving tasks support this focus. The overlapping of the views indicates that PBL is accepted as a cornerstone methodology for enhancing meaningful mathematical learning at the primary level.

Theme 2: The Use of PBL in Mathematical Operations Teaching

The second theme is related to PBL's operationalisation when teaching mathematical operations. The statistics suggest that systematic lesson planning organises and facilitates the implementation process. According to the teacher, "there is a need to prepare a successful lesson plan that can be used in the context of the mathematical operations of the method." The instruction is usually started with the revision of previously gained knowledge; new material is explained, organised problem-solving tasks (individual and group) are presented, guided questions are asked, and finally, evaluation is done.

The testimonies of students justify such built-in integration. They said that "the teacher explains and breaks us into groups to solve operations and repeats to the teacher when we do not understand." This is facilitation and not discovery learning. Curriculum content is also directly connected to PBL since it involves the inclusion of algebraic operations, fractions, and equations in collaborative activities.

Nevertheless, the teacher also admitted that there were limitations to the implementation, stating that students' understanding is slow, there is some noise in the classroom, and time is insufficient. These obstacles indicate that, although the introduction of PBL is pedagogically motivated, the success of this methodology is conditional upon the management of the classrooms and the proper allocation of time.

Theme 3: The Effect of PBL Implementation on the Understanding of the Students

The third theme is the perceived implications of PBL for the conceptual knowledge of mathematical operations among the students. Both the teacher and the students reported positive results. According to the teacher, "PBL helps students to find solutions to the issue, which means better analytical thinking." This view was further perpetuated among the students, who indicated that the process helped them gain knowledge quickly since it provided them with examples and time to practice alone, in pairs, and in groups. Students said that "the opportunity to share ideas and actively work on problem-solving enhances their understanding and critical thinking."

In addition to the classroom performance, students have also been able to relate PBL to real-life applications. One of the participants mentioned that "the approach provides him with a chance to implement mathematical concepts relating to real problems and helps connect mathematical theory and practical life." This is an indication that PBL enhances procedural competence and encourages transferable problem-solving skills.

Overall, the thematic synthesis shows that teachers see PBL as an important teaching method, organise it for teaching math skills, and believe it helps them and their students improve understanding and analytical skills.

Observation Results

The results of observation prove that the teacher is prioritising and actively applying problem-based learning (PBL) to mathematics teaching. It has been observed that the teacher was ready to organise learning activities according to the principles of PBL and support group and individual problem-solving tasks. The teacher allowed students to share their ideas, talk about solutions, and collaborate to solve maths problems. In line with the data collected during the interview, the teacher was stimulating involvement, checking student performance, and allowing time to ask questions and discuss them. These activities indicate a deliberate attempt to develop students' conceptual learning through active participation.

However, the observation also revealed disagreements between the planned practices and those actually implemented. In some cases, the aspects of PBL were not used to the full extent. Certain stages of investigation were superficial, and the facilitation was less involved than presumed. Such findings would imply that, despite the teacher being concerned with PBL, practical implementation is not always completely in line with the theory.

Student observations also support the results of the interview. Most of the students seemed interested and engaged in teamwork, and they showed an understanding of mathematical operations. Practical teamwork was evident and fruitful. However, there is unequal participation, as a small percentage of

students were less engaged and showed minimal participation. The observed data support the opinion that PBL can have a beneficial impact on engagement and understanding and, at the same time, identify areas that need to be optimised with pedagogy.

Document Analysis Results

The document analysis also gives further support to the results of the interviews and observations in terms of the systematic application of Problem-Based Learning (PBL) to mathematics instructional design. The analysis of the lesson plans developed by the teacher revealed a direct integration of the PBL principles, such as clear statements of the learning objectives, problem-based activities, guided inquiry, and the organization of group and individual tasks. Specifically, the lesson plan on multiplication and operations in the Q curriculum outlines a stepwise problem-solving process that is compatible with PBL methodology, starting with the introduction and exploration phase and continuing with practice and conclusion.

The review of students' exercise books and assessment grades revealed that most students were able to solve operational issues, demonstrating conceptual knowledge that aligned with the practices observed in the classroom. Even though a group of learners needed additional assistance, the general outcomes of performance were positive. The recorded instructional strategies, exercise materials, and final evaluations provide evidence that PBL was not only planned but also implemented systematically, demonstrating that its implementation helped students become more engaged, develop critical-thinking skills, and better understand mathematical operations.

DISCUSSION

The empirical results of the present study prove that the intentional implementation of Problem-Based Learning (PBL) has a positive effect on the conceptual understanding of the mathematical operations of the students, their interactions in the classroom setting, and their skill in solving problems in a team. The findings are consistent with previous literature, which has continually demonstrated the ability of PBL to enhance higher-order thinking and to stimulate genuine learning experiences within the context of mathematics. In their example, Demirel and Dagyar (2016) were able to find, based on a systematic meta-analysis, that PBL significantly increases the affective dispositions and learning outcomes in learners compared to traditional didactic modalities. Similarly, Rahayu et al. (2024) have found out that the systematic PBL model strengthens the critical-thinking skills of primary mathematics students.

The current findings are exclusively aligned with the assumptions of Rahmadani (2019) and Mardiyah (2019), who believe that PBL is a knowledge-building strategy that drives its learners to build knowledge through authentic problem situations, rather than passively engaging knowledge. In this research, the respondents demonstrated greater proficiency in mathematical operations, such as multiplicative and fractional notions, when attempting investigative discussions and directed problem-solving. This empirical data supports the argument that PBL supports the development of conceptual and procedural knowledge (Tortella and Borochovcus, 2014). In addition, learners' ability to link math concepts to real-life situations supports the views of Peranginan (2025) and Risandy et al. (2023), who emphasise that PBL helps develop problem-solving skills that apply outside the classroom.

Despite all these advantages, the research described various barriers to implementation, namely heterogeneity in student engagement, as well as restrictions with regard to timing. These reflections can be compared to the warnings of Markula and Aksela (2022), who point to the fact that an effective PBL requires a carefully coordinated pedagogical design and facilities capacity. Without the right support, inquiry-based activities can end up being shallow, and the conclusion is backed by the fact that some students needed extra help, which aligns with Demirel and Dagyar's (2016) findings that the quality of teaching is the most important factor for effective PBL.

The study adds contextually relevant insights from Timor-Leste, where pedagogies that focus on teachers still exist (Ximenes, 2025). The recorded positive results indicate that PBL could be a useful tool when it comes to promoting learner-centred education in this national setting. However, in line with Ximenes (2024), the sustainability of this kind of innovation will depend upon the competency and professional readiness of teachers, as well as the institutional approval. Overall, the findings of the study support the existing body of literature that confirms the pedagogical value of PBL and strongly emphasises the contextual and instructional factors that have to be considered to implement the method successfully.

CONCLUSION AND RECOMMENDATION

This study finds that problem-based learning is a pedagogically important method of enhancing students' understanding of mathematical operations in primary education. The data show that the instructors, who consciously focus on and systematically incorporate PBL in the lesson design, have the ability to foster analytical thinking, collaborative skills and conceptual knowledge. The data obtained through interviews with teachers, observations in the classroom, and the analysis of documents will all lead to the conclusion that PBL can motivate active engagement and ensure deep learning, not limited to the repetition of procedures.

However, the study also observed pragmatic difficulties, leading to inequitable student activity, time constraints, and partial completion of inquiry stages. These results suggest that, while PBL holds significant promise, its efficacy is contingent upon the quality of its instructional design and facilitation.

Following such conclusions, there are a few recommendations. Firstly, we recommend that teachers engage in long-term professional learning, specifically focusing on the design of effective PBL experiences, classroom management practices, and scaffolding strategies. Second, schools should set aside enough class time to allow maximum implementation of the inquiry-based activities. Third, teacher reflection and peer observation should be institutionalised to increase consistency in pedagogical practices. Lastly, future studies ought to include more cohorts and schools to generate more valuable evidence about the long-term effects of PBL on mathematical performance in Timor-Leste.

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