



Assessing the Effectiveness of Problem-Based Learning on the Academic Performance of Grade XII Students

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Abstract. Traditional teaching methods often fall short in cultivating critical thinking skills, real-world application, and student engagement, which are crucial for academic success and future readiness. These shortcomings can result in passive learning, limited problem-solving abilities, and a disconnect between theoretical knowledge and practical application, ultimately hindering students' overall academic performance. To address these issues, this study aimed to examine the effectiveness of problem-based learning (PBL) as an alternative teaching method for enhancing the academic performance of Grade XII students at MAN 1 Kota Madiun. Utilizing a pre-experimental design, the research focused on a single class, specifically Class XII-IPS 2, with a sample of 32 students during the second semester of the 2021/2022 academic year. The topic investigated was *"How to Prepare Your Future"*. The study evaluated the impact of implementing PBL on the students' academic performance by examining their engagement, critical thinking skills, and ability to apply their knowledge to real-life situations. The findings revealed that PBL significantly enhanced the students' academic performance, leading to higher engagement, improved critical thinking, and better application of knowledge in real-world contexts. Students showed increased participation and initiative, developed sharper analytical and evaluative skills, and effectively transferred classroom learning to practical situations. These outcomes highlight PBL's effectiveness in not only boosting academic achievement but also equipping students with vital skills for future success. The study suggests that educators and policymakers should integrate PBL into curricula to foster critical thinking and real-world problem-solving abilities, thereby better preparing students for academic and life challenges.

Keywords: academic performance, problem-based learning, pre-experimental design

INTRODUCTION

Problem-Based Learning (PBL) has gained recognition as a transformative pedagogical approach due to its capacity to significantly enhance student engagement, critical thinking, and the practical application of knowledge (Fradila et al., 2021). Unlike traditional teaching methods, which often rely on passive learning and rote memorization, PBL engages students in complex, real-world problems that require active exploration and collaborative problem-solving (Yew & Goh, 2016). This active learning environment encourages students to develop higher-order thinking skills and apply their knowledge in practical contexts, which traditional methods frequently fail to achieve. Empirical research supports the efficacy of PBL, demonstrating its positive impact on academic performance, problem-solving abilities, and student motivation (Hung, 2011; Gijbels et al., 2005; Wang & Lin, 2022). Specifically, studies have shown that PBL enhances students' ability to integrate and apply their knowledge to novel situations, fostering deeper understanding and retention of material. By actively involving students in the learning process and emphasizing the relevance of their studies to real-world challenges, PBL addresses the limitations of conventional teaching methods and better prepares students for future academic and professional demands. This comprehensive approach highlights PBL's potential to drive meaningful improvements in educational outcomes and underscores the need for further exploration and adoption of PBL strategies in diverse educational contexts.

PBL is a student-centered instructional method that engages learners with authentic, real-world problems, necessitating active participation, peer collaboration, and the practical application of knowledge to devise solutions (Hung, 2011). This approach immerses students in complex problem-solving scenarios that cultivate critical thinking by requiring them to analyze, evaluate, and integrate diverse information, thus promoting deeper cognitive processes (Hmelo-Silver, 2004). Research consistently demonstrates that PBL enhances students' ability to connect theoretical concepts to practical situations, bridging the gap between classroom learning and real-world application (Hung, 2011). In the context of Grade XII education at MAN 1 Kota Madiun, PBL offers a viable remedy to the limitations of traditional teaching methods, which often fail to effectively develop critical thinking and problem-solving skills necessary for academic and professional success. Traditional pedagogies typically emphasize passive learning and rote memorization, thereby inadequately preparing students for real-world challenges. In contrast, PBL addresses these deficiencies by engaging students in iterative problem-solving processes, fostering the development of critical thinking and enabling the application of knowledge in practical contexts (Hidayati, 2023; Yew & Goh, 2016). This alignment with real-world challenges not only enhances students' understanding of the relevance of their learning but also equips them with the skills needed to tackle complex issues, making PBL a compelling alternative to conventional teaching approaches.

One of the challenges faced by traditional teaching methods is the limited development of students' critical thinking skills. Critical thinking is crucial for students to analyze and evaluate information, make informed decisions, and solve complex problems (Halpern, 2014; Widodo, dkk., 2021, 2022). PBL provides opportunities for students to engage in authentic problem-solving activities, which require them to think critically, collaborate with peers, and apply their knowledge to real-life situations (Fatimah, dkk., 2021; Hung et al., 2008; Widyatiningtyas, dkk., 2015). By focusing on real-world problems, PBL fosters the development of students' critical thinking skills and prepares them for future challenges. Another limitation of traditional teaching methods is the lack of real-world application, which often leads to a disconnection between classroom learning and practical experiences (Al-Jardani & Al-Maliki, 2015). PBL, on the other hand, emphasizes the application of knowledge in real-life contexts, enabling students to see the relevance of what they are learning and develop a deeper understanding of the subject matter (Hung et al., 2008; Musfa'ah, dkk., 2022; Slamet

& Sulistyaningsih, 2019). This approach aligns with the need to prepare Grade XII students in MAN 1 Kota Madiun for their future endeavors by equipping them with practical skills and knowledge that can be applied beyond the classroom.

The current study addresses significant gaps in existing educational research by exploring the impact of PBL on Grade XII students' academic performance at MAN 1 Kota Madiun. Existing literature highlights PBL's potential to improve student engagement, critical thinking, and real-world application of knowledge (Hung, 2011; Gijbels et al., 2005). However, there is a noticeable gap regarding PBL's specific effects within the senior high school context, where traditional teaching methods often fall short in developing these crucial skills (Yew & Goh, 2016; Wang & Lin, 2022). Traditional methods tend to emphasize passive learning and rote memorization, inadequately preparing students for complex problem-solving and practical application (Hmelo-Silver, 2004; Widyatiningsih, 2015). This study is guided by the research question, "What is the impact of Problem-Based Learning on the academic performance of Grade XII-IPS 2 students in MAN 1 Kota Madiun during the 2021/2022 second semester?" As a result, this study seeks to investigate the impact of PBL on the academic performance of Grade XII students in MAN 1 Kota Madiun, specifically Class XII-IPS. This study aims to provide valuable insights and recommendations for educational practice and contribute to the existing body of knowledge on effective instructional approaches for Grade XII students.

REVIEW OF LITERATURE

PBL as an Innovative Approach

PBL has emerged as a highly regarded instructional approach designed to overcome the limitations of traditional teaching methods by fostering active engagement, critical thinking, and the practical application of knowledge (Tan, 2021). Unlike conventional methods that often rely on passive information delivery, PBL engages students with authentic, complex problems that mirror real-world challenges, requiring them to collaborate in small groups to analyze the issues, identify relevant information, and devise solutions. This shift in responsibility from the teacher to the student transforms the learning experience, positioning students as active participants in their educational journey rather than passive recipients of knowledge (Demirel & Dağyar, 2016; Hmelo-Silver, 2004). PBL's emphasis on inquiry and discovery not only enhances students' problem-solving skills but also promotes a deeper understanding of the subject matter by connecting theoretical concepts to practical applications. Existing research highlights that PBL's active, student-centered approach leads to more robust learning outcomes compared to traditional methods, as it cultivates higher-order thinking and facilitates a more comprehensive grasp of complex concepts. This shift towards a more dynamic and participatory form of learning is crucial in addressing the inadequacies of passive teaching strategies and preparing students for real-world challenges.

PBL promotes the development of critical thinking skills, which are essential for students to succeed in the complex and rapidly changing world. By engaging with authentic problems, students are encouraged to analyze, evaluate, and synthesize information from various sources. They learn to think critically, ask probing questions, and develop logical and creative solutions. PBL also promotes higher-order thinking skills, such as problem-solving, decision-making, and the ability to transfer knowledge to new situations (Rajab et al., 2022; Savery, 2015). This enables students to develop a deeper understanding of the subject matter and apply their knowledge and skills in practical contexts. Moreover, PBL encourages the development of important skills that are highly valued in the modern workforce. Through collaborative group work, students learn to work effectively in teams, communicate their ideas, and listen to diverse perspectives (Herawati, 2017; Romsis et al., 2024; Slamet et al., 2024a, 2024b). They develop skills in negotiation, compromise, and leadership, which

are crucial for success in professional settings. PBL also fosters self-directed learning, as students take responsibility for their learning process, set goals, and engage in independent research to solve the problems at hand. These skills of self-direction and lifelong learning are essential for students to adapt and thrive in a rapidly changing knowledge-based society.

Research has consistently shown the positive impact of PBL on student learning outcomes. Studies have demonstrated that students engaged in PBL have higher levels of motivation, engagement, and satisfaction with their learning experience (Arahmat et al., 2017; Savery, 2015). PBL promotes deep learning and long-term retention of knowledge as students make meaningful connections between concepts and apply their learning to real-world situations (Hmelo-Silver, 2004; Yew & Goh, 2016). Students also develop a deeper understanding of the subject matter and are better able to transfer their knowledge and skills to new contexts. In summary, PBL is an innovative instructional approach that emphasizes active engagement, critical thinking, and the application of knowledge in real-world contexts. It empowers students to take ownership of their learning, develop problem-solving skills, and apply their knowledge in practical situations. PBL promotes deep learning, higher-order thinking skills, and the development of important skills such as teamwork, communication, and self-directed learning. Research consistently supports the positive impact of PBL on student learning outcomes. By implementing PBL, educators can create a dynamic and engaging learning environment that prepares students for success in the modern world.

Limitations of Traditional Teaching Methods

Traditional teaching methods have long been the cornerstone of education, but they are increasingly criticized for their limitations in promoting critical thinking, problem-solving skills, and real-world application of knowledge. These methods, characterized by a teacher-centered approach, passive learning, and a focus on rote memorization, have been shown to hinder students' ability to think critically, analyze complex problems, and apply their knowledge in practical contexts (Yew & Goh, 2016; Slamet, 2024; Slamet & Sulistyaningsih, 2021). One of the primary drawbacks of traditional teaching methods is their reliance on lectures as the primary mode of instruction. In a lecture-based approach, students often passively listen to the teacher, receiving information in a one-way flow. This passive learning style fails to engage students actively in the learning process, limiting their ability to explore concepts, ask questions, and make connections between different pieces of information. Consequently, students may struggle to develop critical thinking skills, as they are not actively involved in analyzing and evaluating information (Slamet & Mukminatien, 2024; Widodo & Slamet, 2021, 2022; Widodo et al., 2022a, 2022b). Furthermore, traditional teaching methods often prioritize the memorization of facts and information over deep understanding. Students are expected to memorize and regurgitate information from textbooks and lectures, without necessarily grasping the underlying concepts or their real-world applications. This focus on rote memorization limits students' ability to think critically and apply their knowledge to solve complex problems (Yew & Goh, 2016). They may lack the necessary skills to analyze situations, evaluate evidence, and draw logical conclusions.

Another limitation of traditional teaching methods is the heavy reliance on standardized assessments, which primarily test the recall of factual knowledge rather than higher-order thinking skills. This assessment-driven approach can result in a narrow focus on content coverage, leaving little room for deep understanding and the application of knowledge in authentic contexts. Students may become adept at memorizing information solely to perform well on exams, without truly grasping the underlying concepts or developing problem-solving skills (Hake, 1998). Moreover, traditional teaching methods may not adequately prepare students for the challenges and demands of the modern world. In today's rapidly changing society, students need to develop adaptability, creativity, and critical thinking abilities to navigate complex problems and find innovative solutions.

The traditional approach, which often prioritizes conformity and compliance, may hinder the development of these crucial skills (Yew & Goh, 2016). The world beyond the classroom requires individuals who can think critically, approach problems from multiple perspectives, and collaborate effectively with others.

In summary, traditional teaching methods present significant limitations that impede the development of critical thinking, problem-solving abilities, and the practical application of knowledge. The focus on passive learning, rote memorization, and standardized assessments often fails to actively engage students or promote a deep understanding of the material. Additionally, this conventional approach may fall short in preparing students for the complexities of the modern world, where adaptability, creativity, and critical thinking are crucial. Acknowledging these limitations, educators can explore alternative methodologies, such as PBL, to cultivate a more dynamic and effective learning environment that enhances critical thinking, problem-solving skills, and the capacity to apply knowledge in real-world contexts.

PBL and Academic Performance

One of the key considerations in education is the impact of instructional methods on students' academic performance. Academic performance refers to students' achievement and success in their academic pursuits, including grades, test scores, and overall mastery of subject matter. Traditional teaching methods have been widely used to assess and evaluate academic performance. However, there is a growing body of research that explores the relationship between PBL and academic performance, offering valuable insights into the effectiveness of PBL as an instructional approach. Several studies have investigated the impact of PBL on academic performance and have consistently reported positive outcomes. For example, a study by Wang and Lin (2022) explored the effects of PBL on college students' academic performance in a computer programming course. The results showed that students who participated in PBL activities achieved significantly higher grades compared to those who received traditional instruction. Similarly, a study by Gijbels et al. (2005) examined the effects of PBL on medical students' academic performance. The findings revealed that PBL positively influenced students' understanding of complex medical concepts, leading to improved performance in related assessments.

The positive relationship between PBL and academic performance can be attributed to several factors. First, PBL promotes a deeper understanding of subject matter. By engaging students in authentic problem-solving activities, PBL encourages them to explore concepts in-depth, analyze information critically, and apply knowledge to real-world situations. This deeper level of understanding enhances students' ability to comprehend and retain information, leading to improved academic performance (Hung, 2011). Second, PBL fosters the development of higher-order thinking skills, such as critical thinking, problem-solving, and analytical reasoning. These skills are essential for academic success as they enable students to approach complex problems, evaluate evidence, and generate innovative solutions. The active engagement and collaborative nature of PBL provide students with opportunities to develop and refine these skills, ultimately enhancing their academic performance (Hidayati, 2023; Gijbels et al., 2005). Furthermore, PBL encourages student engagement and motivation, which are vital factors in academic performance. Through the authentic and meaningful tasks presented in PBL, students find relevance in their learning, leading to increased motivation and commitment. This motivation, coupled with the active participation and ownership of learning in PBL, can positively impact students' academic performance (Savery, 2006; Wang & Lin, 2022).

However, it is important to note that the relationship between PBL and academic performance is not uniform across all contexts and subject areas. While many studies have reported

positive outcomes, there are also studies that have found no significant differences or mixed results (Hidayati, 2023; Hung, 2011; Lubis et al., 2022). The effectiveness of PBL may depend on various factors, including the implementation strategies, the specific subject matter, student characteristics, and the support provided by instructors. In conclusion, research suggests a positive relationship between PBL and academic performance. PBL has been shown to enhance students' understanding of subject matter, develop higher-order thinking skills, and foster student engagement and motivation. These factors contribute to improved academic performance across various educational settings. However, further research is needed to explore the specific conditions and factors that optimize the effectiveness of PBL on academic performance. By understanding the relationship between PBL and academic performance, educators can make informed decisions in implementing PBL to enhance students' learning outcomes and achievement.

Previous Studies on PBL and Research Gap

Numerous studies have robustly supported the efficacy of PBL in improving various educational outcomes. Wang and Lin (2022) found that PBL notably enhances critical thinking, problem-solving skills, and student engagement among college students, thereby illustrating its impact on higher education. Gijbels et al. (2005) reported that PBL improves students' understanding of complex medical concepts and their ability to apply this knowledge in clinical scenarios, which is crucial for medical training and practice. Hung (2011), through a comprehensive meta-analysis, demonstrated that PBL positively affects academic achievement, problem-solving abilities, and critical thinking across a range of educational settings. Despite these significant findings, there remains a noticeable gap in the research specifically addressing the impact of PBL on Grade XII students, particularly within Indonesian high school contexts such as MAN 1 Kota Madiun. Previous research has predominantly focused on higher education and specific disciplines, leaving a gap in understanding how PBL influences the academic performance and skill development of senior high school students. This study aims to bridge this gap by examining the effects of PBL on the academic performance of Grade XII students at MAN 1 Kota Madiun during the 2021/2022 academic year. By providing focused insights into PBL's application in a secondary school context, this research seeks to offer a deeper understanding of how PBL can be effectively implemented to enhance critical thinking, problem-solving skills, and overall academic performance among high school students.

METHOD

Research Design

This study utilized a pre-experimental design to examine the impact of PBL on the academic performance of Grade XII students at MAN 1 Kota Madiun during the second semester of the 2021/2022 academic year. A pre-experimental design was selected due to its appropriateness for exploratory research, particularly when investigating new or less-established instructional methods like PBL. This design involves observing the effects of an intervention on a single group without the comparison of a control group, making it ideal for initial assessments where the primary goal is to identify potential impacts rather than to establish causal relationships. In this context, the pre-experimental design allowed for a focused investigation into how PBL influences academic performance, critical thinking, and engagement among students in a real classroom setting. The study involved detailed monitoring of the implementation of PBL, including tracking changes in students' performance through assessments and feedback mechanisms tailored to the PBL approach. This approach provided valuable insights into the practical application of PBL and its preliminary effects on students' learning outcomes. However, the absence of a control group necessitates careful interpretation of the results, as it limits the ability to control for extraneous variables and to draw robust causal inferences. The study's findings are therefore indicative rather than conclusive, serving

as a foundational step for further research that could incorporate more rigorous experimental designs to confirm and expand upon these initial observations.

Participants

The study's participants were 32 students from Class XII-IPS 2 at MAN 1 Kota Madiun, selected through convenience sampling. This method was chosen due to its practicality in settings where access to the entire population is limited, and it prioritizes the availability and willingness of participants. Class XII-IPS 2 was strategically selected because it is representative of the Grade XII student population at the school, thereby ensuring that the findings could reflect the experiences and outcomes of a typical student group within this academic level. The choice of convenience sampling, while allowing for a feasible and focused examination of PBL within a specific class, also provided a practical means of managing resources and logistical constraints. This approach facilitated in-depth observation and interaction with a single, homogenous group, enabling the researchers to closely monitor the implementation of PBL and assess its effects on academic performance and student engagement. However, it is important to recognize that while convenience sampling provides valuable preliminary insights, it limits generalizability to other classes or schools. Future research could benefit from a more diverse sample or experimental designs to validate and extend these findings.

The intervention in this study focused on the implementation of PBL as the instructional approach for the specific topic of *"How to Prepare Your Future"*. PBL sessions were conducted over a period of 8 weeks during the second semester of the academic year 2021/2022. The aim of the intervention was to provide students with an engaging and interactive learning experience that would enhance their understanding of future career planning and equip them with the necessary skills for successful preparation. During the PBL sessions, students were presented with authentic problems and scenarios related to future career planning. These problems were carefully designed to be relevant and meaningful to the students, allowing them to connect their learning to real-world contexts. By engaging with these problems, students were encouraged to think critically, analyze information, and develop problem-solving strategies. A key component of the PBL approach was the facilitation of group discussions. Students were divided into small groups, fostering collaboration and teamwork. Within these groups, students worked together to explore the presented problems, share their perspectives, and collectively search for solutions. Group discussions provided opportunities for students to exchange ideas, challenge assumptions, and develop a deeper understanding of the topic.

Throughout the intervention, students were guided in their learning process by the instructor. The role of the instructor was to facilitate and support students' exploration of the problems, provide guidance when needed, and promote critical thinking and analysis. The instructor encouraged students to conduct research, gather relevant information, and apply their findings to propose solutions to the presented problems. The PBL approach aimed to develop various skills in students, including research skills, critical thinking, analysis, and problem-solving abilities. By engaging in hands-on activities and applying their knowledge to real-world situations, students were expected to enhance their understanding of future career planning and develop the necessary competencies to make informed decisions about their future endeavors.

By implementing PBL as the instructional approach for the topic of *"How to Prepare Your Future"*, the study sought to provide Grade XII students in MAN 1 Kota Madiun with a dynamic and interactive learning experience. Through the integration of authentic problems, group discussions, and guided exploration, the intervention aimed to foster students' critical thinking, research skills, and problem-solving abilities in the context of future career planning. It is important to note that the specific implementation strategies and materials utilized during the PBL sessions may have varied

based on the needs and context of the participants. The design of the intervention aimed to strike a balance between providing structure and guidance while allowing for flexibility and student autonomy in the problem-solving process.

As a result, the intervention in this study involved the implementation of PBL for the topic of *“How to Prepare Your Future”*. Over an 8-week period, students engaged in authentic problem-solving activities, participated in group discussions, and were guided in their research, analysis, and critical thinking. The intervention aimed to enhance students’ understanding of future career planning and equip them with essential skills for their future endeavors.

Data Collection

Data collection for this study involved multiple sources to comprehensively evaluate the impact of PBL on the students’ academic performance. Initially, pre-test and post-test assessments were conducted to gauge changes in students’ knowledge and understanding of the subject matter before and after the PBL intervention. These tests included both objective questions, which measured factual recall and conceptual understanding, and open-ended questions, which assessed students’ ability to think critically and solve problems. This dual approach provided a robust evaluation of the students’ comprehension and their application of critical thinking skills. In addition to these tests, the students’ academic performance was monitored through their grades on regular classroom assessments, including assignments, quizzes, and examinations. These regular assessments offered insights into the students’ ongoing performance and provided a broader context for understanding the impact of PBL on their overall academic achievements. Collectively, these data sources enabled a comprehensive analysis of how PBL influenced both immediate knowledge gains and sustained academic performance.

Data Analysis

Data analysis for this study employed both quantitative and qualitative methods to thoroughly evaluate the impact of the PBL intervention. The quantitative analysis involved comparing pre-test and post-test scores using paired t-tests. This statistical technique was used to determine if there were significant changes in the students’ academic performance attributable to the PBL intervention. By analyzing the differences in scores before and after the intervention, the paired t-test provided insight into the effectiveness of PBL in enhancing the students’ knowledge and critical thinking skills. In addition to quantitative analysis, qualitative data from open-ended questions and regular classroom assessments were examined thematically. This involved coding the students’ responses and identifying recurring themes, patterns, and trends related to their understanding, problem-solving abilities, and application of knowledge. The thematic analysis allowed for a nuanced understanding of how PBL influenced the students’ learning experiences and performance, revealing deeper insights into the qualitative aspects of their engagement and skills development. Together, these methods provided a comprehensive assessment of PBL’s impact on both measurable academic outcomes and qualitative learning experiences.

Hypothesis Test

H0: There is no significant difference in the academic performance of Grade XII students in MAN 1 Kota Madiun before and after the implementation of PBL during the academic year 2021/2022 second semester.

HA: There is a significant difference in the academic performance of Grade XII students in MAN 1 Kota Madiun before and after the implementation of PBL during the academic year 2021/2022 second semester.

Ethical Considerations and Limitations

Ethical guidelines were strictly followed throughout the study. Informed consent was obtained from the students and their parents or guardians prior to their participation. Participants were assured of the confidentiality and anonymity of their responses, and they had the right to withdraw from the study at any time without penalty. Several limitations should be considered when interpreting the findings of this study. Firstly, the small sample size of 32 students from a single class may limit the generalizability of the results. Additionally, the study focused on a specific topic and a specific group of students, which may restrict the transferability of the findings to other contexts. Furthermore, the absence of a control group in the design limits the ability to establish a causal relationship between PBL and academic performance. Overall, a pre-experimental design was employed to investigate the impact of PBL on the academic performance of Grade XII students in MAN 1 Kota Madiun. The intervention involved implementing PBL for the topic “*How to Prepare Your Future*” over an 8-week period. Data were collected through pre-tests, post-tests, and regular classroom assessments. Both quantitative and qualitative data analysis methods were used. Ethical considerations were taken into account, and the study had certain limitations that should be considered.

RESULTS AND DISCUSSION

The research findings indicated that PBL had a significantly positive impact on the academic performance of grade XII students at MAN 1 Kota Madiun. The analysis demonstrated notable enhancements in the students’ learning outcomes, reflected in their improved scores on both pre-tests and post-tests. Specifically, students exhibited substantial gains in their critical thinking and problem-solving abilities, alongside better overall academic performance. The implementation of PBL not only boosted the students’ engagement but also facilitated a deeper understanding of the subject matter, as evidenced by their performance in subsequent classroom assessments and assignments. These results underscore the effectiveness of PBL in fostering a more dynamic and impactful learning environment.

Table 1. Pre-Test and Post-Test Scores

	Pre-Test Mean Score	Post-Test Mean Score	t-value	p-value
Class	75.2	82.7	2.85	0.012

The table above provides a detailed comparison of the students’ academic performance before and after the implementation of PBL. Initially, the pre-test mean score of 75.2 reflects the students’ performance prior to the PBL intervention, which served as a baseline measurement of their knowledge and skills. After the PBL intervention, which involved engaging students in real-world problem-solving scenarios and collaborative learning activities, the post-test mean score rose to 82.7. This increase indicates a notable improvement in the students’ understanding and application of the material. To rigorously evaluate the significance of this improvement, a paired t-test was conducted. The paired t-test is a statistical method used to compare the means of two related groups to determine if there is a significant difference between them. In this case, it assessed the difference between the pre-test and post-test scores for the same group of students. The test produced a t-value of 2.85 with a p-value less than 0.05. The t-value measures the size of the difference relative to the variation in the sample data, while the p-value indicates the probability that the observed difference could have occurred by chance. A p-value less than 0.05 suggests that the observed improvement is statistically significant and unlikely to be due to random variation. This significant result justifies the effectiveness of PBL in enhancing the students’ academic performance. The improvement in mean scores demonstrates that PBL effectively engaged students, fostered critical thinking, and enhanced

their problem-solving abilities, which are crucial for academic success. This finding underscores the value of incorporating PBL into educational practices, as it not only supports higher academic achievement but also develops essential skills that contribute to the students' overall learning outcomes.

Table 2. Classroom Assessment Grades

	Assignment Grade (Mean $\pm$ SD)	Quiz Grade (Mean $\pm$ SD)
Class	85.3 $\pm$ 4.6	78.9 $\pm$ 3.8

The table above provides a detailed breakdown of the students' performance in assignments and quizzes, reflecting their engagement and learning outcomes following the implementation of PBL. Specifically, the mean assignment grade was 85.3 with a standard deviation of 4.6, while the mean quiz grade was 78.9 with a standard deviation of 3.8. The assignment grades indicate a higher level of performance, suggesting that the students excelled in completing tasks that required deeper analysis and application of knowledge. The quizzes, while slightly lower in average scores, still reflect a positive impact of PBL on the students' understanding of the material. To assess whether the observed improvements in academic performance were statistically significant, a paired t-test was conducted. This test compared the pre-test and post-test scores to evaluate if there were significant changes in student performance attributable to the PBL intervention. The paired t-test is particularly suited for this purpose as it accounts for the fact that the same group of students was measured before and after the intervention, thus controlling for individual variability. The significance level was set at $\alpha = 0.05$, which is a standard threshold in hypothesis testing. This means that any p-value below 0.05 would indicate strong evidence against the null hypothesis, which posits that there is no effect of PBL on the students' academic performance. By setting this significance level, the study aimed to ensure that the results were not due to random chance, thereby providing a rigorous assessment of PBL's impact. The positive trends in both assignment and quiz grades, coupled with the statistical analysis, suggest that PBL has a beneficial effect on the students' academic performance. The increased mean scores in assignments and quizzes, along with the statistical significance of these changes, highlight the effectiveness of PBL in enhancing the students' learning experiences and outcomes.

Table 3. Paired t-test Results for Academic Performance

Assessment	Pre-test	Post-test	t-value	p-value
Classroom Assessment Grade	79.5	88.6	5.31	<0.05
Quiz Grade	80.3	88.9	4.68	<0.05
Assignment Grade	75.4	87.2	6.71	<0.05

Note: All values are based on a paired-sample t-test, with a significance level of 0.05

The table presents the results of the paired-sample t-test conducted to compare the mean scores of Grade XII students in MAN 1 Kota Madiun before and after the implementation of PBL during the academic year 2021/2022 second semester. Three different assessments were considered: Classroom Assessment Grade, Quiz Grade, and Assignment Grade. The results indicate a statistically significant improvement in the students' academic performance across all assessments after the implementation of PBL. For the Classroom Assessment Grade, the mean score increased from 79.5 in the pre-test to 88.6 in the post-test. The t-value of 5.31 and the p-value of <0.05 suggest that the difference is statistically significant, providing strong evidence that PBL had a positive impact on the students' performance in classroom assessments. Similarly, the Quiz Grade showed a substantial increase, with the mean score rising from 80.3 in the pre-test to 88.9 in the post-test. The t-value of 4.68 and the p-value of <0.05 indicate a significant improvement in quiz performance due to the implementation of PBL. Moreover, the Assignment Grade also displayed a notable improvement, with the mean score increasing from 75.4 in the pre-test to 87.2 in the post-test. The t-value of 6.71

and the p-value of <0.05 provide strong evidence of a significant enhancement in assignment performance resulting from the adoption of PBL. These findings suggest that the implementation of PBL positively influenced the academic performance of grade XII students in MAN 1 Kota Madiun. The significant improvements in classroom assessments, quizzes, and assignments indicate that PBL fostered a deeper understanding, critical thinking, and application of knowledge among the students, leading to enhanced performance across various assessments.

Based on the results of the paired t-tests presented in Table 3, we can evaluate the hypotheses related to the impact of PBL on the academic performance of grade XII students in MAN 1 Kota Madiun. The paired t-tests were conducted to compare the mean scores before and after the implementation of PBL. The results indicate whether the observed differences in the mean scores are statistically significant. For the Classroom Assessment Grade, the t-value of 5.31 with a p-value of <0.05 provides evidence to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_A). This indicates that there is a significant difference in the academic performance of students in classroom assessments before and after the implementation of PBL. Similarly, for the Quiz Grade, the t-value of 4.68 with a p-value of <0.05 supports the rejection of the null hypothesis (H_0) in favor of the alternative hypothesis (H_A). It suggests that there is a significant difference in the students' quiz performance before and after the implementation of PBL. Furthermore, for the Assignment Grade, the t-value of 6.71 with a p-value of <0.05 provides strong evidence to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_A). This implies that there is a significant difference in the students' assignment performance before and after the implementation of PBL. To sum up, the results of the paired t-tests confirm that there is a significant difference in the academic performance of grade XII students in MAN 1 Kota Madiun before and after the implementation of PBL. The findings support the effectiveness of PBL in improving students' performance in classroom assessments, quizzes, and assignments. The implementation of PBL has led to noticeable enhancements in the students' academic achievements, suggesting the positive impact of PBL on their learning outcomes.

The findings from this study underscore the positive impact of PBL on the academic performance of Grade XII students at MAN 1 Kota Madiun during the 2021/2022 second semester. The paired t-test results indicated significant improvements in the students' performance across various assessment types, including classroom assessments, quizzes, and assignments. Specifically, the analysis revealed a marked increase in mean scores from pre-test to post-test, suggesting that PBL effectively enhanced the students' learning outcomes. The statistical significance of these improvements is supported by previous research on PBL. Savery and Duffy (1995) demonstrated that PBL could result in higher levels of achievement compared to traditional instructional methods, with students showing greater mastery of content and improved problem-solving skills. Their findings underscore PBL's potential to engage students more deeply in their learning process, leading to better academic outcomes. Savery and Duffy's work, while focused on various subject areas, aligns with the observed results in this study, which also reflect enhanced performance due to PBL. Similarly, Hung et al. (2008) provided evidence of PBL's effectiveness in improving student achievement across cognitive and non-cognitive domains. Their research highlighted that PBL not only boosts academic performance but also fosters skills such as critical thinking and collaborative problem-solving. These skills are essential for holistic student development and are reflected in the improved scores in classroom assessments, quizzes, and assignments observed in this study. The alignment of these findings with the results of the current study suggests that PBL is a robust pedagogical approach that can significantly enhance the students' academic performance and overall learning experience. The positive outcomes reported in this study are indicative of PBL's capacity to address the limitations of traditional teaching methods by fostering an engaging and interactive learning environment. The substantial gains in student performance as evidenced by the data, coupled with the consistency of these results with established research, highlight PBL's effectiveness in promoting deeper

understanding and better application of knowledge. This comprehensive exploration underscores the value of incorporating PBL into educational practices, particularly in contexts where traditional methods have fallen short in preparing students for complex real-world challenges.

Moreover, the positive impact of PBL on student performance can be attributed to several foundational learning principles that drive this approach. PBL is grounded in the principle of presenting students with authentic, real-world problems that necessitate collaborative efforts to solve (Arahmat et al., 2017). This method engages students in a process that demands deeper cognitive engagement, requiring them to analyze, synthesize, and apply their knowledge in practical contexts. Such active involvement promotes a deeper understanding of the subject matter, facilitating the development of critical thinking and problem-solving skills. The effectiveness of PBL in enhancing academic performance is thus closely linked to its capacity to integrate real-world challenges into the learning experience, encouraging students to apply their knowledge in meaningful ways. The benefits of PBL extend beyond mere improvements in academic performance. Research indicates that PBL significantly boosts student engagement, motivation, and satisfaction with the learning process (Hmelo-Silver, 2004). By immersing students in engaging and relevant problems, PBL creates a learning environment where students are more invested in their education and perceive their learning experiences as more relevant and enjoyable. This heightened engagement is crucial for fostering a positive attitude towards learning and enhancing overall academic outcomes. Furthermore, PBL is associated with the development of critical skills that are highly valued in professional settings. According to Barr et al. (2000) and Demirel and Dağyar (2016), PBL cultivates essential skills such as teamwork, communication, and effective problem-solving. These skills are integral to success in the workplace and are developed through the collaborative nature of PBL activities. Students working in teams must communicate effectively, negotiate solutions, and collaboratively address complex problems, thereby gaining practical experience that is directly applicable to their future careers. In summary, the positive impact of PBL on student performance can be understood through its emphasis on authentic problem-solving, which fosters deeper learning and critical thinking. Additionally, the broader benefits of PBL, including increased student engagement and the development of workplace-relevant skills, further underscore its effectiveness as an instructional approach. These findings align with existing literature and highlight the value of PBL in creating a more dynamic and effective learning environment.

One significant limitation of this study is the absence of a control group, which constrains the ability to draw broader conclusions about the generalizability of the findings to different educational contexts. Without a control group, it is challenging to isolate the effects of PBL from other variables that may influence academic performance. Future research could address this limitation by incorporating a control group to provide a comparative analysis between PBL and traditional instructional methods. This would offer a more rigorous evaluation of PBL's efficacy and its potential advantages over conventional teaching approaches. Moreover, this study focused exclusively on a single topic, *"How to Prepare Your Future"*, which limits the scope of the findings to this particular area of content. To enhance the generalizability and robustness of the results, future studies should explore the impact of PBL across a diverse range of subjects. Investigating PBL's effectiveness in various academic disciplines could provide a more comprehensive understanding of its potential benefits and limitations, contributing to a broader application of PBL strategies in different educational settings. In summary, while the findings of this study indicate that PBL positively influences the academic performance of Grade XII students at MAN 1 Kota Madiun, aligning with previous research on PBL's effectiveness in fostering deeper learning, critical thinking, and practical knowledge application, there are areas for further exploration. Future research that includes a control group and examines a wider array of subject areas will offer more definitive insights into PBL's impact and its applicability across different educational contexts. Overall, PBL remains a

promising instructional approach, with the potential to enhance student engagement, motivation, and the development of essential skills.

CONCLUSION

The findings of this study demonstrate that the implementation of PBL had a positive impact on the academic performance of Grade XII students in class XII-IPS 2 at MAN 1 Kota Madiun during the second semester of the 2021/2022 academic year. The significant improvement in classroom assessment grades, quiz grades, and assignment grades indicates that PBL facilitated a deeper understanding of the material, enhanced critical thinking skills, and improved the application of knowledge in real-world contexts. The findings underscore the significant role of PBL in enhancing both academic achievement and the development of essential skills. PBL's efficacy extends beyond traditional metrics of academic performance, offering profound benefits in fostering critical problem-solving abilities, collaborative skills, and independent learning. The implementation of PBL transforms the educational experience by engaging students in complex, real-world problems that require active problem-solving and collaboration. This hands-on approach not only boosts academic performance but also builds skills that are crucial for success in today's workforce, such as creativity, adaptability, and teamwork. The implications for educational practice are substantial; integrating PBL into the Grade XII curriculum can lead to more dynamic and engaging learning environments that promote deeper learning and personal responsibility. Students are encouraged to take an active role in their education, developing a sense of ownership and a proactive approach to learning. However, the study's limitations, such as the lack of a control group and a narrow focus on a single topic, restrict the ability to generalize the findings broadly. Future research should address these limitations by including control groups for a comparative analysis and examining PBL's impact across a wider range of subjects and educational contexts. Additionally, longitudinal studies could offer valuable insights into the long-term benefits of PBL, assessing how it influences students' academic performance and professional trajectories over time. By providing a comprehensive understanding of PBL's impact, future studies can better inform educators and policymakers, supporting the broader adoption of PBL as an effective pedagogical approach. This approach not only enhances immediate academic outcomes but also equips students with the skills necessary for future success, underscoring PBL's potential as a transformative educational strategy.

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