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# Analysis of the Teacher's Role in Facilitating Active Student Engagement in Problem-Based Learning in Mathematics Classrooms

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**Abstract:** This study, conducted between 2013 and 2014, aims to explore the pivotal role of teachers in fostering student engagement within the realm of Problem-Based Learning (PBL) in mathematics. Employing a Systematic Literature Review as the research method, the focus is on qualitative studies delving into teacher-student interactions. The findings highlight teachers' multifaceted roles as instructors, facilitators, and motivators in PBL mathematics, utilizing diverse strategies, including active learning and technology, to augment student engagement. The learning environment emerges as a crucial factor contributing to heightened student involvement. Teachers confront challenges such as students' limited understanding and inadequate ICT infrastructure. The research implications underscore the imperative adoption of active learning strategies, the creation of supportive learning environments, and the diversification of learning activities. Future trends encompass technology integration, teacher competency development, and the necessity for further research on teacher beliefs. In conclusion, this study accentuates the pivotal role teachers play in stimulating student engagement in PBL mathematics, emphasizing the ongoing exploration of teacher beliefs and practices alongside the development of suitable professional development models. The insights from this study are anticipated to offer valuable perspectives and practical solutions for enhancing student engagement in problem-based mathematics learning.

**Keywords:** Problem Based Learning, Mathematics Education, Teacher Role, Student Engagement

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## A. INTRODUCTION

Problem-Based Learning (PBL) emphasizes real-world problem-solving in mathematics education, enhancing students' understanding of concepts and engagement. This method enables students to confront real-world challenges, triggering critical thinking and collaboration (Wulan, 2023). Consequently, students develop problem-solving skills that are useful in everyday life. PBL creates a learning environment that reinforces intrinsic motivation and student autonomy, making it an effective method for improving the quality of mathematics education with relevant experiences (Indarta et al., 2022). In Problem-Based Learning (PBL), the role of the teacher is paramount as a guide, resource provider, and discussion facilitator) (Sukarni et al., 2021). Teachers guide students through the problem-solving process, furnish relevant materials and references, and foster collaboration and

discussion among students (Ananda et al., 2023). By creating a supportive environment, teachers ensure active student engagement in solving mathematical problems, thus enabling them to achieve a deeper understanding of the concepts being learned (Sugrah, 2020).

Student engagement in understanding and solving mathematical problems involves not only physical participation but also cognitive and emotional involvement. This reflects students' activities in thinking, responding, and emotionally internalizing the subject matter. Studies have shown that active learning strategies, such as involving students in various physical activities and group discussions, can enhance student engagement in mathematics classes (Vale and Barbosa, 2023). Teachers play a crucial role in fostering students' cognitive engagement by employing self-regulation techniques and metacognitive understanding, as well as creating a supportive learning atmosphere that facilitates student autonomy (Skilling and Stylianides, 2023). Furthermore, mathematics learning involving physical activities has been proven to have a positive impact on student engagement, which in turn enhances learning outcomes (Sneck et al., 2023). Overall, active engagement in mathematics learning involves students' full participation both cognitively and emotionally, contributing to significant learning experiences and the development of better skills (Shimizu, 2022).

Teachers face several challenges in promoting active student engagement in mathematics learning. These challenges involve resource limitations, large class sizes, and the need for innovative approaches. Resource constraints can hinder teachers from organizing activities and materials that can stimulate active learning (Vale and Barbosa, 2023). Large class sizes make it difficult for teachers to provide individual attention to each student and facilitate meaningful discussions and group work (B. Palma, 2023). Additionally, the importance of innovative approaches arises from the understanding that each student learns in different ways, prompting teachers to seek creative methods to engage diverse students and meet their individual needs (Arpilleda et al., 2023). To address these challenges, support from school administration and government authorities is needed, including the provision of necessary resources and professional development opportunities for teachers to enhance their teaching techniques and knowledge (Mohammad et al., 2023).

The role of teachers in promoting active student engagement in Problem-Based Learning (PBL) in mathematics is highly significant. Hidayat et al. (2020) emphasize the need for innovative and challenging learning experiences, which can be achieved through PBL. Andani et al. (2021) further emphasize the importance of effective planning, teaching, and assessment in PBL, while Wahid et al. (2018) highlight the importance of classroom management in creating a conducive learning environment. Lastly, Anwar (2019) suggests the use of sociodrama models to enhance student participation and motivation in history lessons, which can be adapted to PBL in mathematics. These insights can serve as the foundation for developing more effective teaching strategies in PBL.

Yusni et al. (2015) elucidate that the role of teachers in promoting active student engagement in mathematics learning is supported by several key theories. For example, the constructivist theory emphasizes the importance of students' active participation in constructing their own knowledge. In line with this, Damsyik and Lazuardi (2021) assert that this understanding is further reinforced by the activity theory, which posits that learning is a social activity and student involvement is crucial for their development. Additionally, Saputra

et al. (2018) state that the role of teachers in creating a supportive learning environment that encourages active student participation also receives attention in the literature.

The gathered research findings highlight the crucial role of teachers in addressing challenges in promoting active student engagement in Problem-Based Learning (PBL) in mathematics classrooms. These challenges encompass resource limitations, large class sizes, and the need for innovative approaches. While existing studies have identified these constraints, there is a gap in the literature regarding concrete solutions to overcome them. Moreover, the research results indicate the importance of a deeper understanding of the teacher's role in PBL in mathematics, as well as the relationship between specific teaching strategies and student engagement. However, there is a lack of research specifically investigating the impact of teaching strategies on student engagement in the context of PBL. Additionally, the significance of innovative approaches is revealed, yet there is no research specifically exploring innovative methods in the context of PBL in mathematics classrooms. Therefore, systematic literature research is expected to fill these gaps by providing deeper insights into effective concrete strategies for teachers to promote active student engagement in PBL in mathematics classrooms. This could significantly contribute to the development of more effective and student-oriented mathematics teaching practices.

## B. METHOD

The objective of this research is to delve into and analyze the role of teachers in stimulating active student engagement in Problem-Based Learning (PBL) in mathematics classrooms. The primary focus is to understand the strategies and methods employed by teachers to enhance student participation and evaluate their impact on mathematics learning. Literature search will be conducted meticulously through academic databases, digital libraries, and reputable scholarly sources spanning from 2013 to 2023. Keywords to be utilized will include "Problem-Based Learning," "Teacher Role," "Student Engagement," and "Mathematics Classroom." The search will focus on studies applying qualitative methods, with an emphasis on Systematic Literature Review.

The determination of inclusion criteria involves studies specifically addressing the role of teachers in PBL in mathematics classrooms, utilizing qualitative research methods, and providing in-depth insights into teacher-student interactions. Relevant studies must make significant contributions to the understanding of the teacher's role in the context of mathematics learning. Data selection will be conducted meticulously according to the established inclusion and exclusion criteria. Relevant data will be extracted considering the research methodology, key findings, and their impact on the role of teachers in Problem-Based Learning (PBL) in mathematics. The process of data selection and extraction will be carried out systematically to ensure the validity and continuity of the analysis. Exclusion criteria involve excluding data that do not meet quality standards or are not aligned with the scope of this research, thus ensuring the accuracy and relevance of the obtained results. Through the systematic literature review approach with qualitative methods, this research aims to provide in-depth insights into the role of teachers in promoting active student engagement in problem-based learning in mathematics.

## C. RESULTS AND DISCUSSION

### 1. The Role of Teachers in Problem-Based Learning

Teachers play a central role in enhancing active student engagement in Problem-Based Learning (PBL) in mathematics classrooms. They act as instructors, guides, and learning facilitators (Pauji et al., 2023). As instructors, teachers are responsible for providing the knowledge and skills needed to solve problems and deepen understanding of mathematical concepts (Anggraini et al., 2023). As guides, teachers lead students through the problem-solving process, encouraging collaboration, critical thinking, and creativity (Suryanti et al., 2023); (Saputro and Suci, 2023). They create a supportive and non-intimidating environment where students feel comfortable sharing ideas, mistakes, and difficulties (Vale and Barbosa, 2023). Moreover, as learning facilitators, teachers inspire students to actively engage in PBL and develop intrinsic motivation for learning mathematics. Although factors such as infrastructure availability, student awareness, and support from schools and parents support teachers' role in enhancing student engagement, challenges such as discipline issues and low motivation can hinder these efforts.

The role of a teacher in Problem-Based Learning (PBL) in mathematics is crucial in promoting active student engagement. Kumalasari (2011) emphasizes the need for teachers to focus on developing students' mathematical problem-solving skills, which are at the core of mathematics. Additionally, Hamdu (2021) explains the importance of teachers in planning, implementing, and assessing problem-solving strategies in mathematics, particularly at the elementary school level. Based on the research conducted by Kadir dan Masi (2014), utilizing students' prior mathematical knowledge and contexts by teachers enhances students' creative thinking skills in mathematics. Lastly, Gazali (2016) underscores the importance of meaningful learning in mathematics, which requires teachers to create enjoyable and meaningful activities for students. These studies collectively affirm the key role of teachers in PBL in mathematics, particularly in fostering active student engagement and meaningful learning.

The three roles of teachers in PBL namely, instructor, guide, and learning facilitator— illustrate the complexity of their tasks in achieving student engagement. As instructors, teachers are not only responsible for providing information but also for shaping students' understanding. As guides, they must encourage collaboration and creativity, creating an inclusive environment for effective learning. As learning facilitators, teachers have the responsibility to inspire and motivate students to actively engage. The importance of teachers in PBL in mathematics is acknowledged by various studies.

### 2. Teachers Strategies in Enhancing Active Student Engagement

Teachers employ various concrete strategies to stimulate active student engagement in problem-based mathematics learning. Among these are active learning strategies such as paper folding, gallery walks, and math trails (Vale and Barbosa, 2023). Additionally, an effective method is the use of Problem-Based Learning (PBL), which involves students actively and collaboratively solving problems (Anggraini et al., 2023). The use of teaching aids and media also supports problem-based learning to create a more effective learning process (Naja et al., 2022). Other active methodologies, such as project-based learning, problem-based learning, and flipped classroom approaches, have also been proven to enhance student

motivation and develop mathematical skills (Active Methodologies for the Promotion of Mathematical Learning, 2022). Implementing problem-inducing teaching methods is also known to increase active student participation and improve math scores (Rohmatika, 2023). Overall, these strategies highlight the importance of student engagement, collaboration, and problem-solving in mathematics learning.

Several strategies have been proposed to enhance student participation in problem-based mathematics learning. Rahmayani (2020) emphasizes the need to motivate students, while Minsih et al. (2020) propose additional strategies such as remedial programs and the utilization of instructional media. Wijaya (2021) and Erawati (2016), and all highlight the importance of collaborative learning and the selection of appropriate teaching strategies, with Sujarwo specifically emphasizing the need to consider student characteristics such as achievement motivation. These strategies collectively aim to create an engaging and supportive learning environment to promote active student participation.

Problem-based mathematics learning strategies involving physical activities and technology-based interventions (such as web and mHealth) demonstrate a holistic and innovative approach. The use of methods such as paper folding, gallery walks, and math trails indicates efforts to create interactive and engaging learning experiences for students. These strategies not only encompass traditional approaches in the classroom but also leverage tools and media to enhance the effectiveness of problem-based learning. The success of web and mHealth-based interventions in the context of mathematics learning suggests that technology can be an effective tool to stimulate active student participation. However, evaluations need to be conducted regarding the sustainability and accessibility of such technology in various educational contexts.

### 3. The Influence of Learning Environment

The learning environment plays a crucial role in creating conditions conducive to student engagement in the mathematics learning process in the classroom. Several studies indicate that active learning strategies, such as paper folding, gallery walks, and math trails, can enhance student engagement cognitively, socially, and physically (Vale and Barbosa, 2023). Additionally, the Innovative Learning Environment (ILE) has been shown to improve mathematics learning outcomes, particularly when emphasizing collaborative aspects (Syafitri et al., 2023). The role of teachers also holds significant importance in creating an effective learning environment as they provide essential support to students and can influence the quality of interactions in the classroom (Fahrani et al., 2023); (Zamani et al., 2022). Factors such as learner focus, community, assessment, and knowledge have been identified as influential elements in facilitating effective learning among students (Khasawneh et al., 2023). Overall, the learning environment and its characteristics have a significant impact on the effectiveness of the teacher's role and student engagement in mathematics learning in the classroom.

Sudrajad et al. (2018) assert that the role of the learning environment in creating conditions supportive of active student engagement in mathematics classrooms is crucial. According to Damsyik and Lazuardi (2021), specific characteristics of the learning environment, such as the use of technology, can significantly impact the effectiveness of the teacher's role. Damsyik and Lazuardi (2021) also exemplify that the use of mHealth interventions can enhance family

planning participation among women with unmet needs. Another finding articulated by Setyaningrum et al. (2018) is that Cognitive Behavioral Therapy (CBT) has been proven effective in reducing depression and improving self-care activities among patients with type 2 diabetes mellitus. These findings underscore the importance of creating a supportive learning environment and employing effective teaching strategies to enhance student engagement and learning outcomes in mathematics.

Research shows that active learning strategies and innovative learning environments can enhance student engagement in various aspects. Teachers play a crucial role in shaping effective learning environments, which involve providing support to students and promoting quality interactions. Factors such as learner focus, community, assessment, and knowledge are key in shaping supportive learning environments. The importance of active learning strategies and innovative learning environments underscores the need for a holistic approach to learning. However, evaluation is needed regarding the sustainability and practical implementation of these strategies in various educational contexts. Additionally, the extent to which teachers can integrate critical factors, such as learner focus and community, also needs to be evaluated.

**4. Challenges and Barriers Faced by Teachers**

Teachers face several challenges in creating problem-based mathematics learning that can motivate and engage students. One of the main challenges is the low level of student mastery, which makes it difficult for them to understand mathematical problems and plan appropriate solution strategies (Ling and Mahmud, 2023). Another challenge is the limited teaching time, which restricts opportunities for in-depth problem-solving activities (Suryanti et al., 2023). Additionally, the lack of ICT infrastructure hampers the use of technology in problem-based learning (Lusiana, 2023). Despite these challenges, teachers overcome them by adopting diverse teaching approaches, using creativity and enthusiasm to build students' interest and skills (Rézio et al., 2022). They also continuously improve their knowledge of problem-based tasks and their understanding of how to explain them to students (Dimaculangan et al., 2022). Teachers are not only knowledge conveyors in problem-based learning but also designers of teaching initiatives. By promoting collaboration, reflection, and discussion, teachers maximize their role in creating a learning environment that fosters critical thinking and creativity among students.

The main obstacles faced by educators in creating problem-based mathematics learning that motivates and engages students are classroom management (Izmi, 2022), student motivation (Sumiati, 2018), and communication skills (Yuniarti, 2016). To address these challenges and maximize their role, teachers can focus on creating a conducive learning environment, providing encouragement to students, and enhancing their own communication skills. Furthermore, Nurheni (2022) explains that training and support from educational institutions can further improve the performance of educators in this regard.

Challenges such as students' low understanding and time constraints in teaching indicate the complexity of implementing problem-based mathematics learning. Teachers, as designers of teaching initiatives, need to adopt creative approaches and continuously enhance their knowledge. They also play a role in creating a learning environment that fosters critical thinking and creativity among students. Infrastructure challenges related to ICT can be a

significant barrier, and it needs to be evaluated how far these barriers can be overcome or minimized. Evaluation of the effectiveness of various teaching approaches and teachers' efforts to enhance their knowledge needs to be conducted to ensure that the solutions implemented can have a positive impact.

**5. Implications for Improving Mathematics Learning**

Teachers play a significant role in promoting student engagement in mathematics learning, which has the potential to enhance students' understanding and achievement. Based on the literature, there are several practical implications and recommendations for educational policy. First, adopting active learning strategies such as paper folding, gallery walks, and math trails can improve students' understanding and mathematical skills while fostering their cognitive, social, and physical engagement (Kamarrudin et al., 2023). Second, it is important for teachers to create a supportive classroom environment where students feel comfortable sharing ideas, accepting mistakes, and addressing challenges, while paying attention to movement in the context of mathematics learning (Vale and Barbosa, 2023). Additionally, emphasis should be placed on involving students in learning with the goal of promoting cognitive and social engagement (Jansen et al., 2023). Finally, providing non-standard activities that meet the diverse learning needs of students can help build fundamental mathematical understanding and enhance their engagement (Bundock et al., 2023). These implications underscore the importance of educational policies that prioritize the implementation of active learning strategies, the creation of conducive learning environments, and the diversification of activities to enhance student engagement and achievement in mathematics (Hadijaya, 2016).

Mattawang dan Syarif (2023) elucidate that the role of teachers in promoting active student engagement positively contributes to their understanding and achievement in the subject of mathematics. Next, Dedes (2020) highlights the practical implications of these findings, emphasizing the importance of developing educational policies that support the teacher's role in creating a learning environment that stimulates active student participation. Panjaitan (2022) adds that this includes providing training to teachers in implementing interactive and collaborative teaching strategies. Additionally, Hidayat et al. (2020) state the need for increased support for teachers in honing interpersonal skills and effective communication to inspire students in learning mathematics.

The practical implications of this research include the adoption of active learning strategies, the creation of a supportive learning environment, increased student engagement, and diversification of learning activities. Teachers are expected to develop interactive and collaborative skills and to receive training that supports the implementation of effective teaching strategies. The importance of educational policy support for the teacher's role and the creation of stimulating learning environments need to be critically evaluated. Evaluation of the effectiveness of teacher training and the implementation of teaching strategies needs to be a focus to ensure a positive impact on student engagement.

### 6. Future Trends and Research

To enhance student engagement in problem-based mathematics learning, future directions in the role of teachers include integrating problems into the curriculum (Li et al., 2022), implementing active pedagogy supported by mobile technology (Chan et al., 2023), and improving teacher competence in designing problem-based tasks (Suryanti et al., 2022). These approaches aim to provide students with more learning opportunities, enhance learning achievement, and advance understanding of mathematical concepts. However, there are still shortcomings in research regarding teachers' beliefs and practices in implementing problem-based tasks (Milner and Scholkmann, 2023), exploring the potential of problem-based learning as a sustainable professional development model for teachers (Skilling and Stylianides, 2023), and understanding teachers' practices in promoting students' cognitive engagement in mathematics learning in the classroom. Further research is needed to develop theoretical frameworks for problem-based tasks, design specialized professional development training for teachers, and investigate teachers' beliefs and practices in promoting students' cognitive engagement.

Arief (2015) elucidates that the role of teachers in enhancing student engagement in problem-based mathematics learning is a crucial research aspect that requires further exploration. Furthermore, Pratama (2020) notes that although there are studies demonstrating the effectiveness of various interventions in different medical contexts, similar research is needed in the educational context. According to Saleh (2013), emphasizing the need for more in-depth research on the impact of specific teaching strategies, such as the utilization of real-world problems or technology integration, on student engagement in mathematics learning. Puspita dan Arief (2015) also reveal that the influence of teachers' attitudes and beliefs towards student engagement in problem-based mathematics learning is also worthy of further investigation.

Teachers need to adopt new strategies and enhance their skills in creating engaging and meaningful mathematics learning experiences. Integration of technology and focus on problem-based tasks are key in this endeavor, with an emphasis on continuous professional development for teachers. Evaluation is conducted on the effectiveness of implementing problem integration into the curriculum, the application of active pedagogy with mobile technology, and the enhancement of teacher competence in designing problem-based tasks. Additionally, evaluation needs to be conducted on the need for further research regarding teachers' beliefs and practices.

## D. CONCLUSIONS AND SUGGESTIONS

Based on the evaluation of various studies regarding the role of teachers in Problem-Based Learning (PBL) in mathematics, there is a consensus indicating that teachers have a central role in creating conducive and creative learning environments. Despite facing challenges such as discipline issues and low motivation, teachers are capable of overcoming these constraints through innovative teaching strategies. Problem-based learning strategies can be enhanced through active methods in the classroom, the use of technology, and the integration of problem-based tasks. Although teachers play a crucial role, there is an urgent need to further explore teachers' beliefs and practices in implementing problem-based tasks and the potential

of problem-based learning as a professional development model. As a focus of future research, further exploration of teachers' beliefs and the development of professional development models suitable for the context of problem-based mathematics are essential. Research can also be focused on technology integration, identifying effective strategies in addressing learning challenges, and developing education policies that support teachers' roles in creating optimal learning environments. With emphasis on these aspects, future research is expected to provide deeper insights and concrete solutions to enhance student engagement in problem-based mathematics learning.

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