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Research Article

AN ANALYSIS OF THE APPLICATION OF PROBLEM BASED LEARNING (PBL) MODEL IN MATHEMATICS FOR ELEMENTARY SCHOOL STUDENTS

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Abstract
The problem-based learning model remains an innovative model that is often implemented for learning in the 21st century, as an effort to achieve students' soft skill competencies. Therefore, the purpose of this study is to identify the necessary learning model in Mathematics at Girimarto District Elementary Schools and to analyze the application of the problem-based learning model at these schools. This research is classified as descriptive quantitative research, and it involves a random sample of 106 students and 10 elementary school teachers in the Girimarto area. The data collection technique used is non-test, specifically through the use of questionnaires. The data obtained from the questionnaires are analyzed descriptively using percentages to depict the research findings. The study highlighted a suboptimal implementation of the Problem-Based Learning (PBL) model in Girimarto District, with only 44.94% of the sample demonstrating mastery of critical thinking, 35.67% exhibiting creative reasoning, and 25.09% performing analytical thinking. This indicates a lack of High Order Thinking Skills (HOTS)-based learning among teachers. Various obstacles were identified, including student passivity, fear, and unfamiliarity with the PBL model. Interviews and observations further revealed that many teachers had not fully grasped the concept of PBL. The study emphasizes the need to address these obstacles to enhance PBL implementation and improve Mathematics learning outcomes in Girimarto District Elementary Schools. The implications of these findings underscore the necessity of addressing these barriers to enhance the implementation of PBL and improve Mathematics learning outcomes in Girimarto Elementary School.

Keywords: Elementary School, Mathematics, Problem Based Learning (PBL) Model

INTRODUCTION

In the domain of compulsory education, Mathematics serves as more than a mere tool for calculating and answering test queries. It rather acts as a conduit for honing students' critical thinking and analytical prowess, which will enable them to tackle real-world problems. This is in line with the

view of the NCTM (National Council of Teaching Mathematics) which makes problem solving, reasoning and proof, communication, and representation (presentation) as standard processes in mathematics learning (Abadi & Ekawati, 2018). Mathematics has a significant role in the development of human thought. By learning Mathematics students can develop ideas to think logically and systematically, so that they can assist in analyzing problems or situations, formulating hypotheses, planning, making decisions, and solving problems that can be utilized in everyday life. The process of learning Mathematics is focused on developing students both in learning achievement and problem solving to improve students' abilities. However, students consider this subject as a subject that only deals with numbers so that it interferes with their interest in learning. In addition, Mathematics for students is a boring topic. In order to make learning outcomes in Mathematics maximal, teachers must prepare lesson plans carefully (Sari, 2015).

Teachers often apply cooperative-based learning in the teaching and learning process. Cooperative-based learning focuses on learners by collaborating in groups. Group activities allow students to work together and the benefits can be enjoyed together. In fact, cooperative-based learning not only allows students to work in groups, but also guides students to make reports, carry out new creative activities, discuss, and experiment and the teacher summarizes the results. However, teachers should also try to use some strategies by allowing students to modify various activities carried out (Rattanatumma, Tawachai. 2016).

One of the learning models that can build students' thinking and explore their potential is Problem Based Learning (PBL) learning model (Qomariyah, 2019). As an education approach, problem-based learning (PBL) begins the learning process with a problem, which is tailored to real-world scenarios and refined to align with educational goals and standards. These problems possess the capacity to spark hypotheses that serve as foundational trajectories of the learning journey and prioritize the art of questioning over the quest for answers. This approach fosters heightened motivation and deeper comprehension among learners (Fajari & Chumdari, 2021). PBL offers learners the opportunity to gain theory, knowledge, and content understanding, in addition to advancing their cognitive abilities, including creative thinking, problem-solving, and communication skills (Panggabean et al., 2022). This practice enables learners to understand concepts and subject matter, so learners understand themselves and the situations around them that allow effective learning. PBL as a pedagogical strategy appeals to many educators due to its instructional framework that advocates active and collaborative learning, grounded in the premise that meaningful learning emerges from social interaction and guided inquiry (Yusuf et al., 2022; Dewi et al., 2021). Problem-based learning (PBL) stands as a pedagogical approach that centers on deconstructing and deliberating over case studies within small groups, typically under the guidance of expert tutors or instructors.

PBL learning model emphasizes the premise that problems in the learning environment can encourage learning activities (Hasan et al., 2023). Learning activities begin with a real-world problem, which is crafted to allow students to acquire fresh knowledge before offering an effective solution (Davidi et al., 2021). In the learning process, students interpret the problem, collect the required information, identify solutions, evaluate the selected solutions, and conclude. Students can be good problem solvers if they learn Mathematics heuristically. The experience they have can also help them solve math problems well. Problem-based learning is a strategy that regulates Mathematics learning by presenting a problem, enhancing critical thinking skills, fostering the expression of creative ideas, and facilitating mathematical communication among peers through additional activities and opportunities for engagement (Qomariyah, 2019).

By using PBL learning model, students must be skilled in problem solving, creative thinking, and critical thinking. PBL in Mathematics will provide many opportunities for students to think critically, find their own creative ideas, and encourage students to engage in mathematical communication with their peers. Learners who can develop their authentic problem-solving strategies will integrate conceptual knowledge with procedural skills. Students when applying PBL learning model usually have a greater opportunity to learn mathematical processes related to communication, representation, modeling, and reasoning. In addition to presenting mathematical knowledge to students, teachers in PBL must involve students in compiling information and using their knowledge. They must demonstrate a deep understanding of Mathematics that allows them to guide students in applying knowledge in various situations (Nurtanto et al., 2019).

In *The Effects of Problem-Based Learning Instruction on University Students' Performance of Conceptual and Quantitative Problems in Gas Concepts*, Ibrahim Bilgin et al mentioned the

effectiveness of the PBL model in improving the performance of lecturers and students, as the method PBL is considered suitable for problem-solving during learning activities. The subjects of the study consisted of 78 students from the University of Turkey. A total of 40 students were included in the experimental group, while 38 students were in the control group. The examination unveiled that participants within the experimental group exhibited superior proficiency in addressing conceptual challenges compared to their counterparts in the control group, notwithstanding the absence of variance in quantitative performance among students (Yorganci, 2018).

In *Enhancing Students' Learning Activity and Outcomes via Implementation of Problem-based Learning*, Noviana Astuti Irna Sakir and Jae Geun Kim revealed an increase in students' learning outcomes due to the implementation of PBL in biology class since the beginning of the second cycle. The approach was highly effective even though the students did not have prior experience or knowledge. The application of PBL models can overcome students' learning difficulties, offering resolution for education. This learning model proves the improvement in students' learning outcomes (Sakir & Kim, 2020: 1).

Yaron Doppelt in a research titled *Implementation and Assessment of Project-Based Learning in a Flexible Environment* showed that the PBL learning model could significantly increase students' motivation and self-confidence. The three-year learning process was summarized, signifying an increase in the number of learners who successfully passed the college entrance requirements. Most of the low-achieving learners did well in the same matriculation exam as the high-achieving learners in the same school (Dopplet, 2003: 255).

In the process of development, children not only master the experiences they have, but also the habits and forms of behavior, as well as methods of reasoning. Vygotsky argues that when students have not been able to complete the task well, then the steps that can be taken are with the guidance of a more expert mentor (Nithyanantham et al., 2019). Furthermore, children's cognitive development competencies are largely influenced by interactions with people, especially parents, other children, teachers, and mentors in their social environment. This is what is called social constructivist, namely learning occurs when students create new knowledge based on existing knowledge that they inherently have. The knowledge they have can come from various sources including the environment where they live, the school environment, and so on. The development of the social constructivist paradigm can be done by carrying out learning innovations; both from the teaching methods used, the models used, the media, and others (Vygotsky, L.S. 2018: 415).

This study aims to bridge the gap between the concept and implementation of problem-based learning (PBL) models in elementary schools in Girimarto. There are limitations in teachers' understanding of the PBL concept, resulting in suboptimal implementation and a lack of learning objectives achievement. Although the PBL concept offers an attractive approach to enhancing critical thinking skills and student learning outcomes, its implementation has not been fully successful in practice, indicating the need for further research to explore the best ways to address this gap. The novelty of this research lies in its holistic approach to identifying suitable learning models to improve mathematics learning outcomes in elementary schools, as well as in a deeper understanding of the challenges and opportunities in implementing the PBL model. By focusing on the research objectives to analyze the PBL implementation process and analyze the most effective learning models, this study is expected to make a significant contribution to improving learning outcomes.

The Nature of Mathematics

Mathematics has a very important role in this modern era. For example, classical Mathematics which consists of analytic geometry, trigonometry, calculus, and complex numbers is very useful in various aspects of human life. Mathematics consists of several types, namely pure and simple Mathematics, theoretical and applied Mathematics, combinatorial and algorithmic Mathematics. Mathematics is deep, fundamental, and essential to the human experience. Mathematics is seen as a symbol of precision embodied in the use of symbols in calculations and formal proofs. Symbols are just symbols, not ideas. The intellectual content of Mathematics lies in the ideas, not in the symbols themselves. In short, Mathematics does not lie in the easily seen subject of symbols but lies in human ideas. Here are some characteristics of Mathematics: Mathematics is abstract, Mathematics has an objective existence, Human Mathematics is just a subset of abstract and transcendent Mathematics, Mathematics constitutes an inherent aspect of the universe that furnishes a coherent framework. It manifests through various phenomena, such as the presence of Fibonacci sequences in flora, logarithmic

spirals in mollusks, fractal patterns in geological formations, and parabolic forms in architectural constructs.

The foundational principles of learning Mathematics encompass four key facets, including problem solving, reasoning, communication, and abstraction (Ahmad et al., 2019). Mathematics is a product of human cognition, structured within the confines of our cognitive capabilities. Our comprehension of mathematics is inherently bound by the limitations and organization of the human brain. However, it's crucial to acknowledge that the scope of mathematics extends beyond the confines of human cognition, encompassing realms beyond the cognitive domain. Mathematics can actually be learned from objects and the surrounding environment. These objects can help students to learn new mathematical ideas. With the help of these objects students can model and describe them through sensory, then the knowledge is directed to the cognitive of students (Andriyani & Wilujeng, 2022)

Most educational researchers agree that Mathematics learning is not only passive absorption of certain abstracts, but also contextual concepts and procedural skills that individuals acquire through transmission teaching methods. In contrast, researchers speak of developing a mathematical mindset that encompasses more than just specialized knowledge and problem-solving abilities. It also covers fundamental comprehension, self-regulation capabilities, motivation, and beliefs regarding the nature of mathematics (Zainiyah & Marsigit, 2019). Mathematical knowledge is a combination the individual's inclination to interact within social settings, while perceiving mathematical problem scenarios by constructing mental actions, processes, and objects, and organizing them within a framework of situational analysis and problem solving (Gabriel et al., 2020). Mathematics is not only a process of one's participation, but also the process of knowledge products from complex social interactions. Mathematics should no longer be taught in schools only as a tool, but as a subject that has several different goals that reflect the diversity of the role of Mathematics in society (Annisavitri et al., 2020).

Mathematics offers a mode of thinking and reasoning that enables the assessment of the validity of ideas and their potential accuracy. It encourages exploration and discovery, in which novel concepts continually emerge. Employed as a cognitive tool, mathematics addresses a variety of challenges across scientific, governmental, and industrial domains. Mathematics is a symbolic language that can be understood by all civilized nations. Mathematics is an art, like music, full of symmetries, patterns, and rhythms that can be very entertaining (Lahdenperä et al., 2022). In essence, mathematics is an abstract deductive science, while elementary school-aged children are relatively in concrete thinking with varying abilities so that psychological strategies and approaches as temporary bridges are one alternative. Mathematics is a deductive, axiomatic, formal, hierarchical, and abstract science, characterized by a dense language of symbols, that facilitates the development of mathematical systems by mathematicians. Given the differences in these characteristics, it is necessary to have a special ability from a teacher to bridge the world of children who have not thought deductively to understand the deductive world of Mathematics. Mathematical models as interpretations of this mathematical system can then be used to solve real-world problems. Another benefit that stands out from Mathematics is to shape the mindset of people who study it into a mathematical mindset that is systematic, logical, critical with great accuracy. Mathematics facilitates a practical tool for young learners to foster their understanding of their surrounding environment, improve their growth mindset, and lay a foundation for future exploration in various scientific disciplines. The usefulness of Mathematics for elementary school students is something that is clear and does not need to be questioned anymore, especially in the era of the development of science and technology today (Karso, H. 2014:1-5).

Mathematicians in the United States view Mathematics as an important science that needs deepening, expansion, refinement, and clarification from basic Mathematics to advanced Mathematics (Howe, 1999). Therefore, to be able to understand advanced Mathematics is influenced by how to understand basic Mathematics. Some schools consider Mathematics to be a science that is passed down from generation to generation. Mathematical theories and formulas become references in understanding mathematical problems (Ahmad et al., 2019). Mathematics is studied based on definitions and then leads to mathematical formulas. The formula is then applied to solving math problems. However, the phenomenon that occurs is the memorization of the formula without knowing the theory and the initial definition of Mathematics so that there are often misconceptions about the use of formulas. Some of the obstacles experienced can be overcome by modifying the teacher's teaching style. This teaching style begins with the teacher working on a problem in detail. Furthermore, students try to do activities according to the teacher's instructions, then imitate what the teacher does. This activity is carried out

with many problem-solving exercises with similar contexts. This is done repeatedly to get maximum results (Yorganci, 2018).

To sum up, Mathematics has a very broad branch and is very influential in this modern era. Mathematics is taught at every school level. In addition, Mathematics also has a very important role in everyday life. Mathematics is not only limited to symbols, but the content of Mathematics also lies in the mathematical idea itself. The symbols in question are numbers, shapes, and so on. Mathematics is not only limited to specific knowledge of Mathematics itself but also involves students in contexts and social problems that can be solved through Mathematics itself. Mathematics has various roles in people's lives; therefore, Mathematics can be taught in a complex manner to prepare students to face various problems in the community and school environment.

Problem-Based Learning (PBL)

The learning model is a conceptual framework for designing, implementing, and organizing learning, as an attempt to achieve goals/competencies and guide the process systematically based on the learning syntax. A learning model is characterized by an array of specific educational goals, for instance, the design of an inductive thinking model. It provides a guideline for improving classroom-based teaching and learning activities, such as the use of the synectic model to improve creativity in writing classes. The inclusion of a sequence of learning steps (syntax), reaction principles, social systems, and support systems may guide the implementation of the learning model to offer measurable primary and secondary impacts of its application for long-term learning outcomes. A learning model should also provide guidelines for preparing instructional designs (Mawardi, 2018; Nurdyansyah & Fahyuni, 2016; Nurfitriyanti, 2016).

PBL is considered a 21st century learning models that reinforces high-order thinking skills among students through the implementation of ideas, motivation to achieve the learning goals, and enhancement of school quality. This learning model promotes the attainment of learning objectives tailored to real-world contexts. It underscores the role of problems as initiators of the learning journey, which is seamlesslyaligned with educational objectives and standards. Problems can serve as catalysts for forming hypotheses as the fundamental that determines the learning trajectory and prioritizes problem formulation over mere answers. It fosters the increasing learners' motivation and comprehension (Eka Putra & Iswantir, 2021; Suhirman et al., 2020).

As an instructional methodology, PBL offers instructional solution for learning to use problems. The main goal of PBL is to enhance learning by asking students to solve problems. This model has the following characteristics: a. PBL model focuses on problems so that students begin to learn by dealing with authentic and unstructured problem simulations. The knowledge and skills learned are organized through the problem. Rather than a structured hierarchy of topics, the concept should envision knowledge and a specific problem in a symbiotic relationship. The problem catalyzes knowledge construction, which is then actively re-applied to address the problem; b. It implements participant-centered activities since learning cannot be solely dictated by schools; c. It empowers individuals to take a self-directed approach that enables them to collectively and independently shoulder the responsibility of resolving learning challenges through self-assessment and peer-assessment processes, as well as accessing the teaching materials they need; d. Self-reflection so that students can monitor their understanding and learn to adapt strategies for independent learning; e. Tutors are facilitators (not knowledge distributors) who support and model the reasoning process, facilitate group and inter-student processes, examine students' knowledge in depth, and do not provide direct answers to questions posed (Hadiyanti et al., 2018).

PBL model was popularized at McMaster University Canada in the 1970s and this model continues to develop. The developments that occur are influenced by several things, namely, the increasing demands to bridge theory and practice with information accessibility and knowledge expansion, the urgency to prioritize real-world competencies in learning, and the development of psychology and pedagogy. PBL is an effective model for learning certain knowledge. PBL can help learners build lifelong skills in problem solving, teamwork, and communication (Amir, 2016).

PBL is a pedagogical approach that engages students in an active learning environment (Yew & Goh, 2016). Students engage in problem-solving within their environment that fosters their creativity and cultivates independent learning habits through practice and reflection. This approach aligns with the philosophy that views learning as a constructive, independent, collaborative, and contextual activity. Rooted in constructivism, this principle positions students as active seekers of knowledge who integrate

new experiences with their prevailing knowledge. Beyond understanding concepts, these experiences help students gain insights into themselves and methods that they can conduct to effective learning processes. PBL is appealing to educators as it provides a framework to sustain active and collaborative learning by emphasizing the notion that effective learning emerges from social interaction and guided exploration for constructing ideas.

PBL is an educational pedagogical approach that focuses on helping learners develop independent learning skills. This theory highlights that learning actively involves students in constructing new knowledge upon their existing understanding. PBL encourages students to acquire theoretical knowledge and a deeper understanding of content. This model fosters the development of advanced cognitive skills, including creative thinking, problem solving, and effective communication (Musyaffa et al., 2019).

PBL is a learning approach that focuses on surgery and discussion of problems or cases in small groups which are usually supervised by one or more expert tutors or instructors (Chang, Bliss J. 2016:88). The interactions that occur between students and teachers as well as between students can foster participation so that it affects learning outcomes. Furthermore, it can also shape the character of students (Strayhorn. 2008:1-2). As an educational methodology, PBL views problems as the catalyst for learning. These problems are contextualized to real-life situations and tailored to meet educational objectives. Moreover, problems can stimulate the formulation of hypotheses that determine the learning trajectories and encourage the formulation of questions rather than answers. It also allows the learning process to increase students' motivation and understanding (Putra et al., 2021)(Rahman et al., 2018).

Problem Based Learning (PBL) is a pedagogical learning model. The learning process using this model begins by presenting problems to students, interesting questions, or puzzles. Learners then come up with their own concepts as they analyze the problem. PBL has its roots in cognitive science research on learning processes. This educational model is structured to empower students to pinpoint the concepts and competencies required for problem-solving. By engaging in this process, students not only acknowledge gaps in their understanding of a subject but also become motivated to grasp these concepts and apply them to real-world challenges. PBL enables students to evaluate and experiment with their existing knowledge, identify areas for further learning, hone interpersonal skills essential for teamwork, enhance their speaking and writing abilities (particularly in articulating and defending ideas with robust reasoning and evidence), and cultivate adaptability in problem analyses (Anderson & Rivera-Vargas, 2020).

PBL employs real-world problems as a framework for students to develop critical thinking and problem-solving abilities, while also gaining essential knowledge and concepts from the subject matter. PBL has the idea that learning is most effective when educational tasks or problems are authentic, relevant, and situated within a meaningful context (Triyanto et al., 2022). PBL model was chosen because it has a number of advantages to consider: a. PBL ignites students' critical thinking skills by presenting them with challenging problems and fostering a sense of satisfaction as they uncover new knowledge through problem-solving; b. Students find PBL learning enjoyable due to the engagement with scientific activities through collaborative group work; c. PBL provides students with valuable opportunities to apply their knowledge to real-world situations; d. Through PBL, students actively construct their knowledge through hands-on learning experiences; e. By focusing on problem solving, PBL reduces the need for students to memorize unrelated information, thus allowing them to concentrate on mastering essential skills and concepts; f. PBL encourages students to independently explore a variety of knowledge sources, including libraries, the internet, interviews, and observations; g. Engaging in PBL activities equips students with the ability to communicate their findings effectively through discussions and presentations, thus enhancing their scientific communication skills; h. PBL fosters a supportive learning environment where students can collaborate with peers to overcome individual learning challenges (Rosidah et al. 2014).

Problem-based learning is a learner-centred instructional approach that aims to help learners acquire problem-solving, reasoning, and metacognitive skills as well as domain-specific knowledge, using authentic, complex, and unstructured problems as a starting point, and stimulus for learning in a collaborative environment (Amin et al., 2020). In PBL learning model, unstructured problems are used as a starting point for learning that can create a deep interest in students to learn new knowledge and integrate existing ones and force them to think critically and creatively to solve problems. The advantages of PBL in learning include; forming attitudes, creating interest and joy in learning, and

motivating students to foster an attitude of interdependence in learning, thinking and solving problems together in teams (Syarifah & Nikmaturrohmah, 2021).

The PBL model focuses on providing students with learning experiences in organizing, researching, and solving complex life problems (Techanamurthy et al., 2018). Tambak et al. (2023) mentioned three characteristics of lessons from problem-based learning, including 1) the emphasis on problem-solving, 2) the students' responsibility for solving problems, and 3) the teachers' support during the problem-solving process by the students.

Musriadi Rubiah in his research entitled "Implementation of Problem Based Learning Model in Concept Learning Mushroom as a Result of Student Learning Improvement Efforts Guidelines for Teachers" mentioned that PBL emerged as a training strategy where students collaborated in groups by assuming responsibility for tackling professional problems together. Problem-based learning requires students to learn actively and independently to produce students who are independent and apply the principles of lifelong learning. In the problem-based learning model, the classroom atmosphere is livelier with discussions and debates so that it raises the curiosity of students. Problem-based learning is a learning model that can motivate students to achieve success (Rubiah. 2016:26-27).

In addition, according to Nor Farida Harun, student motivation is one of the keys to the successful implementation of PBL. The transition from the conventional to The model may sometimes generate a negative perception among students who are unaccustomed to inductive learning approaches. The level of motivation of students can be increased to encourage them to learn in depth (Panggabean et al., 2022). The involvement of students during learning activities is also a factor supporting the success of the learning carried out by the teacher. However, it is essential to prioritize the objectives of the learning because it often occurs that the focus of learning is only on the results and overrides the process. In this case, several parties involved in learning activities are students, peers, facilities, and tutors (teachers). All these factors influence each other in learning activities. Self-control is also needed by every individual and the thing that can affect self-control is motivation (Fukuzawa et al. 2017:175-176).

The steps of PBL learning model include: a. Problem orientation. At this stage, the teacher conveys and discusses the learning objectives. The teacher presents real problems to students. The teacher begins to introduce problems related to everyday life, which are commonly faced by the community and the students themselves. Furthermore, the teacher motivates students to engage in problem solving activities; b. Learning orientation. Teachers guide students in comprehending the real problems by helping them identify what they already know, what additional information they require, and the necessary steps to address the problem effectively. Learners share roles/tasks to solve the problem; c. Individual and group investigations. The teacher encourages and guides students to collect data/information (knowledge, concepts, theories) through various ways to find various alternatives/problem solving solutions; d. Development and presentation of solutions. Students are guided to select the most suitable solution from various alternatives they have identified. They compile reports on their problem-solving outcomes, such as in the forms of ideas, models, charts, or PowerPoint presentations; e. Analysis and evaluation of the problem-solving process. The teacher facilitates students to reflect and evaluate the problem solving process carried out (Son et al., 2020; Suparman et al., 2021).

RESEARCH METHOD

Research is one way to find answers to the questions asked. This is indicated by the use of systematic procedures and methods in the exploration process. Bob Ryan in Research Method and Methodology in Finance and Accounting mentioned research as an intellectual discovery that will potentially reform our knowledge to comprehend the world around us (Ryan et al. 1992:7). This study employs a quantitative approach with a descriptive type (Meet & Kala, 2021).

The location of this research was in elementary schools in Girimarto District. The population was five elementary schools in five clusters of Girimarto District. The sample in this study were teachers and students. The sample of students was 106 with details of 53 male students and 53 female students. Teachers as the research sample amounted to 10 people taken from 5 elementary schools that selected randomly.

The data collection technique in this research uses a questionnaire (Yuningtyas et al., 2023; Irawati et al., 2022). Questionnaires were distributed to elementary schools included in the research subjects, The question contains several inquiries regarding aspects of mastery of the PBL learning

model, learning evaluation processes, enthusiasm, and motivation in mathematics learning. This research used a number of instruments for collecting the data, including questionnaires (question lists) and check lists were used to ask questions and observe at the research stage; and objective tests were used to measure students' learning outcomes in Mathematics. The information gathered via surveys was then examined utilizing the method of descriptive percentage analysis (Alfalah, 2018), In order to ascertain the response of the research subjects (teachers and students) towards the implementation of problem-based learning model, an investigation is conducted.

RESULTS AND DISCUSSION

Based on the theories that have been described, children's learning and self-development are heavily influenced by the social environment. This is because interaction activities and children's experiences can stimulate the learning process. When they enter the realm of education, children will get to know new friends who will become their collaboration partners in learning activities. Students will work together and collaborate in the observation and exploration of old knowledge which can then bring up new knowledge or ideas based on the knowledge/experience they have. In problem solving activities, learning models are needed that can facilitate and encourage students to be able to solve problems effectively and can bring up various alternative problem-solving solutions. For example, when students solve HOTS-based questions, finding solutions is done collaboratively so that many ideas emerge. Based on observations, interviews, and tests conducted to analyze the application of PBL model, the data obtained are as follows.

Table 1. Teacher Questionnaire Results

No.	Assessment Aspect	Score
1	Master the concept of PBL model	40%
2	Implement the PBL model according to the syntax	30%
3	Evaluating the implementation of learning	20%

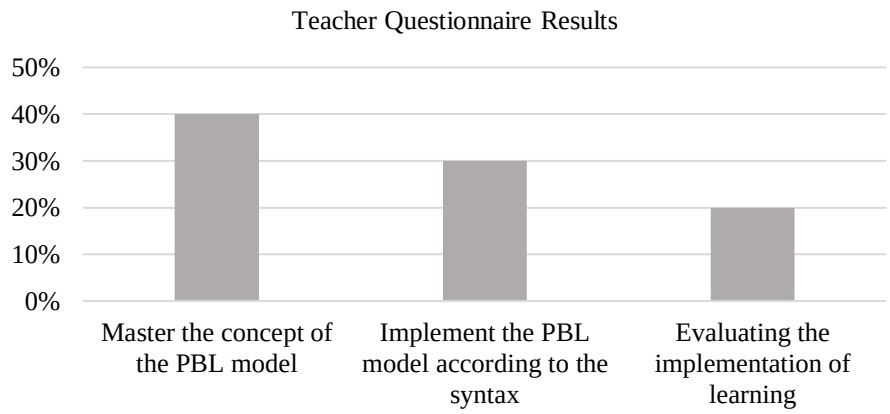

Figure 1. Teacher Questionnaire Results

Based on the table above, it can be seen that 40% of teachers had mastered the concept of PBL learning model, but only 30% had implemented PBL model according to the syntax. Furthermore, only 20% of teachers had evaluated the implementation of the learning carried out. The low mastery of the concept of the model affected the application of the model in learning activities. This had an impact also on the evaluation of the learning implementation by teachers. The challenge among teachers in evaluating learning activities stemmed from students' limited grasp of concepts. The following are the results of the questionnaire on students in elementary schools in Girimarto District.

Table 2. Student's Questionnaire Result

No.	Assessment Aspect	Score
1	Love math lessons	37.74%
2	Like learning activities	33.02%
3	Enthusiasm in learning	28.30%

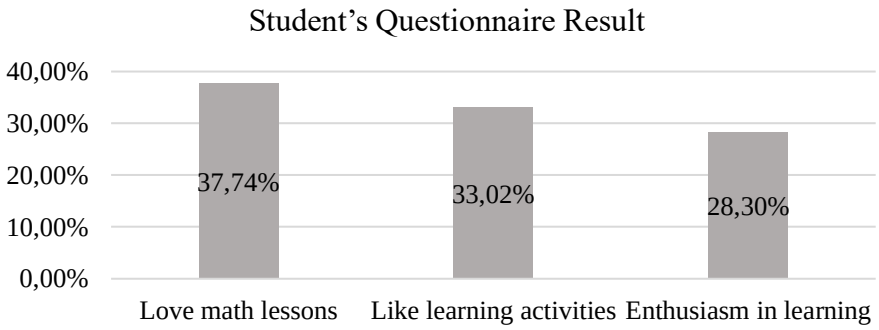

Figure 2. Student's Questionnaire Result

Based on the table above, the data obtained were 37.74% of students liked Mathematics, 33.02% of students liked learning activities, and 28.30% of students were enthusiastic in learning activities. From these data it can be concluded that there were still many students who had difficulty in Mathematics because many of them did not like Mathematics. In addition, students also did not like learning activities carried out with the teacher, resulting in students not being enthusiastic in the learning process.

Table 3. Students' Math Score

No.	Range (%)	Amount
1	91 – 100	37.74%
2	71 – 90	33.02%
3	51 – 70	28.30%
4	31 – 50	34.91%
5	10 – 30	33.02%

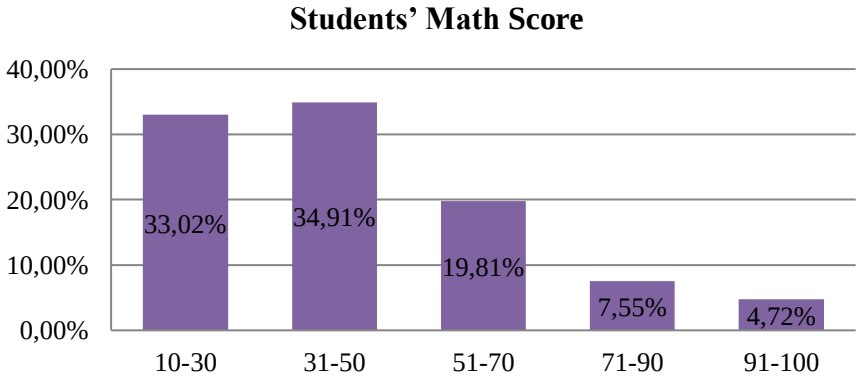

Figure 3. Students' Math Score

Based on the data above, there were 33.02% of students who got a score range of 10-30. The students who scored 31-50 were 34.91%. A total of 19.81% of students scored 51-70. In the value range of 71-90, there were 7.55% and as many as 4.72% of students got a score of 91-100. Based on the data in the table, the value of students in Mathematics was still very low. It is necessary to evaluate the learning process so that students can experience increased learning outcomes.

Research conducted by Heri Mulyanto et al entitled "The Effect of Problem Based Learning Model on Student Mathematics Learning Outcomes Viewed from Critical Thinking Skills" showed that there was a significant gap in Mathematics learning outcomes between students who were treated using

PBL model and those using conventional models. It is indicated that the influence of PBL learning model on Mathematics learning outcomes was very significant (Mulyanto et al. 2018).

Another research conducted by Wa Malmia et al entitled "Problem-Based Learning as an Effort to Improve Student Learning Outcomes" showed that there was an increase in the average value of students after teachers used problem-based learning. Based on the research findings, there was a substantial improvement in the average posttest scores among students in the experimental class. This indicates that the implementation of the PBL model had a significant influence on student learning outcomes (Malmia et al. 2019).

The results of research conducted by Abigail Josephine Kusumatuty entitled "The Implementation of Problem Based Learning (PBL) Based E-Book to Improve The Learning Outcome of Vocational High School (VHS) Students" conducted in vocational high schools, showed that the experimental class using PBL model achieved high learning outcomes compared to the control class using the conventional model. The comparison showed that in the experimental class that used the PBL model, the average value increases significantly (Kusumatuty et al. 2018).

Research by Andi Kaharuddin entitled "Effect of Problem Based Learning Model on Mathematical Learning Outcomes of 6th Grade Students of Elementary School Accredited B in Kendari City" indicated that students who were in the learning process using PBL model got satisfactory scores compared to those who did not apply this learning model. There were several aspects that had not been maximized due to several things, such as: students tended to be quiet and paid attention to the teacher who explained the subject, thus lowerred students-teachers interaction, students were sleepy, and even chatted with peers. Based on these data, it can be concluded that the application of PBL model in learning activities had a positive influence, namely increasing student learning outcomes (Kaharuddin. 2019).

The results of research conducted by Rahmi Ramadhani et al entitled "The Effect of Flipped-Problem Based Learning Model Integrated with LMS-Google Classroom for Senior High School Students" proved the effectiveness of using PBL model that had been modified in its implementation (Ramadhani et al. 2019). Yusuf et al. (2022)mentioned that PBL is designed by confronting learning with contextual problems, so the students manage to understand the reason for their learning, identify problems, collect information from learning sources, and discuss it with their group members to generate solutions and achieve learning goals. Irawati et al. (2022) also highlighted that PBL applies real-world problems to engage students in critical thinking processes and problem-solving activities, thus enabling them to acquire essential knowledge and concepts from their learning materials.

The previous findings relevantly marked that the application of PBL (Problem Based Learning) model has a significant effect on learning outcomes and student activities. This model is effectively used to provide solutions to educational problems, namely student learning outcomes are still low. Researchers have also conducted research in elementary schools and the results of their research showed that student learning outcomes were still low, especially in Mathematics. In addition, teachers were also still less familiar with the concept and implementation of PBL model. Furthermore, researchers can recommend the application of PBL model with modifications to be applied in elementary schools to improve learning outcomes and student's activities.

The development of PBL model based on socio constructivism is as follows: a) Problem-oriented. The teacher conveys and discusses the learning objectives and continues by presenting real problems to students; b) Oriented learning. Teachers assist the students to comprehend the presentation of the real problems and guide them to identify what they already know, what additional information they need, and what they should do to address the problem; c) Individual and group investigations. Teachers encourage and guide students to collect data/information (knowledge, concepts, theories) through various ways to find various alternatives/problem solving solutions; d) Guided group discussion. This activity is a continuation of the group and individual investigations of students and teachers; e) Development and presentation of solutions. Students are guided to select the most suitable solution from various alternatives they have identified; f) Analysis and evaluation of the problem-solving process. The teacher facilitates students to reflect and evaluate the problem solving process carried out (Yorganci, 2018; Lin & Wang, 2023).

In general, the research findings have successfully provided an overview of the implementation of problem-based learning models in primary schools, which still face many obstacles and challenges in order to achieve optimal results. The implication of these findings is the need for addressing these barriers to improve the implementation of PBL and enhance mathematics learning outcomes in

Girimarto Elementary School. However, this study has limitations, such as focusing on one district and may not represent the conditions in other districts. Therefore, further research involving a larger area is needed to strengthen the generalization of the findings. As a recommendation, intensive training for teachers to understand and implement PBL effectively is necessary, in addition to attempting to integrate problem-based learning models with a constructivist social values approach to create a truly authentic learning experience for students.

CONCLUSION

In conclusion, the research underscores the inadequate implementation of the Problem-Based Learning (PBL) model in Girimarto District Elementary Schools, as revealed through questionnaires that filled out by teacher and students. Teachers' limited mastery of the PBL concept led to non-sequential execution and missed steps, impeding learning objectives, while students' unfamiliarity hindered optimal material absorption, resulting in poor Mathematics performance. Given the research's focus on identifying an effective learning model for Mathematics and analyzing PBL's application, it is imperative to adopt a robust model prioritizing critical thinking skills, diverse solution generation, deep comprehension, and effective communication. Collaborative efforts between teachers and students are vital, with PBL, grounded in socioconstructivist principles, emerging as a promising approach to enhance learning outcomes and skills, thereby improving Mathematics education and overall academic success in Girimarto District Elementary Schools.

Furthermore, fostering a supportive and conducive learning environment that promotes active student participation, critical thinking, and open communication is essential. School administrators can facilitate this by providing resources, encouragement, and recognition for innovative teaching practices. By implementing these recommendations, school administrators can play a pivotal role in improving the quality of Mathematics education and overall academic success in Girimarto District Elementary Schools.

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Conceptualization, Sarnoko Pariman; Methodology, Sarnoko Pariman, Asrowi and Gunarhadi; Software, Sarnoko Pariman and Budi Usodo; Validation, Asrowi, Gunarhadi and Budi usodo; Formal Analysis, Sarnoko Pariman; Investigation, Sarnoko Pariman; Resources, Sarnoko Pariman; Data Curation, Sarnoko Pariman, Asrowi, Gunarhadi and Budi Usodo; Writing – Original Draft Preparation, Sarnoko Pariman; Writing – Review & Editing, Sarnoko Pariman, Asrowi, Gunarhadi and Budi Usodo; Visualization, Sarnoko Pariman and Gunarhadi; Supervision, Asrowi, Gunarhadi, and Budi Usodo.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

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