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IMPLEMENTATION OF PROJECT-BASED LEARNING ON ACID-BASE TO IMPROVE LEARNING OUTCOMES AND ACTIVITIES STUDENTS SMAN 2 PERCUT SEI TUAN

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ABSTRACT

This research investigates the differences in learning outcomes and student activities between the Project-Based Learning (PBL) model and the conventional teaching model on acid-base material at SMAN 2 Percut Sei Tuan. Two classes from the XI grade were selected as samples: one experimental class using the PBL model and one control class using traditional lecture and discussion methods. Data analysis involved tests for normality, homogeneity, hypotheses, and correlations. The Independent Sample T-test results indicated a significant difference in both learning outcomes and student activities, with a significance value of 0.00 ($p < 0.05$), supporting the acceptance of Ha and the rejection of H0. Furthermore, the correlation test revealed a significant relationship between learning outcomes and student activities in the PjBL context, with a Sig. (2-tailed) value of 0.000 ($p < 0.005$). These findings highlight the efficacy of the PjBL model in enhancing student engagement and academic performance in learning acid-base concepts.

Keywords: project-based learning model; learning outcomes; student activities

INTRODUCTION

Chemical stuff is intricate, complex, and more straightforward to grasp with thorough knowledge (Yang & Shen, 2016). Topic complexity, intrinsic skills, practical instruction, and student motivation influence learning results. Low motivation, inadequate understanding, and little experience in practice can all contribute to less-than-ideal learning outcomes. Collaboration between educators and learners is necessary to enhance chemistry learning objectives. Project-based learning can improve psychomotor, emotional, cognitive, and academic results (Tarigan & Latief, 2022). Projects foster curiosity, teamwork, a thorough understanding of chemical topics, and improved presenting abilities among pupils. Instructors can assist students in improving their abilities and future learning outcomes by giving them additional guidance and constructive criticism (Sahroni et al., 2022).

Project-Based Learning (PjBL) has significant potential to enhance students' skills. However, its implementation in educational institutions is hindered by factors such as lack of resources, teacher training, and support from school administration (Masbukin et al., 2023). PjBL requires intensive preparation and planning, as teachers must design projects that fit the curriculum and ensure assignments are appropriate for student's abilities. Access to necessary facilities and technology may also be limited. Despite these challenges, PjBL can significantly improve student learning outcomes in chemistry and other subjects. It creates an authentic context, allowing students to apply chemistry concepts in everyday life increasing their motivation and skills (Yamin et al., 2023).

An interview with Mrs. Niar Rehulina Perangin Angin, M.Pd., revealed that class XI students at SMA Negeri 2 Percut Sei Tuan still need help understanding chemistry material, particularly acid-base material. Despite various learning models, the learning outcomes could be improved by fostering more active and enthusiastic participation. The teacher also noted the need for more Project-Based Learning models, as teachers are often the primary source of information in chemistry lessons. Despite students' high courage, curiosity, and creativity, they still need to explore their needed knowledge. Activities in learning can include visual, verbal, auditory, writing, drawing, metric, mental, and emotional activities.

The Merdeka Curriculum is a new Indonesian education system emphasizing active and adaptive learning through project-based learning. It aims to enhance students' educational experience by promoting active engagement and cultivating adaptability in diverse contexts. The curriculum also emphasizes soft skills and character development, such as communication, problem-solving, and critical thinking. Projects are essential in the Merdeka curriculum because they allow students to apply their knowledge in real-world settings, develop critical thinking abilities, and enrich their learning experience (Azizah and Widjajanti, 2019). Project-based learning (PjBL) is a teaching paradigm that combines student-centered instruction with project assignments, allowing students to work autonomously, expand their knowledge, and create a product. This method cultivates cognitive capacities, comprehension, competencies, aptitudes, and ethical virtues within daily experiences. Teachers act as facilitators, guiding and supporting students as they work on projects (Kurniasih, 2023).

Based on the concerns mentioned above, the goal of comparing the project-based learning model to the conventional model is to assess the differences in student learning results when using the project-based learning method in the context of acid-base materials. Learning Activities to assess students who use the project learning approach with acid-base content and to identify the relationship between student activities and student learning results.

METHOD

This study was carried out at SMAN 2 Percut Sei Tuan, which is situated on Jl. Pendidikan, Bandar Klippa, Percut Sei Tuan, Deli Serdang Regency, North Sumatra, 20371. Two of the four classes in XI SMAN 2 Percut Sei Tuan were chosen as samples: the experimental and control groups. The experimental class adopts a project-based learning model, whereas the control class relies on lectures and discussions. The experimental class is XI-A, while the control class is XI-D.

This study is experimental, with a pretest-posttest control group design. Table 1 below shows the experimental research design.

Table 1 Pretest Posttest Control Group Class Research Design

Class	Circum-stances	Treat-ment	Final State	Enhan-cement
Experiment	T_1	X	T_2	T_2-T_1
Control	T_1	Y	T_2	T_2-T_1

Information:

X: Chemistry learning uses a project-based learning model

Y: Chemistry learning uses the lecture method

T_1: The experimental class and control class were given a pretest
T_2: The experimental class and control class were given a posttest

This study collects data in the form of learning outcomes and student activities. Learning outcome data was gathered using before and post-tests on acid-base material, which was then analyzed using the SPSS 22 tool, specifically the right-hand t-test. Meanwhile, student activity is obtained by directly observing student activity during the learning process at each meeting by giving a score on a questionnaire for each indicator measured at each meeting. Data normality, homogeneity, hypothesis, and correlation tests were used in this study to analyze data. The hypothesis developed in this study is as follows (Sugiyono, 2014) :

1. If Sig. (2-tailed) < 0.05 = H0 is rejected, and Ha is accepted. There are differences between the project-based learning model and the conventional model.
2. If Sig. (2-tailed) > 0.05 = Ha is rejected and H0 is accepted. There is no difference between the project-based learning model and the conventional model.

The correlation developed in this research is as follows:

1. If Sig. (2-tailed) < 0.05, then there is a correlation between the variables being linked.
2. If Sig. (2-tailed) > 0.05, then there is no correlation between the variables being linked.

RESULT AND DISCUSSION

Description of Pretest and Posttest Student Learning Results Data and Activities

Based on the results of research conducted at SMA Negeri 2 Percut Sei Tuan, data was obtained and collected through test instruments so that student learning outcomes could be known. The following is a list of pretest and posttest scores for class XI students at SMA Negeri 2 Percut Sei Tuan.

Table 2 Descriptive Statistics Learning Result Data

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Experiment	36	20	50	36.81	9.498
Posttest Experiment	36	65	95	82.50	7.416
Pretest Control	36	20	40	29.72	5.969
Posttest Control	36	60	90	73.47	8.849
Valid N (listwise)	36				

Based on data obtained from the pre-test of students in the experimental class before treatment, the average pre-test score was 36.81, with a standard deviation of 9.498. After being taught using the project-based learning model, the post-test average score was 82.50, with a standard deviation of 7.416. Meanwhile, data obtained from the pre-test of students in the control class before being given treatment obtained an average pre-test score of 29.72 with a standard deviation of 5.969, and after being taught using the conventional model, an average post-test score of 73.47 was obtained. With a standard deviation of 8.849.

Meanwhile, the results of descriptive statistical analysis for student learning activities using the project-based learning model are shown in Table 3 below.

Table 3 Descriptive Statistics Activities

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Experiment	36	59	82	70.89	7.301
Posttest Experiment	36	68	92	80.17	5.501
Pretest Control	36	58	86	72.06	7.379
Posttest Control	36	70	90	78.81	4.910
Valid N (listwise)	36				

The average pre-test score for experimental class students before to treatment was 70.89, with a standard deviation of 7.301. Following learning with the project-based learning model, the average posttest score was 80.17, with a standard deviation of 5.501. Meanwhile, before receiving treatment, control class students had an average pre-test score of 72.06 with a standard deviation of 7.379, and following conventional model learning, an average posttest score of 78.81 with a standard deviation of 4,910 was attained.

Statistical Data Analysis of Learning Results

Normality Test

This test reveals if the data being evaluated is regularly distributed or not. The Shapiro-Wilk normal distribution test uses the SPSS version 22.0 program with a significance threshold of 5%, or 0.05. The normal distribution is determined using the results of the normal distribution test, as shown in Table 4.

Table 4 Tests of Normality

Class		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Learning outcomes	Experimental Pretest	.131	36	.123	.926	36	.190
	Experimental Posttest	.215	36	.100	.926	36	.190
	Control Pretest	.185	36	.103	.916	36	.100
	Control Posttest	.124	36	.177	.940	36	.149

a. Lilliefors Significance Correction

The table above shows that in the experimental class, the pre-test significance was 0.190. The post-test significance level is 0.190, and both pre-test and post-test significance values are more than 0.05 (Sig value > α (0.05)). This indicates that the data is regularly distributed. The control class has a pre-test significance level of 0.100 and a post-test significance level of 0.149. These values are greater than 0.05, indicating that the data is normally distributed.

Homogeneity Test

Once the data is determined to be normally distributed, the next step is to perform a homogeneity test to determine whether the sample is homogeneous or not. The homogeneity test was performed in this study using the SPSS 22.0 program at a significance level of 5% (0.05). If the significance value exceeds α (0.05), the data is homogeneous. The results of the homogeneity test were obtained, as shown in Table 5.

According to Table 5, the pretest and posttest significance of students adopting the project-based learning model (PjBL) is 0.140, which is homogenous. The results reveal a significant value > α (0.05), indicating the pretest and posttest data are homogeneous.

Table 5 Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Learning outcomes	Based on Mean	3.688	3	140	.140
	Based on Median	2.828	3	140	.410
	Based on Median and with adjusted df	2.828	3	131.432	.410
	Based on trimmed mean	3.750	3	140	.130

Hypothesis Testing

In this study, the Independent Sample T-test was carried out to determine whether there were differences in student learning outcomes taught using the Project Based Learning model and the conventional model using the SPSS 22.0 program at a significance of 5% or 0.05. Data results from the Independent Sample T-test can be seen in the following table 6.

Table 6 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Learning outcomes	Equal variances assumed	2.770	.101	-22.751	70	.000	-45.694	2.008	-49.700	-41.689
	Equal variances not assumed			-22.751	66.112	.000	-45.694	2.008	-49.704	-41.685

Based on Table 6 shows that the significance value of the Independent Sample T-test is 0.00. These results show a significance value of less than 0.05 ($nilai\ sig < \alpha$ (0.05)). Thus, it can be concluded that there are differences in student learning outcomes taught using the Project-Based Learning model and the conventional learning model on acid-base material, so Ha is accepted, and H0 is rejected.

Implementation of the Project Based Learning (PjBL) approach in the context of acid-base material has resulted in a significant increase in student learning outcomes. Comparative analysis between traditional teaching methods and the PjBL approach showed that students engaged in PjBL demonstrated higher levels of understanding and retention of acid-base concepts. Test scores and practical assessments reveal marked improvements in students' ability to apply theoretical knowledge to practical scenarios. The PjBL approach encourages collaborative learning, critical thinking, and problem-solving skills, all of which contribute to improved academic performance. Thus, the observed differences in student learning outcomes confirm the effectiveness of PjBL in fostering a deeper understanding of acid-base material.

Activity Statistical Data Analysis

Normality Test

This test is used to determine whether the data to be analyzed is normally distributed or not. Shapiro-Wilk normality test with the help of the SPSS version 22.0 program at a significance level of 5% or 0.05. Based on the normality test results, normality is obtained as follows in Table 7.

Table 7 Tests of Normality

Class		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Activities	Experimental Pretest	.133	36	.109	.923	36	.116
	Experimental Posttest	.182	36	.104	.940	36	.151
	Control Pretest	.165	36	.114	.915	36	.109
	Control Posttest	.207	36	.100	.932	36	.129

a. Lilliefors Significance Correction

Based on the table above, in the experimental class, the significance level of pretest activities is 0.116. The significance level of posttest activities is 0.151, where the significance value of pretest and posttest activities is more significant than 0.05 (sig value > α (0.05)), so it can be concluded that the result data pretest and posttest activities were usually distributed. Meanwhile, in the control class, the significance level of pretest activities is 0.109. The significance level of posttest activities is 0.129, where the significance value of pretest and posttest activities is more significant than 0.05 (sig value > α (0.05)), so it can be concluded that the data from the pretest and posttest are normally distributed.

Hypothesis Testing

In this research, an Independent Sample T-test was carried out to determine whether there were differences in the activities of students taught using the Project-Based Learning model and the conventional model using the SPSS 22.0 program at a significance of 5% or 0.05. Data from the Independent Sample T-test results can be seen in the following table 8.

Table 8 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Activities	Equal variances assumed	7.750	.007	-6.090	70	.000	-9.278	1.524	-12.316	-6.239
	Equal variances not assumed			-6.090	65.052	.000	-9.278	1.524	-12.316	-6.239

Table 8 shows that the independent sample t-test has a significance level of 0.00. The data have a significance level below 0.05 (value $sig<0.05$). It is conceivable to conclude that students who are taught acid-base content through project-based learning models perform differently than students who are taught using traditional learning models. Thus, Ha is approved, whereas H0 is refused.

The application of the Project Based Learning approach has significantly enriched student learning activities in the context of acid-base material. Observations and activity records showed that students were more engaged and participative during PjBL sessions compared to traditional lecture-based classes. The nature of PjBL, involving practical projects, group discussions, and real-world problem solving, stimulates active learning and sustained interest in the course material. Students demonstrate a high degree of creativity and initiative, often collaborating to design experiments, conduct research, and present their findings. This increased engagement not only makes the learning process more enjoyable but also facilitates a deeper and more practical understanding of acid-base concepts.

Correlation Test

Data on the two variables under consideration were collected in order to investigate the correlation between student activities and learning outcomes. Each student sampled in the study was assessed in terms of their learning activities and outcomes. Based on the correlation test findings, the correlation is calculated as follows.

Table 9 Correlations

		Activities	Learning Outcomes
Activities	Pearson Correlation	1	.787**
	Sig. (2-tailed)		.000
	N	36	36
Learning Outcomes	Pearson Correlation	.787**	1
	Sig. (2-tailed)	.000	
	N	36	36

**. Correlation is significant at the 0.01 level (2-tailed).

Based on the correlation test between learning outcomes and student activities in acid-base material, the Sig was found. (2-tailed) is 0.000 < 0.005, so there is a correlation between the linked variables, namely learning outcomes and students' learning activities at SMA Negeri 2 Percut Sei Tuan on acid-base material.

There is a positive and significant correlation between student activities and student learning outcomes when using the Project Based Learning approach. Statistical analysis shows that higher levels of student engagement and participation in PjBL activities are strongly associated with better academic performance. Students who are more actively involved in collaborative projects and assignments tend to achieve higher test scores and demonstrate superior problem-solving abilities. This correlation between student activity and learning outcomes highlights the important role of active learning strategies in increasing educational attainment. These findings validate the application of PjBL as an effective pedagogical approach that not only increases student engagement but also produces better learning outcomes in the study of acid-base material.

CONCLUSION

Based on the findings of the analysis and debate, the following conclusions might be reached:

1. The findings of hypothesis testing on learning outcomes suggest that the independent t-test has a 0.00 significance level. The results indicate a significance level of less than 0.05 (value $sig < \alpha$ (0.05). There are disparities in student learning results when taught utilizing the project-based learning approach vs the classic acid-base material model. Thus, Ha is approved, and H0 is refused.
2. The activity hypothesis test yields a 0.00 significance level for the independent sample t-test. The results indicate a significance level of less than 0.05 (value $sig < \alpha$ (0.05). As a result, it is possible to conclude that the activities of students who are taught acid-base content using project-based learning models differ from those taught using standard models. Thus, Ha is approved, and H0 is refused.
3. The correlation test between learning outcomes and student activities in acid-base material shows a Sig. (2 tailed) 0.000 < 0.005, indicating a correlation between related variables at SMA Negeri 2 Percut Sei Tuan.

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