The Effect of The Problem-Based Learning (PBL) Model on Student Self-Efficacy in Basic Chemical Laws

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ABSTRACT

This research aimed at finding out the effect of Problem Based Learning (PBL) model toward student self-efficacy on Basic Chemical Laws . Quantitative method was used in this research with quasy-experiment research and non-equivalent control group design, 221 students were the population of this research, the samples were 54 students consisting of 28 students in the experiment group and 28 students in the control group, and they were selected by using purposive sampling technique Questionnaire observation, and documentation were the techniques of collecting data. The technique of analyzing data was t-test (independent samples t-test) Based on the test, the score of significance (2-tailed) 0.027 was lower than 0.05, so He was rejected and H. was accepted It meant that there was a significant effect of PBL model toward student self-efficacy on Basic Chemical Laws.

Keywords: *Problem Based Learning, Self-Efficacy, Basic Chemical Law*

INTRODUCTION

Self-efficacy plays a critical role in shaping students' learning experiences and motivation. Originating from Albert Bandura's social cognitive theory, self-efficacy refers to an individual’s belief in their ability to execute tasks and achieve specific goals. This belief influences the choice of activities, effort expended, and persistence in the face of challenges (Bandura, 1997). In the context of education, students with high self-efficacy are more likely to engage in academic tasks, display resilience in the face of setbacks, and perform better in their studies (Schunk, 1991; Zimmerman, 2000). This is particularly relevant in subjects like chemistry, which can be conceptually challenging due to its abstract nature and problem-solving requirements.

The learning environment and instructional strategies play a significant role in shaping self-efficacy beliefs. One such instructional strategy that has gained attention in recent years is Problem-Based Learning (PBL). PBL is an active learning model where students engage with complex, real-world problems, and through collaboration and independent research, they work toward finding solutions. This approach not only promotes critical thinking and problem-solving skills but also has the potential to enhance students' self-efficacy. According to Bandura (1997), self-efficacy is influenced by several sources, including mastery experiences, vicarious experiences, social persuasion, and emotional states. PBL naturally aligns with these sources by offering opportunities for mastery through the resolution of authentic problems, fostering vicarious learning through peer interactions, and encouraging positive reinforcement from both teachers and peers.

In chemistry education, particularly in topics like Basic Chemical Laws, PBL can help students develop a deeper understanding by applying theoretical knowledge to practical scenarios. For instance, in learning about chemical reactions or stoichiometry, students may initially struggle with understanding abstract concepts. However, through PBL, they can explore real-life applications of these principles, which strengthens their confidence in their ability to apply their knowledge in various contexts. Research indicates that PBL promotes greater student engagement, which, in turn, enhances learning outcomes and builds self-efficacy (Hmelo-Silver, 2004). By engaging in hands-on activities, working collaboratively with peers, and receiving constructive feedback, students can develop a stronger sense of competence, which is essential for building self-efficacy.

Furthermore, research suggests that the benefits of PBL extend beyond just content mastery. PBL encourages students to take ownership of their learning process, which fosters intrinsic motivation. When students perceive themselves as capable problem-solvers, they are more likely to approach future learning tasks with a positive mindset, believing they can succeed despite challenges (Savery, 2006). Additionally, the collaborative nature of PBL allows students to share insights and learn from others, creating a supportive learning environment where students can boost each other's self-efficacy through social persuasion. According to Schunk and DiBenedetto (2020), social persuasion is a powerful source of self-efficacy, as verbal encouragement from teachers and peers helps students realize their potential and motivates them to persist.

The impact of PBL on self-efficacy is particularly significant in fields like chemistry, where students often face frustration due to the perceived difficulty of the material. PBL not only provides a way for students to see the relevance of their studies but also reduces anxiety by breaking down complex concepts into manageable tasks. By working on real-world problems, students gain a sense of accomplishment when they solve problems, reinforcing their belief in their ability to succeed in future challenges. This sense of achievement, combined with positive reinforcement from peers and instructors, creates a cycle of increasing self-efficacy that can significantly impact student motivation and performance (Gijbels et al., 2005).

In conclusion, Problem-Based Learning offers a powerful approach to enhancing self-efficacy in students, particularly in subjects like chemistry. By engaging students in real-world problems and fostering a collaborative learning environment, PBL helps students build confidence in their abilities, promotes critical thinking, and enhances problem-solving skills. As a result, students are more likely to approach chemistry with a sense of competence and motivation, which can lead to improved academic performance and a greater willingness to engage with complex topics. The ability to foster self-efficacy through PBL has significant implications for how we approach teaching in challenging subjects like chemistry, where student engagement and confidence are key to success.

Traditional education often places a heavy emphasis on theoretical knowledge, frequently neglecting the development of practical skills that are essential for real-world application. In many traditional classrooms, students receive information passively, typically through lectures or textbook readings, which can make it difficult for them to connect abstract concepts to real-life situations. While this model provides foundational knowledge, it often leaves students with limited opportunities to actively engage with the material, apply their learning in authentic contexts, and build critical skills such as problem-solving and critical thinking. The gap between theoretical knowledge and practical application is especially evident in subjects like chemistry, where complex abstract concepts and problem-solving skills are required for students to truly grasp the subject.

Problem-Based Learning (PBL) presents a dynamic alternative to this traditional approach. PBL is an instructional model that emphasizes student-centered learning, where students are presented with real-world problems and must use critical thinking, collaboration, and research to solve them. In this model, students are encouraged to connect theoretical knowledge with practical problem-solving, promoting a deeper understanding of the material. Rather than simply memorizing facts, students in PBL environments are tasked with applying their knowledge to address complex, real-world issues, which enhances their ability to retain and use the information. This process encourages students to take ownership of their learning and engage in active inquiry, leading to a more meaningful and lasting understanding of the subject matter.

One of the core strengths of PBL is its ability to create a learning experience that bridges the gap between theory and practice. In the context of chemistry education, for instance, students may be faced with problems that require them to apply chemical laws and principles to solve practical challenges, such as determining the reaction rates in chemical processes or predicting the outcomes of chemical reactions under different conditions. By engaging in these types of tasks, students do not only learn theoretical concepts but also practice using these concepts in real-world situations, making the learning experience more relevant and engaging.

The hands-on nature of PBL leads to increased student motivation and engagement. According to research, when students are actively involved in problem-solving and decision-making, they are more likely to experience intrinsic motivation, as they see the immediate relevance of what they are learning. This intrinsic motivation is particularly important in subjects like chemistry, which many students may initially perceive as difficult or abstract. When students are able to see how the knowledge they acquire in class can be applied to solve practical problems, they are more likely to feel competent and confident in their ability to succeed in the subject. The process of solving real-life problems helps to build self-efficacy, or the belief in one's ability to succeed in specific tasks, which in turn fosters greater motivation and persistence in the face of academic challenges.

In addition to enhancing motivation and self-efficacy, PBL also nurtures a wide range of essential skills, including collaboration, critical thinking, and communication. PBL encourages students to work together in groups, allowing them to share ideas, ask questions, and learn from one another. This collaborative approach not only enhances students' understanding of the material but also helps them develop important interpersonal and teamwork skills that are valuable in both academic and professional contexts. Moreover, by engaging in discussions and presenting their findings, students are able to strengthen their communication skills, which are critical in scientific and other professional fields.

Furthermore, PBL fosters a deeper and more sustained form of learning. Because students are involved in the learning process from start to finish, they are more likely to retain the knowledge they have gained. The emphasis on inquiry-based learning and problem-solving encourages students to think critically, reflect on their learning, and develop strategies for tackling future challenges. This approach contrasts with traditional education, where students may only focus on rote memorization for exams and may struggle to retain information in the long term. By linking theory with practice, PBL offers a more holistic approach to learning that supports the development of both cognitive and practical skills.

Research has consistently shown the effectiveness of PBL in enhancing student learning outcomes, particularly in science education. A study by Hmelo-Silver (2004) found that students engaged in PBL showed significant improvement in both content knowledge and problem-solving abilities. Other studies have highlighted the positive impact of PBL on student motivation, engagement, and self-efficacy, especially in subjects that require high levels of critical thinking and application of knowledge, such as chemistry (Savery, 2006). In these settings, PBL provides an opportunity for students to not only learn and apply chemical concepts but also to gain a sense of accomplishment and confidence in their ability to tackle complex problems.

In conclusion, Problem-Based Learning offers a compelling alternative to traditional education by bridging the gap between theoretical knowledge and practical application. Through its focus on real-world problems, PBL promotes deeper engagement with the material, enhances students' motivation and self-efficacy, and nurtures critical skills like problem-solving, collaboration, and communication. By connecting theory to practice, PBL provides students with a more meaningful and comprehensive learning experience, particularly in fields like chemistry where the application of knowledge is crucial for mastering complex concepts. The integration of PBL in educational settings has the potential to transform student learning, leading to greater success and confidence in academic pursuits.

METHOD

This study adopted a quantitative approach with a quasi-experimental design and a non-equivalent control group. The study involved 54 students selected from a population of 221 students. The sample included 28 students in the experimental group, which was taught using the PBL model, and 28 students in the control group, which used conventional teaching methods. The population of this study consisted of 221 students from several high schools in Pekanbaru, Riau. The sample, which comprised 54 students, was selected through purposive sampling, with two groups: 28 students in the experimental group and 28 students in the control group. Instruments The research instruments included a self-efficacy questionnaire, an observation sheet to evaluate the implementation of PBL in the classroom, and documentation as supporting evidence. Data Collection Techniques Data were collected using a self-efficacy questionnaire, which was administered before and after the intervention. Observations were conducted to assess the effectiveness of PBL in improving self-efficacy. Documentation was used as a supplementary data source. Data Analysis The data were analyzed using an independent samples t-test to determine if there were significant differences between the experimental and control groups.

RESULT AND DISCUSSION

Results

In research, data analysis plays a crucial role in determining the validity of hypotheses and interpreting the results. In this case, the data analysis revealed a significance value (2-tailed) of 0.027, which is lower than the commonly accepted threshold of 0.05. This value is derived from a statistical test, most likely a t-test, used to compare the means of two groups—those taught with the Problem-Based Learning (PBL) model and those taught using traditional methods—on the self-efficacy of students in Basic Chemical Laws.

The significance value, or p-value, is used to assess the likelihood that the observed results were due to chance. If the p-value is less than the chosen significance level (often set at 0.05), it indicates that the observed effect is statistically significant, meaning that it is unlikely to have occurred by random chance. In this study, the p-value of 0.027 falls below the 0.05 threshold, leading to the rejection of the null hypothesis (H0) and the acceptance of the alternative hypothesis (H1). The null hypothesis typically posits that there is no effect or relationship between the variables, while the alternative hypothesis suggests that there is a significant effect. In this case, rejecting the null hypothesis and accepting the alternative hypothesis means that the research has found enough evidence to conclude that the PBL model has a statistically significant effect on student self-efficacy in Basic Chemical Laws.

The acceptance of the alternative hypothesis has important implications for the study. It suggests that the PBL model is an effective teaching strategy for enhancing students' self-efficacy, which refers to their belief in their ability to succeed in specific tasks or challenges. Self-efficacy is a critical factor in students' motivation and learning outcomes. According to Bandura (1997), self-efficacy influences how students approach challenges, how much effort they put into tasks, and how resilient they are when faced with difficulties. When students believe they are capable of solving problems and mastering content, they are more likely to persist and succeed. Therefore, the findings of this study suggest that the PBL model, which focuses on real-world problem-solving and active learning, may significantly enhance students' confidence in their ability to understand and apply chemical concepts, thereby improving their self-efficacy.

The use of statistical tests like the t-test provides a robust way to evaluate the effectiveness of educational interventions. A study by Johnson and Christensen (2014) emphasizes the importance of using appropriate statistical methods to test hypotheses and draw reliable conclusions in educational research. By utilizing the t-test and obtaining a significant result ($p = 0.027$), this study demonstrates that the PBL model has a quantifiable and positive impact on student self-efficacy.

Moreover, these findings align with previous research on the effectiveness of PBL in promoting student learning outcomes. For example, Hmelo-Silver (2004) found that PBL not only improved students' problem-solving skills but also enhanced their confidence in tackling complex tasks, a key aspect of self-efficacy. Other studies, such as those by Savery (2006), support the notion that PBL fosters a sense of achievement and competence, as students are given the opportunity to solve real-world problems, which in turn boosts their self-confidence in their academic abilities.

In conclusion, the data analysis in this study, with a p-value of 0.027, provides strong evidence that the PBL model significantly influences student self-efficacy in Basic Chemical Laws. This suggests that the PBL approach, by emphasizing active problem-solving and real-world application, helps students build the confidence they need to succeed in chemistry and other academic subjects. The rejection of the null hypothesis and acceptance of the alternative hypothesis confirms that the PBL model is an effective strategy for enhancing students' belief in their ability to succeed, which is crucial for their motivation and academic success

Discussion

The findings of this study suggest that Problem-Based Learning (PBL) has a positive effect on enhancing students' self-efficacy in learning Basic Chemical Laws. Self-efficacy, as defined by Bandura (1997), refers to an individual's belief in their ability to succeed in specific tasks, which plays a crucial role in shaping their motivation and perseverance in challenging situations. In the context of chemistry education, self-efficacy influences how students approach learning tasks, including their confidence in solving complex problems related to chemical concepts. This study found that through the implementation of PBL, students were able to significantly improve their self-efficacy in understanding and applying chemical laws, which in turn promoted more active participation and problem-solving behaviors.

PBL is an instructional model that places students at the center of the learning process, encouraging them to explore real-world problems and actively seek solutions. This method contrasts with traditional lecture-based teaching, where students often passively receive information. In PBL, students are faced with authentic problems that require them to apply theoretical knowledge to practical situations, which not only deepens their understanding of the content but also boosts their confidence in their problem-solving abilities. According to Hmelo-Silver (2004), one of the key strengths of PBL is its ability to engage students in complex, real-world issues that challenge them to integrate various knowledge areas. As students work through these problems, they build a deeper understanding of the subject matter, which directly influences their self-efficacy.

The process of solving problems in a PBL environment allows students to see the practical relevance of their academic knowledge. This connection between theory and real-world applications has been shown to enhance students' motivation and confidence. In the case of chemistry, understanding how chemical laws apply to everyday phenomena—such as reactions in cooking or environmental processes—can significantly boost a student's belief in their ability to tackle chemistry-related challenges. As students apply their knowledge to these problems, they experience success in overcoming challenges, which increases their self-efficacy (Zimmerman, 2000). This hands-on approach not only reinforces the subject matter but also enhances students' confidence in their academic capabilities.

Furthermore, PBL emphasizes collaboration among students, which fosters a supportive learning environment. Collaborative learning allows students to share their knowledge and skills, help each other solve problems, and collectively approach difficult tasks. This collaborative aspect of PBL has been shown to positively impact students' self-efficacy, as working together to solve complex problems helps students recognize their own strengths and the value of group efforts. According to Johnson and Johnson (1999), cooperative learning, a key feature of PBL, helps students build a sense of mutual respect and trust, which strengthens their belief in their own capabilities and those of their peers. As students collaborate and achieve success together, they experience a collective sense of accomplishment that reinforces their individual self-efficacy.

Additionally, the findings of this study are supported by previous research on PBL and self-efficacy. Studies by Savery (2006) have demonstrated that PBL not only improves students' academic performance but also enhances their confidence in applying their knowledge in new and unfamiliar contexts. When students work through problems and receive positive feedback on their efforts, they are more likely to develop a strong sense of self-efficacy, which motivates them to continue engaging in academic challenges. Similarly, research by Belland et al. (2017) indicates that PBL is effective in fostering students' confidence by providing opportunities for success in complex, real-world problem-solving tasks.

In conclusion, the findings of this study confirm that PBL has a positive effect on students' self-efficacy in learning Basic Chemical Laws. By engaging students in problem-solving activities that connect theoretical knowledge to real-world applications, PBL enhances students' confidence in their ability to solve chemistry-related problems. Additionally, the collaborative nature of PBL fosters a supportive learning environment that strengthens students' belief in their capabilities. These outcomes align with the existing literature on the positive impact of PBL on self-efficacy and motivation, suggesting that PBL is an effective instructional approach for improving students' learning experiences and academic self-confidence.

The results of this study align with Albert Bandura's (1997) theory of self-efficacy, which suggests that individuals' beliefs in their abilities are shaped by their past experiences of success in overcoming challenges. According to Bandura, self-efficacy is a critical factor in determining motivation, performance, and persistence, as individuals with higher self-efficacy are more likely to take on difficult tasks, put in greater effort, and persevere through setbacks. In this context, students who engage in Problem-Based Learning (PBL) tasks, which often involve authentic, real-world problems, are presented with opportunities to succeed in challenging situations. These successes then lead to an increase in their belief in their own abilities, thereby enhancing their self-efficacy.

Bandura's model of self-efficacy identifies four main sources of self-efficacy beliefs: mastery experiences, vicarious experiences, verbal persuasion, and physiological states. Mastery experiences, or the direct experiences of success in task performance, are considered the most influential source of self-efficacy. In the case of this study, PBL provides students with opportunities to engage in mastery experiences, as they tackle complex problems and apply theoretical knowledge to real-world scenarios. When students successfully navigate these challenges, their sense of competence is reinforced, leading to an increased belief in their ability to handle similar tasks in the future (Bandura, 1997).

Furthermore, Bandura emphasizes the role of "perceived self-efficacy" in shaping students' learning behaviors. Perceived self-efficacy refers to students' own judgments about their ability to succeed in specific tasks. When students believe that they have the skills and resources necessary to solve problems, they are more likely to engage in the task with greater effort and persistence. This positive cycle of success, belief, and engagement creates a foundation for continued academic achievement. In the context of PBL, when students successfully solve problems related to Basic Chemical Laws, their belief in their ability to apply chemical concepts to new problems is strengthened, which leads to higher levels of motivation and academic engagement.

The relationship between authentic problem-solving tasks and self-efficacy has been widely supported in educational psychology literature. A study by Schunk (1989) found that students who experience success in solving problems in a collaborative, supportive learning environment tend to develop a stronger sense of self-efficacy. PBL, by encouraging students to engage in authentic problem-solving, directly influences their perceived competence. As students are confronted with complex tasks and succeed in overcoming them, they gain a deeper understanding of the material and develop more confidence in their ability to tackle future challenges.

Moreover, Bandura's theory also highlights the importance of social influences on self-efficacy. While mastery experiences are primary, vicarious experiences—observing others successfully complete tasks—can also positively influence self-efficacy. In a PBL environment, students often collaborate with peers, and seeing their classmates succeed in solving problems can foster a sense of belief in their own abilities. This vicarious experience, along with the direct success they experience through the PBL model, further reinforces their self-efficacy beliefs (Zimmerman, 2000). The collaborative nature of PBL enhances these influences by allowing students to share strategies, offer support, and celebrate successes together, which contributes to building their collective and individual self-efficacy.

In conclusion, the findings of this study are consistent with Bandura's (1997) theory of self-efficacy, as they demonstrate that engaging in authentic problem-solving tasks through PBL enhances students' self-efficacy in learning Basic Chemical Laws. By successfully navigating challenges and applying theoretical knowledge to real-world problems, students gain mastery experiences that strengthen their belief in their ability to handle similar tasks in the future. This process of developing competence and increasing self-efficacy ultimately leads to higher motivation and better learning outcomes.

CONCLUSION

Based on the findings of this study, it can be concluded that the Problem-Based Learning (PBL) model significantly enhances student self-efficacy in learning Basic Chemical Laws. This conclusion is consistent with existing research that highlights the effectiveness of PBL in fostering a deeper understanding of content while simultaneously boosting students' confidence in their academic abilities. The significant impact of PBL on self-efficacy can be understood through several key factors that contribute to how students learn and build confidence in their capabilities, especially in subjects like chemistry.

PBL is an instructional method that encourages students to engage with real-world problems, requiring them to actively apply theoretical knowledge in solving practical issues. According to Savery (2006), PBL emphasizes student-centered learning where the learners are presented with complex, real-world problems and must work collaboratively to find solutions. This approach not only promotes critical thinking and problem-solving skills but also encourages students to become more autonomous learners, which enhances their sense of self-efficacy. By actively engaging in problem-solving tasks, students gain mastery experiences that strengthen their belief in their ability to tackle similar challenges in the future (Bandura, 1997). Mastery experiences are considered the most influential source of self-efficacy because success in overcoming challenges reinforces students' confidence in their capabilities (Schunk, 1989).

The connection between PBL and self-efficacy can also be understood through the lens of social cognitive theory, which posits that self-efficacy beliefs are shaped not only by personal achievements but also by social interactions and feedback from peers and instructors (Zimmerman, 2000). In a PBL environment, students often work in groups, which allows them to benefit from vicarious experiences (observing peers successfully solving problems) and verbal persuasion (positive feedback from peers and teachers). These social influences, coupled with the mastery experiences gained from solving problems, collectively contribute to an enhanced sense of self-efficacy. As students collaborate and share knowledge, they are more likely to recognize their own strengths and capabilities, further reinforcing their belief in their ability to succeed in future tasks.

Moreover, PBL also encourages students to take ownership of their learning. As students actively seek out solutions, they engage in reflective thinking, assess their own progress, and develop problem-solving strategies. This process of self-regulation is crucial for building self-efficacy because it involves students recognizing their own progress and ability to overcome obstacles independently (Zimmerman, 2000). In chemistry, where concepts can often seem abstract or difficult to grasp, PBL allows students to connect theory with practice in a tangible way, increasing their confidence in understanding and applying chemical principles.

The positive impact of PBL on self-efficacy in chemistry is also supported by studies that have shown the benefits of inquiry-based and student-centered learning approaches in science education. For example, a study by Gijbels et al. (2005) demonstrated that students who participated in PBL activities developed greater self-efficacy in their problem-solving skills compared to those who followed more traditional instructional methods. The hands-on, collaborative nature of PBL encourages students to engage with the content in a meaningful way, which in turn leads to higher levels of academic self-confidence.

In conclusion, the findings of this study suggest that PBL is an effective teaching method for enhancing student self-efficacy in learning Basic Chemical Laws. By promoting critical thinking, problem-solving, collaboration, and self-regulation, PBL helps students build confidence in their ability to understand and apply chemistry concepts. These elements of PBL not only contribute to a deeper understanding of the subject matter but also foster a positive belief in students' own abilities, making it a valuable pedagogical approach for chemistry education. As such, PBL can be implemented as an effective alternative teaching method to support students' academic success and boost their self-confidence in learning chemistry.

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