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Application of Project Based Learning Learning Model on Electrolyte and Non Electrolyte Solution Material to Improve the Learning Outcomes

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Abstract: Application of Project-Based Learning Models in Electrolyte and Non-Electrolyte Solution Materials to Improve the Learning Outcomes. This study aims to determine student learning outcomes with a project-based learning model on electrolyte and non-electrolyte solutions. The sample in this study was class X MIPA 2 students who were taken by random sampling technique. This study used a quasi-experimental method with a non-equivalent control group design. The experimental class uses the project-based learning and the control class uses the discovery learning model. The results of data analysis can be concluded that the project-based learning model can improve student learning outcomes, this can be seen from statistical data where the average value of student learning outcomes in the experimental class is 81.15 and the control class is 74.45. Based on the N-gain value, the project-based learning model is effectively used, it can be seen from the value of the experimental class 0.73 and the control class 0.6. Based on the results of the independent sample T-test, the results obtained were that there were significant differences in learning outcomes between the control class and the experimental class, obtained from the Sig. (2-tailed) 0.034<0.05.

Keywords: Project-Based Learning, Learning Outcomes, Electrolyte and Non-Electrolyte.

Abstract: Penerapan Model Pembelajaran Project Based Learning pada Materi Larutan Elektrolit dan Non Elektrolit untuk Meningkatkan Hasil Belajar. *Penelitian ini bertujuan untuk mengetahui hasil belajar siswa dengan model pembelajaran project based learning pada materi larutan elektrolit dan non elektrolit. Sampel dalam penelitian ini adalah siswa kelas X MIPA 2 yang diambil dengan teknik random sampling. Penelitian ini menggunakan metode quasi eksperimen dengan non equivalen control group design. Kelas eksperimen menggunakan model project based learning dan kelas kontrol menggunakan model discovery learning. Hasil analisis data dapat disimpulkan bahwa model pembelajaran Project Based Learning dapat meningkatkan hasil belajar siswa, ini dapat dilihat dari data statistik dimana nilai rata-rata hasil belajar siswa pada kelas eksperimen sebesar 81,15 dan kelas kontrol sebesr 74.45. Berdasarkan nilai N-gain, model pembelajaran project based learning efektif digunakan, dapat dilihat dari nilai kelas eksperimen 0,73 dan kelas kontrol 0,6. Berdasarkan hasil uji independent sampel T test di dapatkan hasil yaitu terdapat perbedaan hasil belajar yang signifikan* *antara kelas kontrol dan kels eksperimen, diperoleh dari nilai Sig. (2-tailed) 0.034<0.05*

Keywords: *Project Based Learning, Hasil Belajar, Larutan Elektrolit dan Non Elektrolit.*

- **INTRODUCTION**

Chemistry is a science that is considered more difficult by students than other sciences. This is in accordance the idea that (Lukman et al., 2015) stated, that chemistry I one of the few sciences that is included in subjects that are considered difficult. This may be due to the nature of the chemistry itself which seems abstract and looks complex. As a result, many students are less interested in studying chemistry. Judging from the abstract nature of chemistry. Therefore, the learning process is influenced by the model or style of the teacher teaching. According to (Meriliani, 2019), a teacher must be able to present chemistry material by applying methods and models that attract more students' attention to motivate and encourage students to be more serious about learning chemistry.

There are several learning models that are commonly used by teachers to increase students to be active. The government through the curriculum also always updates learning as is the case with this one curriculum, namely the 2013 curriculum. According to Permendikbud Number 103 of 2014, there are three learning models recommended in the 2013 curriculum (K-13), namely, discovery learning, project based learning, problem based learning. The three learning models are scientific (Permendikbud, 2014). The scientific approach can use several strategies such as contextual learning. According to (Aqih, 2013), contextual learning is a learning concept that helps teachers relate the material being taught to real-world situations.

The learning model applied by chemistry subject teachers is the discovery learning model. However, the discovery learning model is felt to be ineffective because there are still many students whose scores have not reached the Criteria of Minimum Archievement (CMA), where the CMA score at SMA Negeri 5 Konawe Selatan in chemistry is 70 while students' chemistry learning outcomes in the 2021/2022 school year electrolyte and non-electrolyte solution material has an average value of 68. With the percentage of students who achieve KKM (70) as much as 39.29% and 60.71% who do not reach KKM. This is caused by several factors including the lack of student activity and students' difficulties in understanding chemistry.

Based on discussions with chemistry teachers at SMA Negeri 5 Konawe Selatan, students found chemistry material that was considered difficult, namely electrolyte solution and non electrolyte. This is because electrolyte and non-electrolyte solutions are chemical materials that require a better conceptual understanding. In addition, the material for electrolyte and non-electrolyte solutions will be easy to understand if accompanied by practical implementation to prove the differences between electrolyte and non-electrolyte solutions through a light bulb test kit. While the practicum implementation at SMA Negeri 5 Konawe Selatan did not go well due to inadequate facilities. According to (Jannah et al., 2018), one od the materials considered problematic by teachers in class X even semester is electrolyte and non-electrolyte solutions. The material requires a high conceptual understanding and strong memorization as well as real and applicable learning experiences.

Based on these data, efforts are needed to overcome the above problems, namely innovative learning models that can be used to activate students. One of the learning models that can be used is the project-based learning model. Based on research conducted (Atika Rizki Khoirun Nisa, 2022), the use of project-based learning (PjBL) is very effective so that students can understand the chemistry material being taught. The project based learning learning model is effectively used, because the project-based learning (PjBL) learning model is one of the recommended learning models in the 2013 curriculum, the method applied in the 2013 curriculum is more student-centered. According to (Sitaresmi et al., 2017), the application of student-centered methods is very important for increasing student activity during learning w hich affects the level of student understanding, so that the more material students can understand, the greater the student's completeness in the material. In addition, according to (Anggriani et al., 2019), project-based learning is designed to be used on complex problems that students need to investigate and understand.

The project-based learning learning model has its implementation through several stages of learning or learning steps. According to (Muntari et al., 2018), the syntax of the PjBL model according to Lucas includes: (1) determining basic questions, (2) compiling project plans, (3) compiling schedules, (4) monitoring students and projects, (5) assessing results, (6) evaluation of experience. This can be seen from the results of several previous studies.

Previous research conducted by (Siburian et al., 2021) stated that the PjBL model on acid-base material can improve student learning outcomes. Research conducted by (Sasmono, 2018) states that project-based learning can improve student learning outcomes. The project-based learning learning model is very relevant to chemistry because chemistry does not only discuss substances theoretically, but also discusses them empirically and has contextual value.

Based on the background of the problems above, it is necessary to conduct research to find out whether the application of the project-based learning model can improve student learning outcomes in the material of electrolyte and non-electrolyte solutions.

• METHOD

This research was carried out at SMA Negeri 5 Konawe Selatan for students in class X MIPA, Even Semester 2022/2023 Academic Year. Sampling for research was carried out by random sampling so that class X MIPA 2 was obtained as the experimental class.

This study used a quasi-experimental method with a non-equivalent control group design. The following is the research design:

Table 1. Non-equivalent Control Group Design

Group	Pre-test	Free Variables	Post-test
Experiment	T_1	X	T_2
Control	T_1	-	T_2

Information:
T1 = Pre-test given
T2 = Post-test given
X = Application of project-based learning models on electrolyte and non-electrolyte solution materials

- = Electrolyte solution material is taught without using a project-based model learning
  (Moh Kaim in Azmiati, 2019).

The data collection technique used in this study is the learning achievement test. The tests conducted in this study were pre-test and post-test.

The data analysis technique used is descriptive and inferential analysis.

- **RESULTS AND DISCUSSION**

Learning outcomes

Processed student learning outcomes data are pre-test and post-test scores in the experimental class and control class. Data on student learning outcomes in the experimental class and control class can be seen in Table 2 below:

Table 2. Data on Student Learning Outcomes

Statistical Parameters	Pre-test		Post-test	
	Experiments	Control	Experiments	Control
Maximum Value	61	46	100	100
Min Value	15	10	60	53
Means	33.39	28.69	81.15	74.45
Range	46	46	40	47
Median	30.00	31.00	80.00	73.30
Mode	15	15	87	73
Sum	935	832	2272	2159

Table 2. shows that the average value in the experimental class is higher than in the control class. The average value of learning outcomes in electrolyte and non-electrolyte solution materials using the discovery learning model for the 2021/2022 school year is 68. The average value of the control class with electrolyte and non-electrolyte solution materials with the discovery learning model is 74.45 and the experimental class with the project-based learning model the average value of learning outcomes is 81.15. The increase in learning outcomes for the 2021/2022 academic year and the control class was 6, while with the experimental class the increase was 13. Meanwhile, the increase in learning outcomes for the control class and experimental class was 7. So it can be seen that there was an increase in learning outcomes.

One of the reasons for increasing learning outcomes in the experimental class is the use of learning models. According to (Johanna et al., 2023) the learning model greatly influences the activity and learning outcomes of students in participating in learning. The learning model of project-based learning and discovery learning has several advantages so that it can improve student learning outcomes. This increase in student learning outcomes shows that the project-based learning learning model can increase learning outcomes, this is possible because the project-based learning model places more emphasis on active student learning (Riana, 2019). The project-based learning model has several advantages from its characteristics, namely helping students make decisions and frameworks,

Student activity is also one of the effects of increasing learning outcomes. This is in accordance with research conducted by (Saputri et al., 2020), The application of project-based learning requires students to actively participate in making a project through practicum. With the active participation of students in the chemistry learning process, learning activities will be more productive and can improve the quality of the process and student achievement.

The percentage of completeness of student learning outcomes in the experimental class and control class can be seen in Table 3 below:

Table 3. Percentage of completeness of student learning outcomes

Mark	PjBL model	discovery learning Model
≥ 70 (Complete)	24 people (85.7%)	19 (65.5%)
< 70 (Unfinished)	4 people (14.3%)	10 (34.5%)

Table 4.3 shows that the N-gain value for the experimental class is in the high category with a gain value of 0.73. While the control class is in the medium category with a gain value of 0.65. When viewed from the category of interpretation of the effectiveness of N-gain based on percentages, the acquisition of an N-gain value for the experimental class of 85,7% is included in the category of quite effective interpretation. While the N-gain value for the control class is 65.0%, it is included in the fairly effective interpretation category. Research conducted by (Johanna et al., 2023), a learning model that is more effectively applied to improve chemistry learning outcomes is the PjBL model, one of the things that supports the project based learning model is quite effective in improving chemistry learning outcomes is the implementation of learning that has been implemented pretty good.

The Effectiveness of the Project-Based Learning Learning Model on Electrolyte and Non-Electrolyte Solution Material

N-Gain value acquisition data can be seen in Table 4. below:

Table 4. N-gain value

Kelas	Minimum	Maximum	(g)	Category	Percentages
Control	0,45	1.00	0,65	Currently	65,0%
Experimen	0.49	1.00	0,73	Tall	72,6%

Table 4 shows that the N-gain value for the experimental class is in the high category with a gain value of 0.73. While the control class is in the medium category with a gain value of 0.65. When viewed from the category of interpretation of the effectiveness of N-gain based on percentages, the acquisition of an N-gain value for the experimental class of 72.6% is included in the category of quite effective interpretation. While the N-gain value for the control class is 65.0%, it is included in the fairly effective interpretation category. Research conducted by (Johana,et al., 2023), a learning model that is more effectively applied to improve chemistry learning outcomes is the PjBL model, one of the things that supports the project-based learning model is quite effective in improving chemistry learning outcomes is the implementation of learning that has been implemented pretty good.

Table 5. Results of N-gain Analysis of Student Learning Outcomes

Category	Experiment Class	Control Class
	Total Student	Total Student
Tall	17	11
Currently	11	18
Low	-	-

Table 5. shows that the majority of students have increased scores in the medium and high categories. The data shows that student learning outcomes with the project-based learning model experience a better increase compared to the class with the discovery learning model.

Significant Differences in the Application of the Project-Based Learning Model with the Discovery Learning Model in Electrolyte and Non-Electrolyte Solution Materials

Before testing the hypothesis, it is necessary to test the analysis prerequisites first on the research data, such as normality and homogeneity tests.

Normality test

Display of normality test results with the Shapiro-Wilk test using SPSS version 23 can be seen in Table 6. Below:

Table 6. Control and Experiment Class Normality Test Data

Class	Shapiro-Wilk			
	Statistics	Df	Sig	Ket.
Pre-test Experiment	0.933	28	0.075	Normal
Post-test Experiment	0.955	28	0.266	Normal
Pre-test Control	0.954	28	0.235	Normal
Post-test Control	0.956	28	0.261	Normal

Based on Table 6. Above, the normality test using Shapiro-Wilk obtained a significant value for the experimental class pre-test 0.075> 0.05, a significant value for the control class pretest 0.235> 0.05, and a significant value for the post-test for the experimental class 0.235> 0.05, a significant value for the posttest class control 0.261> 0.05. Then the decision criteria for both the control class and the experimental class are normally distributed data. The conclusion from these data is that the pre-test and post-test data for the control class and the experimental class come from normally distributed data.

Homogeneity Test

The homogeneity test aims to find out whether the variance of the control class and the experiment is homogeneous or not. Homogeneity test was carried out with the help of SPSS 23 with a significance level of 0.05. Calculations can be seen in table 7. Below.

Table 7. Homogeneity Test of Experimental Class and Control Class

Test of Homogeneity of Variance

		Levene Statistics	df1	df2	Sig.
Results	Based on Means	.026	1	56	.873
	Based on Median	.015	1	56	.902
	Based on Median and with adjusted df	.015	1	55,984	.902
	Based on trimmed mean	.036	1	56	.850

From Table 7, it can be seen that the Sig. Based on Mean 0.873> 0.05, the decision criteria for both the control class and the experimental class are that H_0 is accepted, and H_a is rejected. So it can be concluded that the variance of the control class posttest data and the experimental class post-test are the same or homogeneous. Thus, one of the requirements (not absolute) of the independent sample t-test has been fulfilled.

Hypothesis testing

Independent Sample t-test is used to determine whether there is a significant difference between the application of project-based learning models and discovery learning models. After the prerequisite test is fulfilled, the data obtained is then analyzed using a hypothesis test (t test), at a significance level of 5% or 0.05 obtained as a sig value. (2-tailed) decisions are taken based on the provisions of hypothesis testing, namely if sig. (2-tailed) > 0.05 means H0 is accepted and if sig. (2-tailed) <0.05 means H0 is rejected. Independent t-test is shown in Table 8. As follows:

Table 8. Independent sample t-test

t test	***Sig.*(2-tailed)**
Experiment Class	0.034
Control Class	0.034

Based on Table 8. the value of Sig. (2-tailed) 0.034<0.05. means that H_a is accepted and H_0 is rejected. The values used for the t test are the post-test values for the control class and the post-test scores for the experimental class. The average value of the control class post-test was 70.78 and the post-test average value of the experimental class was 81.15. In conclusion, there is a significant difference in learning outcomes between the control class which uses the discovery learning model and the experimental class which uses the project-based learning model. The difference in increasing the learning outcomes of the experimental class using the project-based learning model is greater than that of the control class using the discovery learning model.

Significant differences between the control class using the discovery learning model and the experimental class using the project=based learning model occur because the project-based learning model has several advantages in learning activities. According to (Marta et al., 2017), the steps of the project-based learning model can train students' skills. In addition, students who are more actively involved also open opportunities for students to improvise and be more creative starting from finding fundamental problems, designing projects, compiling schedules, monitoring, testing results, to evaluating so that students are more motivate (Muliaman, 2021)

Significant differences in student learning outcomes before and after using the project based learning learning model are also due to the project-based learning model prioritizing challenging questions and complex assignments so that it spurs students in designing, solving problems, work organization, and culminating in real product(Rifai et al., 2020). In addition, the project-based learning model is a learning model in which the learning process is dominated by students (student centered). This is in accordance with what was stated by (Sitaresmi et al., 2017), project-based learning can help students in group study, develop skills and projects that are carried out are able to provide personal experiences to students and can emphasize student-centered learning activities.

The increase in student learning outcomes in the material for electrolyte and non-electrolyte solutions with the project based learning model is because the PjBL model has advantages. According to (Fatnah et al., 2021), the project-based larning (PjBL) learning model that makes students more active, creative and innovative, this is because students are required to design a project by themselves by forming small groups, then produce a product which is finally presented in front of other students and a question and answer session is carried out by discussing issues related to the product presented.

- **CONCLUSION**

Based on the research that has been done, it can be concluded that the project-based learning model can improve student learning outcomes, this can be seen from statistical data where the average value of student learning outcomes in the experimental class is 81.15 and the control class is 74.45. Based on the N-gain value, the project-based learning model is effectively used, the from the value of the experimental class 0.73 and the control class 0.6. Based on the results of the independent sample T-test, the results obtained were that there were significant differences in learning outcomes between the control class and the experimental class, obtained from the Sig. (2-tailed) 0.034<0.05.

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