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Differencesi in Learning Outcomes And Science Process Skills of Students Learned With the Model Project Based Learning and Discovery Learning on Acid-Base Material

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Abstract: The aims of this study is to determine the differences in learning outcomes and science process skills of students learned with Project Based Learning and Discovery Learning models on acid-base material, as well as the correlation between students' science process skills and student learning outcomes. This research is a quantitative research. The samples in this study were taken by random sampling of 2 classes, namely XI MIPA 1 as experimental class I and XI MIPA 3 as experimental class II, where each class was taken by 29 students based on the similarity of pretest results. The instruments used are test instruments in the form of multiple-choice questions and essays and non-test instruments in the form of observation sheets. Hypothesis testing was carried out using the SPSS Statistic version 24 for Windows computer program using the Independent Sample T-Test and Bivariate Pearson Correlation. For hypothesis I obtained the value of sig. (2-tailed) 0.008 < α (0.05) so that H_a is accepted, which means that there are differences in student learning outcomes learned with Project Based Learning and Discovery Learning models on acid-base material. For hypothesis II obtained sig value. (2-tailed) 0.010 < α (0.05) so that H_a is accepted, which means that there are differences in students' science process skills learned with the Project Based Learning and Discovery Learning models on acid-base material. For hypotheses III and IV obtained sig values. (2-tailed) of 0.002 and 0.001< α (0.05) so that H_a is accepted, which means that there is a correlation between students' science process skills and student learning outcomes learned with Project Based Learning and Discovery Learning models on acid-base material.

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Introduction

Students in high school find chemistry difficult. Where in general, chemistry has 2 parts: chemistry as a product and chemistry as a process. The two are interrelated and connected (Priliyanti et al., 2021). In chemistry, there are acid-base materials that tend to be difficult to understand, because the theory of acid-base matter is complex in terms of its characteristics. The characteristics of acid-base are seen from 3 aspects: macroscopic, microscopic, and symbolic. (Zuhroti et al., 2018). At this time, students only studied chemistry through rote memorization of concepts, principles, laws, and theories. As a result, they do not study

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chemistry as an attitude, process, or application (Putu &; Antara, 2014). The ability to master the basic concepts of chemistry is not the only thing taught in class, but the purpose of learning chemistry is to optimize science process skills, namely the skills to think and act based on science knowledge. Process science skills are important in cultivating a scientific attitude as well as problem-solving skills. This will certainly help students develop a more critical, open, innovative, and competitive attitude (Suwandari et al., 2018).

The ability to master chemical knowledge and scientific skills in chemical materials is the benchmark for mastery of chemical materials. Therefore, reading, writing and listening are not the only ways to learn chemistry, but rather practicum activities. Mercuryplays an important role in chemistry learning because it fosters mastery of students' science processes (Jahro et al., 2021).

Based on the results of my interviews and observations at SMA Negeri 5 Medan in October 2023, it was found that the students' learning outcomes and science process skills were relatively low, where there were still many students who failed to achieve KKM in the daily chemistry test, with the KKM for chemistry subjects being 78. Another contributing factor is that teachers still use conventional learning models and media, namely by explaining concepts written in books and writing them on the blackboard, so that students are more dominant in memorizing than understanding them. Another cause is the lack of optimal practicum implementation at SMA Negeri 5 Medan. In addition, students are less actively involved in the learning process, less actively communicate in inferring learning outcomes.

To solve these problems, it is necessary to overcome by applying learning models that are able to improve student learning outcomes and science process skills. There are two models that can improve students' learning outcomes and science process skills, namely the Project Based Learning (PjBL) model and Discovery Learning. The PjBL model includes four main components in the learning process: attitudes, processes, products and applications in everyday life. Thus, the PjBL model helps students learn to use their science process skills to solve problems and create products, which are able to optimize learning outcomes (Wijanarko et al., 2017).

Some studies that support that the PjBL model can improve students' learning outcomes and science process skills are previous research by Susilowati et al. (2013) states that learning and science processnskills can be improved through the PjBL model. Research Mila et al. (2019) states that project-basednlearning is effective in optimizing students' science process skills. In addition, Okoye & Osuafor's (2021) research found that science process skills are better with project-based learning.

In addition to the PjBL learning model, there is a Discovery Learning model that is able to improve students' learning outcomes and science process skills. The Discovery Learning model can maximize science process skills to discover and learn things in a systematic, critical, logical, and analytical way. Students have the ability to think critically, come up with new ideas, and work together on the scientific learning activities made possible by this model. Thus, they can make their own conclusions and practice science process skills that will have an impact on improving learning outcomes (Sari et al., 2019).

Some studies that support that the Discovery Learning model can improve learning outcomes and students' science process skills are that the results of researchnAgustina et al., (2018) in the buffernsolution material, research states that 91.18% of students (31 out of 34 students) achieve completeness with discoveryllearning model learning. In line with research by Kadri & Rahmawati, (2015) found that the discoveryllearning learning model can improvesX of Budi Satrya Medan Private High School about temperature and heat material. Research Kumalasari

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et al. (2015) found that the Discovery Learning learning model is able to optimize students' abilities in the science process.

Research Methods

The population in this study was all grade XI students of SMA Negeri 5 Medan Department of Mathematics and Natural Sciences consisting of 9 classes. The sample in this study was taken 2 classes randomly / random sampling by lottery, with each of the two classes totaling 29 students who were relatively homogeneous in status. This homogeneity is seen from the pretest results. This research included quasi-experimental research (quasy experiment). In this study using research design, namely pretest-posttest control group design.

Table 1. Research Design

Class	Pretest	Treatment	Posttest
Experiment I	T_1	X	T_2
Experiment II	T_1	Y	T_2

Information:
X : The treatment given in experimental class I is using the Project Based Learning model.
Y : The treatment given in experimental class II is using the Discovery Learning model.
T_1 : Posttest experimental class I and II
T_2 : Posttest experimental class I and II

Data in this study were obtained through multiple choice test instruments, essays and non-test instruments. In this study, data were obtained in the form of learning outcomes (posttest) and students' science process skills and observation sheets containing an assessment of the implementation of science process skills. Normality testing using Shapiro-Wil Test, homogeneity using Levene Statistic test, hypothesis tested using Independent Sample T-Test and Bivariate Pearson Correlation, with significance (=0.05).

Results and Discussion

The process carried out is to differentiate the pretest and posttest results. The following are the pretest and posttest results in tables 2 and 3.

Pretest Data

Table 2. Pretest Statistical Data Summary

Data	Statistics	Class	
		Experiment I	Experiment II
Pretest	Average	31,03	32,41
	Standard Deviation	8,17	7,86
	Smallest Value	15	15
	Top Rated	50	45

Posttest Data

Table 3. Posttest Statistical Data Summary

Data	Statistics	Class	
		Experiment I	Experiment II
Post-test	Average	83,28	78,45
	Standard Deviation	6,58	6,83

Smallest Value	70	65
Top Rated	95	95

Based on the summary of pretest and posttest statistical data, the average acquisition of pretest and posttestt scores for experimental classes I and II can be seen in Figure 3.1.

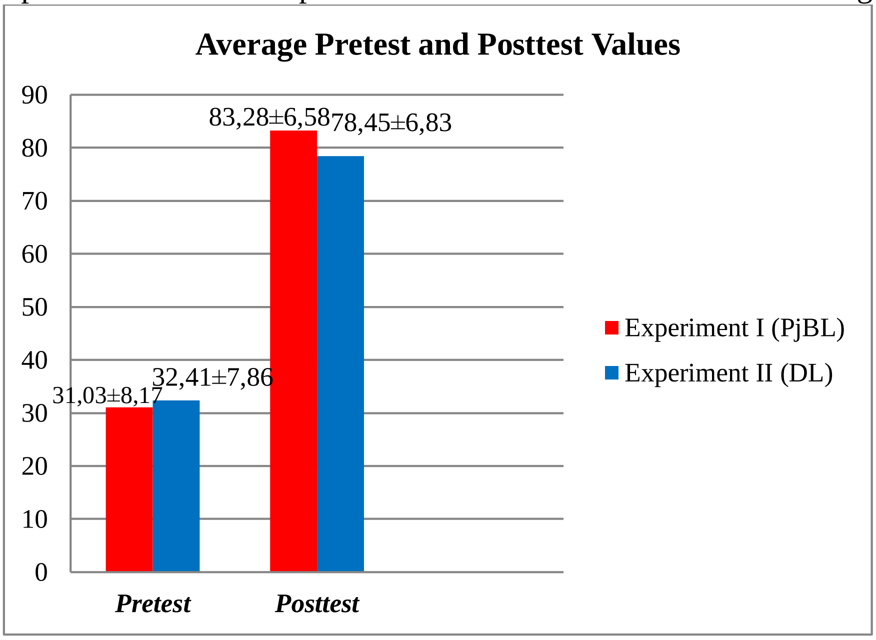

Figure 1. Diagram of the Average Pretest and Posttest Values

Based on the results of the calculations obtained, it can be seen that experimental class I which was taught with the Project Based Learning model obtained an average value of learning outcomes (posttest) of 83.28 while experimental class II which was taught with the Discovery Learning model obtained an average value of learning outcomes (posttest) of 78.45. Student learning outcomes (posttest) in experimental class I are higher than experimental class II.

Testing the normality of pretest-posttest data and science process skills using the Shapiro-Wilk Test. Testing the homogeneity of pretest-posttest data and science process skills using the Levene Statistics test. Hypotheses from posttest data and science process skills were tested using the Independent Sample T-Test and Bivariate Pearson Correlation, with significance (α =0.05).

Data Science Process Skills

Process Science Skills Test Analysis

Table 4. Summary of Science Process Skills Statistical Data

Data	Statistics	Class	
		Experiment I	Experiment II
Process Science Skills	Average	77,16	71,12
	Standard Devia-tion	7,58	9,63
	Smallest Value	65	50
	Top Rated	95	87,5

Based on the summary of statistical data on science process skills above, the average acquisition of KPS scores for experimental classes I and II can be seen in Figure 2.

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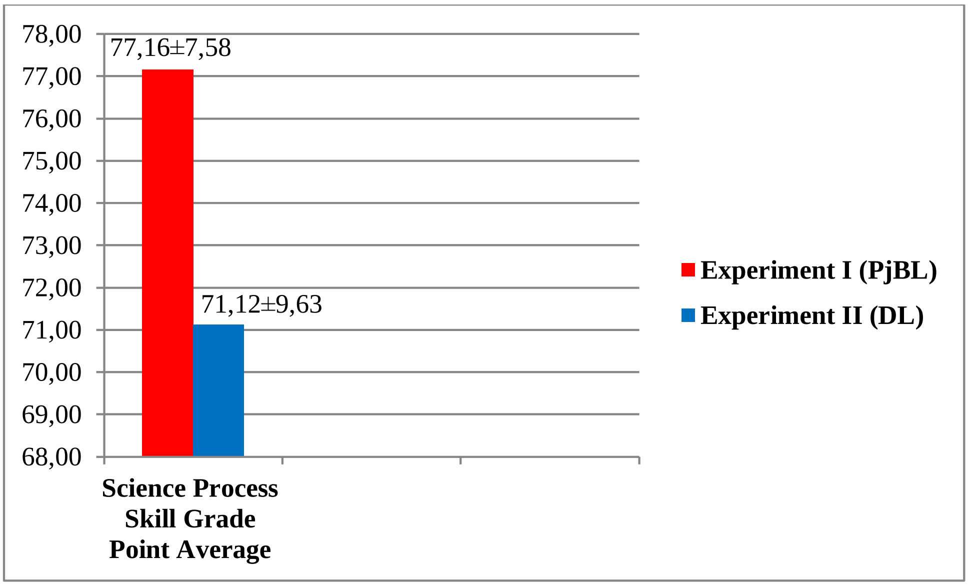

Figure 2. Science Process Skill Grade Point Average Diagram

Based on the results of the calculations obtained, it can be seen that experimental class I taught with the Project Based Learning model obtained an average score of science process skills (posttest) of 77.16 while experimental class II taught with the Discovery Learning model obtained an average value of science process skills (posttest) of 71.12. The science process skills of students in experimental class I are higher than the science process skills of students in experimental class II.

Analysis of Science Process Skills Observation Sheet

To get an overview of practicum implementation with the Project Based Learning model and the Discovery Learning model, an observation sheet was made involving 6 observers. The difference in the percentage of science process skills per aspect can be seen in Table 5.

Table 5. Percentage Differences in Science Process Skills

No	Aspects of KPS	Experimental Class I (%)	Experimental Class II (%)
1	Propose a hypothesis	92	82
2.	Group/Classifying	95	83
3.	Plan/Designing an experiment	89	79
4.	Using Tools &; Materials	95	83
5.	Communicate	90	80
6.	Applying the Concept	94	77
7.	Interpret/Summing Up the Experiment	86	84

Based on the table above, it can be illustrated the difference in the average acquisition of aspects of science process skills experimental class I and II as in Figure 3.

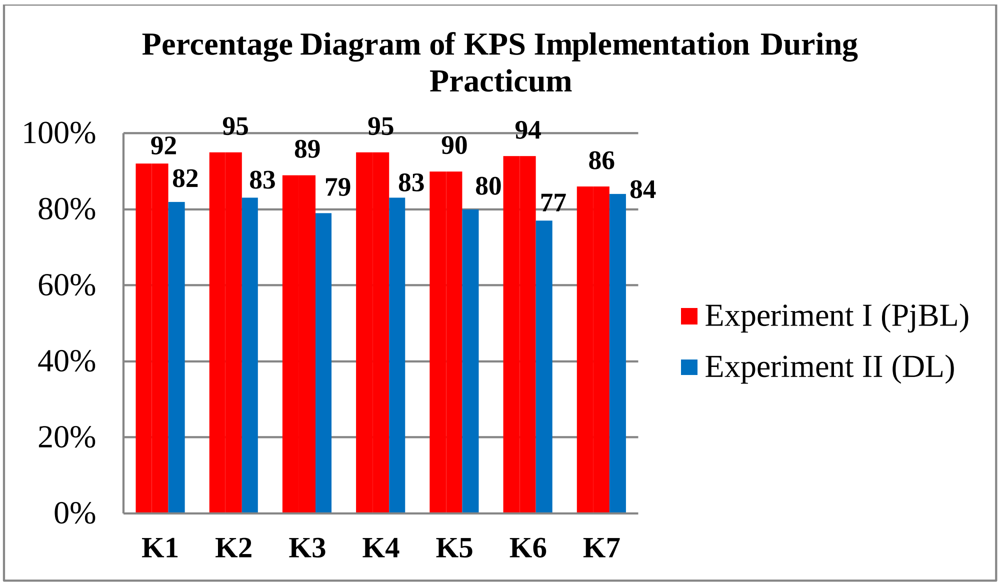

Figure 3. Percentage Diagram of KPS Implementation During Practicum

Based on the diagram above, it can be seen that the percentage of implementation of students' science process skills with the Project Based Learning model has a very good average score (SB) because every aspect of student KPS in experimental class I is in the range of 85≤KPS Percentage<100. While the implementation of students' science process skills with the Discovery Learning model has an average score of Good (B) because every aspect of student PPP in experimental class II is in the range of 70≤KPS Percentage<85.

Data Analysis of Research Results

Normality Test

The normality test results of experimental classes I and II are presented in Table 6.

Table 6. Normality Test Results

Data		Shapiro-Wilk Sig.			Information
		Class Experiment I	Experimental Class II		
Learning Outcomes	Pretest	0,191	0,107	0,05	Usual
	Posttest	0,063	0,090	0,05	Usual
Process Science Skills		0,082	0,139	0,05	Usual

Based on the table above, it shows that posttests in experimental classes I and II have sig values. 0.063 and 0.090 which means greater than the significant level (α=0.05) so that the posttest data is normally distributed. Similarly, the science process skills in experimental classes I and II have sig values. 0.082 and 0.139 which means greater than the significant level (α=0.05) so that the science process skill data is normally distributed.

Homogeneity Test

The homogeneity test results of experimental classes I and II are presented in Table 7.

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Table 7. Homogeneity Test Results

Data		Levene Statistic Sig.		Information
Learning Outcomes	**Pretest**	0,779	0,05	Homogeneous
	Posttest	0,852	0,05	Homogeneous
Process Science Skills		0,168	0,05	Homogeneous

Based on the table above, it shows that posttest and science process skills have sig values. 0.852 and 0.168 are greater than the significant level (α=0.05), so it can be concluded that the sample comes from a homogeneous population.

Test the hypothesis

Hypothesis I

Hypothesis I to see if there are differences in student learning outcomes (posttest) learned with Project Based Learning and Discovery Learning models. The results of hypothesis I tests in experimental classes I and II can be seen in Table 8.

Table 8. Results of Hypothesis Test I (Learning Outcomes)

Data	Class	Average	Standard Deviation	Sig. (2-tailed)		Information
Posttest	Experiment I	83,28	6,58	0,008	0,05	H_a accepted
	Experiment II	78,45	6,83			

For hypothesis I, a sig value is obtained. (2-tailed) of 0.008< α (0.05), it can be concluded that there are differences in student learning outcomes learned with Project Based Learning and Discovery Learning models on acid-base material.

Hypothesis II

Hypothesis II to see if there are differences in students' science process skills learned with the Project Based Learning and Discovery Learning models. The results of hypothesis II tests in experimental classes I and II can be seen in Table 9.

Table 9. Results of Hypothesis II Test (Science Process Skills)

Data	Class	Average	Standard Deviation	Sig. (2-tailed)		Information
Process Science Skills	Experiment I	77,16	7,58	0,010	0,05	H_a accepted
	Experiment II	71,12	9,63			

For hypothesis II, a sig value is obtained. (2-tailed) of 0.010 < α (0.05), it can be concluded that there are differences in students' science process skills learned with Project Based Learning and Discovery Learning models on acid-base material.

Hypothesis III

Hypothesis III to see if there is a correlation between students' science process skills and student learning outcomes learned with the Project Based Learning model. The results of hypothesis III tests in experimental classes I and II can be seen in Table 10.

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Table 10. Results of Hypothesis Test III

Data	Class	Pearson Correlation	Sig. (2-tailed)		Information
Process Science Skills & Posttest Learning Outcomes	Experiment I	0,402	0,002	0,05	Positive Correlation

For hypothesis III, the sig value is obtained. (2-tailed) of 0.002 < α(0.05) with a Pearson correlation of 0.402. This means that there is a correlation between students' science process skills and student learning outcomes learned with the Project Based Learning model on acid-base material. Where the correlation that occurs is a positive correlation.

Hypothesis IV

Hypothesis IV to see if there is a correlation between students' science process skills and student learning outcomes learned with the Discovery Learning model. The results of hypothesis IV tests in experimental classes I and II can be seen in Table 11.

Table 11. Results of Hypothesis Test IV

Data	Class	Pearson Correlation	Sig. (2-tailed)		Information
Process Science Skills & Posttest Learning Outcomes	Experiment II	0,408	0,001	0,05	Positive Correlation

For hypothesis IV, a sig value is obtained. (2-tailed) of 0.001 < α (0.05) with a Pearson correlation of 0.408. This means that there is a correlation between students' science process skills and student learning outcomes learned with the Discovery Learning model on acid-base material. Where the correlation that occurs is a positive correlation.

Discussions

This research was conducted in class XI MIPA SMA Negeri 5 Medan. A total of 2 classes, namely experiments I and II, which were samples of this study were given different treatment. Where in experimental class I was given Project Based Learning model treatment and experiment II was given Discovery Learning model treatment. This research begins with the provision of a pretest totaling 20 questions that have met the requirements ranging from validity, difficulty, discriminating power, distraction, and reliability.

Pretest is carried out to determine the initial ability of students and select the number of students who are sampled in the study. The number of students from each class taken amounted to 29 students based on the similarity of pretest results from the range of values 0-50. In the pretest, the average score in experimental class I was 31.03 and experimental II was 32.41. This shows that the average student in experimental classes I and II is able to answer as many as 6 questions correctly. These 6 questions can be answered by students even though they study because the questions are relatively easy and are material questions about basic theories that are rote and indicators of the questions explaining the understanding of acid-base according to the theory of Arrhenius and Bronsted-Lowry and the equation of acid-base reactions. These things allow students to be able to answer these 6 questions.

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The highest pretest scores in experimental classes I and II are 50 and 45. Where in experimental class I, there was 1 student who was able to answer 10 questions correctly, it was seen that there was a difference of 4 questions from the average student who was able to answer 6 questions correctly. Furthermore, in experimental class II, there were 4 students able to answer 9 questions correctly, it was seen that there was a difference of 3 questions from the average student who was able to answer 6 questions correctly. The 3-4 questions are still about material about basic theories that are rote and indicators of the problem explaining the understanding of acid-base according to Lewis theory and the equation of acid-base reactions according to Bronsted-Lowry.

Posttest is given after completion of treatment in experimental classes I and II. The purpose of the posttest is to determine the learning outcomes of students in experimental classes I and II after being given treatment. In the posttest, the average score in experimental class I was 83.28, meaning that the average student in experimental class I was able to answer 16 questions correctly. While in experimental class II, an average score of 78.45 was obtained, meaning that students were able to answer around 14-15 questions correctly. The questions that can be answered by students are questions that are calculating, connecting, analyzing.

Furthermore, the normality and homogeneity of posttest data were tested using Shapiro-Wilk and Levene Statistics with a level of significance α (0.05) = 0.05 dwhere the data is declared normal if the value of sig. > α (0.05) and the data is declared homogeneous if the value of sig. > α (0.05). Normal experimental class I and II posttest data were obtained, namely by obtaining sig values. 0.063 and 0.090 and homogeneous with the acquisition of sig values. 0.852. After obtaining posttest data on normal and homogeneous learning outcomes, it was continued with hypothesis testing using Independent Sample T-Test and Bivariate Pearson Correlation with a level of significance < α = 0.05 dwhere the alternative hypothesis (Ha) is accepted if the value of sig. (2-tailed) < α (0.05), obtained sig value. (2-tailed) experimental class I and II posttest of 0.008.

Based on the acquisition of sig value. (2-tailed) experimental class I and II posttest of 0.008   0.05, where Ha is accepted means that there are differences in student learning outcomes with Project Based Learning and Discovery Learning models on acid-base material. The average posttest score in experimental class I and II has a difference in the average difference between the two experimental classes of 4.83 with the average posttest score in experimental class I is greater / higher than in experimental class II.

The results of this research show that learning using the Project Based Learning model is better and more effective for learning outcomes compared to the Discovery Learning model. This is in line with research by Choi et al. (2019) who explain that project-based learning (PjBL) can show better mastery of concepts compared to discovery learning. Furthermore, Indriwati et al. (2016), stated in their research that Project Based Learning is effective for improving cognitive learning outcomes. Supported by Dewi's (2013) research, it shows that using the project based learning model is also more effective in improving learning outcomes.

Apart from learning outcomes, in this research the researchers also analyzed aspects of students' science process skills which were measured by giving KPS essay tests and KPS observation sheets during practicum. The science process skills essay test is given with 8 questions that meet the requirements starting from validity testing, level of difficulty, distinguishing power and reliability. In the KPS essay test, the average score obtained in experimental class I was 77.16, while in experimental class II it was 71.12.

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Next, a test for normality and homogeneity of the KPS test data was carried out using Shapiro-Wilk and Levene Statistics with a significance level = 0.05. Obtained normal KPS test data for experimental classes I and II, namely with a sig value. 0.082 and 0.139 and homogeneous with sig values obtained. 0.168. After obtaining the KPS test data with a normal and homogeneous distribution, it was continued with hypothesis testing using the Independent Sample T-Test and Bivariate Pearson Correlation with a significance level of $\alpha = 0.05$, obtaining a sig value. (2-tailed) KPS test for experimental classes I and II is 0.010.

Based on the obtained sig value. (2-tailed) KPS test for experimental classes I and II was $0.010 < 0.05$, where Ha was accepted, meaning there was a difference in students' science process skills with the Project Based Learning and Discovery Learning models on acid-base material. The average KPS test score obtained in experimental classes I and II has a difference in the average difference between the two experimental classes of 6.04 with the average KPS test score in experimental class I being greater/higher than in experimental class II. The results of this research show that learning using the Project Based Learning model is better and more effective for science process skills compared to the Discovery Learning model. This is in line with research by Piliang et al. (2015) shows that the Project Based Learning model has a better influence in stimulating and developing students' science process skills.

Students' science process skills can also be seen on the KPS observation sheet during the acid-base practicum. Of the seven aspects (indicators) of KPS that were measured, the aspect of proposing a hypothesis in experimental class I was 92%, while in experimental class II it was 82%. It can be seen that there is a difference of 10% in the aspect of proposing a hypothesis in experimental classes I and II, this occurs due to differences in the syntax of the two models. In line with research by Nelyaza et al (2015) that even though there is a relationship between the indicators for formulating a hypothesis and the steps in Discovery Learning, namely at the problem identification stage, students still do not understand how to formulate a hypothesis, where students have not yet gained knowledge about the reaction rate material being taught.

The aspect of planning experiments in experimental class I was 89%, while in experimental class II it was 79%. It can be seen that there is a significant difference of 10% in the aspect of planning experiments in experimental classes I and II. This is because learning with the Project Based Learning model begins with the presentation of important issues and students are asked to play an active role in conveying their thoughts and ideas about material related to this. At the project design stage, students actively discuss conducting experiments, then present the results of their project. This is in line with research by Fatimah (2018) which explains that Project Based Learning gives students greater opportunities to think and explore their abilities in completing assignments and finding the right concepts.

Likewise, the aspects of grouping (95%), using tools and materials (95%), communicating (90%), applying concepts (94%), and interpreting/concluding experiments (86%) in experimental class I have a percentage in each aspect of KPS which was higher than in experimental class II, namely the aspects of grouping (83%), using tools and materials (83%), communicating (80%), applying concepts (77%), and interpreting/concluding experiments (84%). This is in line with research by Fitriyani et al. (2018) who explained that learning with PjBL is closely related to students' science process skills, because by using the Project Based Learning learning model students can improve their thinking skills so that students' science process skills can develop.

Next, to find out the correlation between students' science process skills and student learning outcomes in the Project Based Learning model on acid-base material. Obtained sig value. (2-tailed) was 0.002 and the Pearson correlation was 0.402 in experiment I, meaning

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there was a correlation between students' science process skills and student learning outcomes taught using the Project Based Learning model on acid-base material. The results of this research are in line with previous research conducted by Fikriyah & Gani (2015) which stated that there was a significant relationship between science process skills and learning outcomes using a project-based learning model.

And finally, to find out the correlation between students' science process skills and student learning outcomes in the Discovery Learning model on acid-base material. Obtained sig value. (2-tailed) of 0.001 and a Pearson correlation of 0.408 in experiment II, meaning that there is a correlation between students' science process skills and student learning outcomes taught using the Discovery Learning model on acid-base material. The results of this study are in line with research by Khairuna et al. (2021) which states that students' science process skills and student learning outcomes have a positive relationship with the discovery learning model.

Conclusion

There are differences in student learning outcomes taught using the Project Based Learning and Discovery Learning models on acid-base material with the achievement of sig. (2-tailed) of 0.008 < α (0.05). The average posttest score in experimental class I was 83.28, while in experimental class II it was 78.45. There are differences in students' science process skills taught using the Project Based Learning and Discovery Learning models on acid-base material with the acquisition of sig scores. (2-tailed) of 0.010 < α (0.05). The average value of science process skills in experimental class I was 77.16, while in experimental class II it was 71.12. There is a correlation between students' science process skills and student learning outcomes taught using the Project Based Learning model on acid-base material. Where is the sig value obtained? (2-tailed) of 0.002 < α (0.05) and Pearson correlation of 0.402 with the category of positive correlation at a moderate level. There is a correlation between students' science process skills and student learning outcomes taught using the Discovery Learning model on acid-base material. Where is the sig value obtained? (2-tailed) of 0.001< α (0.05) and Pearson correlation of 0.408 with the category of positive correlation at a moderate level.

Recommendations

Based on the results of the research, discussion and conclusions above, the researcher suggests that teachers and prospective teachers who want to teach acid-base material can apply the Project Based Learning or Discovery Learning model because these two models support students to actively learn, in the process of forming science process skills. themselves, but teachers or prospective teachers must really be able to manage the class well so that the learning outcomes they want to achieve are maximized. For future researchers, to further improve skills and knowledge in training students' science process skills and to have thorough preparation both within themselves and the materials needed.

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