The Influence of Project-Based Learning Model on Students' Learning Outcomes in Reaction Rate Material

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Abstract

This study aims to determine the effect of the Project Based Learning learning model on student learning outcomes in the matter of reaction rates at SMA Negeri 1 Ampibabo. The population in this study were all students of class XI IPA at SMA Negeri 1 Ampibabo, academic year 2022/2023, totaling 150 people consisting of 5 classes. This type of research is a type of quasi-experimental research with a research design using the pretest and posttest of the experimental group and the control group. Sampling was carried out based on special considerations (purposive sampling) with a research sample of XI IPA E totaling 30 students as an experimental class using the Project Based Learning learning model, XI IPA A totaling 30 students as a control class using conventional learning models. Data collection techniques using test techniques, Based on the results of the study it can be concluded that there is an influence of the learning model on the material on the reaction rate on student learning outcomes at SMA Negeri 1 Ampibabo. This is based on the results of calculations using the SPSS Version 26 application where the value of Sig (2-tailed) = 0.007 <0.05 then Ha is accepted and Ho is rejected, meaning that there is a significant influence between the use of the Project Based Learning learning model on the reaction rate material on learning outcomes students at SMA Negeri 1 Ampibabo.
Keywords: *Project Based Learning; Reaction Rate; Learning Outcomes.*

I. Introduction

Education is a process aimed at assisting individuals in self-development, enabling them to face any changes that occur. Education is a conscious effort to foster and develop high-quality human resources, capable of mastering and advancing knowledge and technology. The primary focus of education lies in the development of mental and thinking abilities, with the expectation that students possess adequate

intellectual preparation to respond independently and confidently to the challenges of a rapidly changing era. [1].

Learning is an instructional process that takes place within the classroom, aimed at achieving optimal learning outcomes through interaction and communication between educators and learners [2]. The occurrence of the learning process is expected to bring about positive changes in learners, including changes in lifestyle, behavior, character, mindset, and knowledge [1]. The role of the teacher in the learning process is influential in the development of learners; therefore, teachers should be capable of making various efforts to prepare and cultivate the potential within learners, leading to the creation of individuals who will be beneficial in the future [3].

In the pursuit of achieving the best learning outcomes, it is important for educators and learners to engage in classroom learning activities that involve interaction and communication. This learning process is expected to yield positive changes in various aspects of learners' lives, including lifestyle, behavior, character, mindset, and knowledge [4]. Furthermore, the role of the teacher in the learning process is crucial as it can influence the development of learners. Therefore, teachers must possess the ability to prepare and cultivate the potential within learners, enabling them to become valuable individuals in the future [2].

In this context, one of the learning models that can provide a comprehensive and real-world relevant learning experience is Project-Based Learning (PjBL). Through PjBL, learners can engage in authentic projects that allow them to apply knowledge and skills in a relevant context [5]. Thus, PjBL can be an effective means to achieve the aforementioned learning goals, which include positive changes in learners' lifestyle, behavior, character, mindset, and knowledge [4]."

Project-based learning is a student-centered approach to learning that emphasizes the process, has a relative timeframe, focuses on real-world problems, and integrates concepts from various components such as knowledge, disciplines, or fields [6]-[7]. In project-based learning, the learning activities take place collaboratively in heterogeneous groups. As project work inherently involves collaboration, the development of learning skills occurs among students. Additionally, in project-based learning, collaborative work takes place within heterogeneous groups [8]. Considering the collaborative nature of project work, individual strengths and learning approaches can strengthen teamwork as a whole.

By involving learners in challenging projects, apart from enhancing learning outcomes, PjBL can also develop various 21st-century skills that are highly demanded in the modern era, such as critical thinking, collaboration, communication, problem-solving, and creativity [9]. Moreover, through PjBL, learners can gain deep and practical learning experiences that can motivate them to learn better. In order to create valuable individuals for the future, educators should consider the use of learning models

like PjBL as part of their efforts to develop learners' potential [10]. Thus, learning not only takes place within the classroom but also involves real-world experiences that can lead to positive changes within learners.

Project-based learning has become a popular approach in enhancing learning outcomes and developing students' skills. Numerous studies have been conducted to support the effectiveness of PjBL as an effective teaching method in improving learning outcomes and developing students' skills [5]-[13]. Therefore, based on several of these studies, it can be concluded that PjBL has proven effectiveness in improving learning outcomes and developing students' skills. This approach encourages students to actively engage in real projects, collaboration, problem-solving, and reflection, which can help them gain a deeper and more relevant understanding of the subject matter [11]. In addition to providing broad benefits in learning in general, the Project-Based Learning (PjBL) model has also been proven to enhance learning outcomes in specific subjects, such as chemistry, including reaction rate material.

In chemistry education, understanding reaction rates is crucial as it is a fundamental concept in comprehending how a chemical reaction occurs [9]. Through PBL, learners can experience a more comprehensive and applied learning approach in studying reaction rates. Within the context of a PBL project focusing on reaction rate material, learners will have an active role in identifying relevant problems and designing appropriate experiments [10]. They will learn how to measure reaction time, observe changes that occur, and systematically record the acquired data. Furthermore, learners will analyze the data using concepts and formulas they have learned, such as rate equations and reaction laws. The data analysis process will involve rate calculations, graph plotting, and observations of the relationship between reactant concentration and reaction rate. Learners can also apply the principles of reaction rates to compare rates under different conditions, such as various temperatures or concentrations [12]. Consequently, they will gain a deeper understanding of the factors influencing chemical reaction rates.

Moreover, in a PBL project, learners will be encouraged to critically analyze their experimental results and identify possible errors or factors affecting data uncertainty [14]-[15]. This allows them to understand the importance of data validity and accuracy within a scientific context. Learners will also learn how to draw conclusions based on evidence obtained from their experiments. Throughout the PBL process, learners will develop critical thinking skills, such as drawing conclusions from data, questioning assumptions, and connecting reaction rate concepts to observed phenomena. They will also enhance their scientific communication skills by presenting reports or presentations that describe the experimental steps, results, and findings [16]-[17].

Through the implementation of PBL in teaching reaction rate material, learners will gain a more comprehensive and profound learning experience. They will not only understand theoretical concepts but also apply them practically in real-life situations. By combining collaboration, data analysis, critical thinking skills, and scientific communication, PBL can enhance learners' understanding, skills, and interest in the field of chemistry, particularly in reaction rate material [18]-[21].

Based on the aforementioned issues, the objective of this research is to determine the influence of the Project-Based Learning model on students' learning outcomes in reaction rate material at SMA Negeri 1 Ampibabo.

II. Method

This type of research is a quasi-experimental study using a quantitative method because the data collected in this research consists of numerical values and will be analyzed using statistical analysis. The instrument used in this study is a test. The research design employed is a pretest-posttest control nonequivalent design. The data analysis techniques involve scoring and assessing students' learning outcomes through pretest and posttest. The analysis requirements will be tested for normality using the Kolmogorov-Smirnov test, and the homogeneity of variances will be examined using the Levene's test. The hypothesis testing will be conducted using an independent sample t-test [24].

III. Results and Discussion

The results obtained in this study consist of the teaching and learning process using the Project-Based Learning model in the experimental class (XI IPA E) and the conventional teaching method using lecture-based approach in the control class (XI IPA A), as well as the learning outcomes of students in the reaction rate material for grade XI IPA at SMA Negeri 1 Ampibabo. The comparison of students' learning outcomes between the experimental and control classes can be seen in Table 1.

Table 1. Data on Students' Learning Outcomes in the Experimental and Control Classes

Measurement Type	Experimental Class	Control Class
Sample Size	30	30
Minimum Score	68	60
Maksimum Score	98	92
Mean	77,93	72,40
Standard Deviation	7,268	7,955

The results obtained in the experimental class were higher, with an average score of 77.93, while in the control class, the average score was 72.40. The percentage of the average scores of student learning outcomes can be seen in Figure 1.

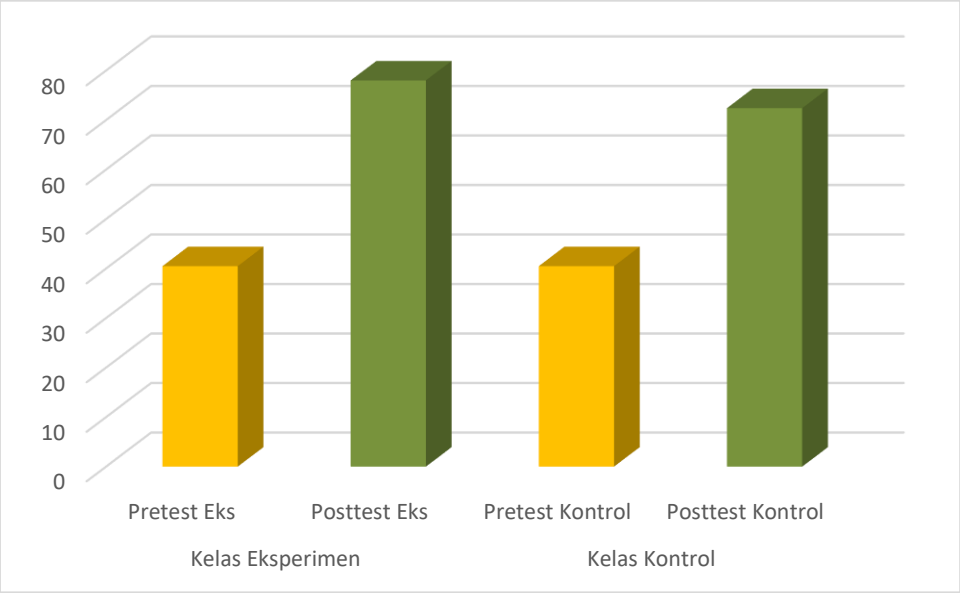

Figure 1. Comparison of Learning Outcomes between the Control and Experimental Classes

a. Normality Test Results

The normality test was conducted to determine whether the obtained data follows a normal distribution, which is a requirement for hypothesis testing. The normality test for this study utilized the One Sample Kolmogorov-Smirnov Test with the assistance of SPSS (Statistical Product and Service Solution) software version 26. The interpretation is based on the Asymp. Sig (2-tailed) value in the output. If the significance value is ≥ 0.05, the data is normally distributed, whereas if the significance value is ≤ 0.05, the data is not normally distributed. The results of the normality test are presented in Table 2.

Tabel 2. Normality Test Results

Class	Data	N	significance	information
XI IPA E (Eksperimen)	*Pretest*	30	,124	Normally distributed
	Posttest		,065	Normally distributed
XI IPA A (Control)	*Pretest*	30	,124	Normally distributed
	Posttest		,070	Normally distributed

Based on the analysis of the normality test above, it can be concluded that the obtained significance value (sig) > 0.05, indicating that the data follows a normal distribution

b. Homogeneity Test Results

The homogeneity test is conducted to determine if there is homogeneity between the two sampled classes. The homogeneity test in this study uses the Levene's test. The decision criterion for the Levene's test is if the significance value > 0.05, the data is considered homogenous, and if the significance value < 0.05, the data is considered non-homogenous. The results of the homogeneity test can be seen in Table 3.

Table 3. Homogeneity Pretest & Posttest Results

Test	Levene Statistik	df1	df2	significance	information
Pretest	,401	1	58	,529	Homogen
Posttest	,010	1	58	,921	Homogen

c. Hypothesis Test Results

Statistical hypothesis testing is used to verify the truth of the hypothesis proposed, in this case, to determine the influence of the Project Based Learning model on student learning outcomes. If the significance value (Sig.) is smaller than 0.05, it indicates that a variable has a significant effect on another variable. Subsequently, hypothesis testing is conducted using the t-test. The results of the data analysis for both samples can be seen in Table 4.

Table 4. t Test Posttest results

Class	Data	N	Mean	T	significance
XI IPA E	Posttest	30	77,93	2,813	,007
XI IPA A		30	72,40		

Therefore, Project Based Learning is an effective and important instructional model to be used in the learning process. PjBL helps students develop essential skills that will contribute to their success in the workplace and enables them to gain a deeper and more holistic understanding of the concepts they learn. By understanding why PjBL is needed in the learning process, educators can begin integrating this model into their curriculum and instructional strategies. One of the key principles of PBL is to focus on the needs, interests, and experiences of students in the learning process. In PjBL, students are given the freedom to choose topics, questions, and approaches that interest them, which in turn enhances their learning outcomes, motivation, and engagement. This model helps students develop a deeper understanding of the concepts they learn and the skills necessary to address real-world situations [23].

In previous studies that support the positive influence of the Project Based Learning instructional model on student learning outcomes, the findings from this research are reinforced. For example, a study conducted by Sasmono [21] demonstrated that the use of the Project Based Learning model can enhance learning outcomes in the subject matter of the nature of chemical science. This is consistent with our findings at SMA Negeri 1 Ampibabo, where students involved in project-based tasks also showed a significant improvement in their understanding and application of reaction rate concepts, resulting in significant improvements in their learning outcomes.

Other studies conducted by Handayani et al. [6], Surya et al. [17], Drastisianti et al. [18], and Johana et al. [20] observed that the Project Based Learning instructional model encourages students to develop critical thinking skills, teamwork collaboration, and problem-solving abilities. These findings also support the results of our research at SMA Negeri 1 Ampibabo, where our students were engaged in projects that emphasized active involvement, exploration, and the application of reaction rate concepts in real-world contexts.

Thus, the utilization of the Project Based Learning instructional model has had a significant positive impact on student learning outcomes in the subject of reaction rate. Through projects that emphasize student engagement, critical thinking abilities, and collaborative skills, students have been able to deepen their understanding of reaction rate concepts and apply them in real-world contexts [19]. The results of this research provide strong evidence that this instructional approach can enhance the quality of education in schools and provide a solid foundation for the development of students' abilities in the future.

IV. Conclusion

Based on the analysis of the research data, it can be concluded that the implementation of the Project Based Learning model has an influence on student learning outcomes in the topic of reaction rates at SMA Negeri 1 Ampibabo. This is evidenced by the results of the t-test, which yielded an average score of 77.93 in the experimental class, compared to 72.40 in the control class, with a significance value of $0.007 < 0.05$. This indicates that the significance value is smaller than the alpha value, leading to the conclusion that the research hypothesis stating "there is an influence of the Project Based Learning model on student learning outcomes in the topic of reaction rates at SMA Negeri 1 Ampibabo" has been proven. Furthermore, the impact of the Project Based Learning model can also be observed in the fact that students are able to learn using this instructional approach, resulting in their achievement of the minimum passing grade (KKM).

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