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The Effect of the Project-Based Learning (PjBL) Learning Model on Cooperative Ability and Physics Learning Outcomes of Students at Madrasah Aliyah Negeri 1 Jambi City

Dhea Febriya, Universitas Negeri Padang, Indonesia*
Ahmad Fauzi, Universitas Negeri Padang, Indonesia
Desnita, Universitas Negeri Padang, Indonesia

Abstract

This research aims to determine the effect of the Project-Based Learning learning model on students' cooperative abilities and physics learning outcomes in the Parabolic Motion with Vector Analysis material at Madrasah Aliyah Negeri 1 Jambi City. This research is a Quasi-Experimental research and One Group Pretest-Posttest research design, so that the results of the treatment can be known more accurately because they can compare the situation before being given treatment and after being given treatment. Data collection was carried out using questionnaires and tests. The subjects in this research were all students of class XI 1 Madrasah Aliyah Negeri 1 Jambi City. The sampling technique uses Simple Random Sampling. Data processing and analysis techniques were carried out quantitatively using the paired t-test. The results of this research show that the Project-Based Learning (PjBL) learning model has an effect on students' cooperative abilities and physics learning outcomes with t- test results for both variables of 0,000 and N-Gain test results of 0,49 and 0,64.

Keywords: Project-Based Learning Model, Cooperative Ability, Physics Learning Outcomes

**** Corresponding Author:***
Dhea Febriya,
Physics Education Postgraduate Study Program
Padang State University
Jl. Prof. Dr. Hamka, Padang, West Sumatra, Indonesia
Email: dheafebri156@gmail.com

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INTRODUCTION

Education is one of the government programs that is carried out on an ongoing basis to develop all of society's potential in order to prepare higher quality Indonesian human resources now and in the future (Mafudiansyah et al., 2020). Physics is one of the selected subjects for Senior High Schools/Madrasah Aliyah (SMA/MA) in the current independent curriculum (Lestari et al., 2023). The structure of the independent curriculum consists of intracurricular activities (in the curriculum) and the Pancasila Student Profile Improvement project (P5). The allocation of learning hours in the curriculum structure is written in total for one year and offers suggestions for the allocation of learning hours if carried out regularly.The determination of subjects consists of general subjects (PAI, Pancasila Education, Indonesian, English, PJOK, Informatics, History, Mathematics, and SBK). Natural Sciences (Physics, Chemistry, Biology) and Social Sciences (Sociology, Economics, Geography, Anthropology). Students get all these subjects in class X as compulsory subjects and then can choose 5 subjects in class XI (Yasmansyah & Sesmiarni, 2022).

Physics is a part of natural science that describes systematic efforts to build and organize knowledge in the form of explanations that can be verified and are able to predict natural phenomena (Melinda et al., 2021). Parabolic motion using vector analysis is one of the materials in phase F of the independent curriculum. Physics learning in this phase aims to enable students to be able to apply the concept of parabolic motion in everyday life and technology as well as to build students' cooperative abilities which are promoted in one of the Pancasila learning profiles, namely mutual cooperation (Kememdikbud, 2022).

Cooperative ability (cooperation) is the ability to communicate, be responsible, help each other and complete an activity together for the common good (Alifah & Mundilarto, 2017). The ability to collaborate is very important to stimulate in education. Students are able to compromise with friends, communicate with each other, exchange ideas to solve problems and are able to respect other people's opinions. Activities carried out in groups giverise to natural cooperation between individual students, this attitude needs to be taught to answer the challenges of today's educational civilization.

Physics material is a subject that is often said to be difficult by students. This is reinforced by the perception of high school students in West Nias Regency in a study conducted by Hia and Sulandari (2016) who stated that physics subjects were difficult subjects,they did not like them and were not even useful for continuing their studies in the future. Moreover, the material is about parabolic motion with vector analysis, which is a combinationof two types of motion, namely uniform rectilinear motion and uniformly changing rectilinear motion. Students still find it difficult to understand why the velocity on the y- axis at the top of a projectile (parabola) is zero, even though the acceleration is not zero. Students think that if the speed is zero then the acceleration must also be zero (Yuwono et al., 2014). In fact, parabolic motion material using vector analysis is physics material that is often used in real life. However, students often misinterpret the concept of the material. So, one of the causes of low physics learning outcomes is a wrong understanding of a concept (Azmi et al., 2012).

Therefore, it is important for this research to be carried out because of the several existing cooperative learning models, Project-Based Learning (PjBL) is one type of cooperative learning that is able to build students' cooperation skills by involving project work that produces real work that can be shown in the form of reports, making products, and completing written assignments given by the teacher (Santyasa et al., 2020).

The application of the Project-Based Learning (PjBL) type cooperative model produces a main idea, namely that students help each other so that togetherness and cohesiveness appear to achieve common goals and train students' emotional nature which is still strong, such as many students who do not want to help their friends and there are Some students are embarrassed if they are seen as weak when asking friends for help (Pratiwi et al.,2018) . This type of Project-Based Learning (PjBL) provides opportunities for collaboration between students to produce cooperative abilities and improve each individual's learning outcomes.

Research on the Project-Based Learning (PjBL) model has been carried out by (Yance et al., 2013) that the physics learning outcomes of experimental classes that use Project Based Learning (PjBL) are higher than the physics learning outcomes of control classes that do not use PjBL. Another research conducted by (Datu et al., 2020) found that there was an increase in students' physics learning outcomes after using the Project-Based Learning (PjBL) learning model on Elasticity and Simple Harmonic Motion material. Further research conducted by (Wahyudi, 2021) stated that the application of the Project-Based Learning (PjBL) model could increase student learning outcomes in static electricity and dynamic electricity compared to other learning models. Research conducted by (B & Arruan, 2023) shows that the Project-Based Learning (PjBL) model in the independent curriculum can improve high school physics learning outcomes. However, research that specifically focuses on students' cooperative abilities and physics learning outcomes is still very limited.

METHODS

Research design

The research carried out is a type of experimental research which leads to quantitative research. Experimental research is a research method used to find the effect of certain treatments on others under controlled conditions (Sugiyono, 2020) . The research design used was Quasi Experimental Design with a One-Group Pretest-Posttest Design . By using this type of research, the results of the treatment can be known more accurately, because it compares the results of the first study before being treated with the results of the assessment after receiving the treatment (Fatimah, 2017) . By comparing the results of the pretest and posttest , the influence of students' cooperative abilities and students' physics learning outcomes can be measured.

Population and Sample

The population in this study was class XI 1 and XI 2, totaling 62 people. This research uses the Simple Random Sampling technique because sample members from the population are taken randomly in the class without looking at grades, student gender, and student groups in the population (Hardani et al., 2020) As a result, the researcher chose class XI 1 as asample, totaling 31 students.

Instruments and Data Collection

There are two instruments used in this research, namely non-test instruments and test instruments. Non-test instruments are used to test students' cooperative abilities and test instruments in the form of pretest-posttest are used to test student learning outcomes. The cooperative ability instrument in this research is in the form of a questionnaire. The

questionnaire statements given consisted of 12 statements using a Likert scale. The questionnaire used in this research is to determine student cooperation which is covered in four indicators, namely supporting each other, complying with group rules, roles (tasks), and team support for physics learning while using the Project Based Learning (PjBL) model . Meanwhile, the learning outcomes instrument in this research is a formative test in the form of multiple choices. The test is used as an evaluation tool to collect data in the form of pretest and posttest . The pretest questions will be made in 5 items and the posttest questions will be made in 25 multiple choice questions. The cognitive domain learning outcome test instrument indicators are based on the aspects assessed, namely C1, C2, C3, C4, and C5.

Data Analysis

Data analysis in this research uses descriptive and inferential analysis techniques. Experimental research design by providing pretest and posttest in the form of questionnaires and formative questions to 1 class. The data analysis technique used is descriptive statistical analysis using percentage techniques. Further data analysis uses inferential statistical analysis with SPSS 21 (Statistical Product and Service Solution 21). This analysis uses the paired t-test. and the N-Gain test , which provides an assessment of whether there is an influence of the Project Based Learning (PjBL) model on students' cooperative abilities and physics learning outcomes.

FINDINGS AND DISCUSSION

Findings

Cooperative ability is measured by a non-test instrument in the form of a self-assessment questionnaire with details of 6 positive statements and 6 statement items. The same 12 statement items were tested on the pretest and posttest . Meanwhile, physics learning outcomes are measured by a test instrument with 5 pretest questions and 25 posttest questions .

Descriptive Analysis

Descriptive analysis functions to present subject characteristics obtained from research results. Based on the results of the physics learning process at MAN1 Jambi City before using the Project Based Learning (PjBL) model, the pretest test results and descriptive statistics can be seen in table 1.

Table 1. Student Cooperative Ability Scores Before the Experiment

Category	Criteria	Frequency
Tall	X ≥ 45	0
Currently	27 – 45	17
Low	X ≤ 27	14
Average Score		26,90

The average score of students' cooperative abilities before using the Project-Based Learning (PjBL) cooperative learning model was 26.90. Based on the results of the cooperative ability questionnaire before the experiment, the highest score was X ≥ 45 and the lowest score was Scores in the medium category with a range of 27 – 45 were obtained by 17

students and scores in the low category, namely scores below 27, were obtained by 14 students. The descriptive statistics of the pretest test data are explained in table 2.

Table 2. Descriptive Statistics of Cooperative Ability Pretest Using SPSS 21

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cooperative Ability PreTest	31	17	34	26,87	4,478
Valid N (listwise)	31				

Based on processing cooperative ability pretest data with the SPSS 21 application , from a total sample of 31 students the highest score was 34 and the lowest score was 17 with a mean score of 26.57. Meanwhile, the score obtained most often by students (mode) was 24.83. The average value (mean) is 26.87 and the standard deviation value is 4.478. This calculation was carried out to see how cooperative the students' abilities were before using the Project-Based Learning (PjBL) learning model. This can be seen through the average, middle value, frequently occurring values, and standard deviation. The pretest score variationindex was obtained at 8.66%, which means that students' cooperative abilities are still relatively low. The pretest questionnaire scores based on the four indicators of cooperative ability obtained by students are summarized in Figure 1.

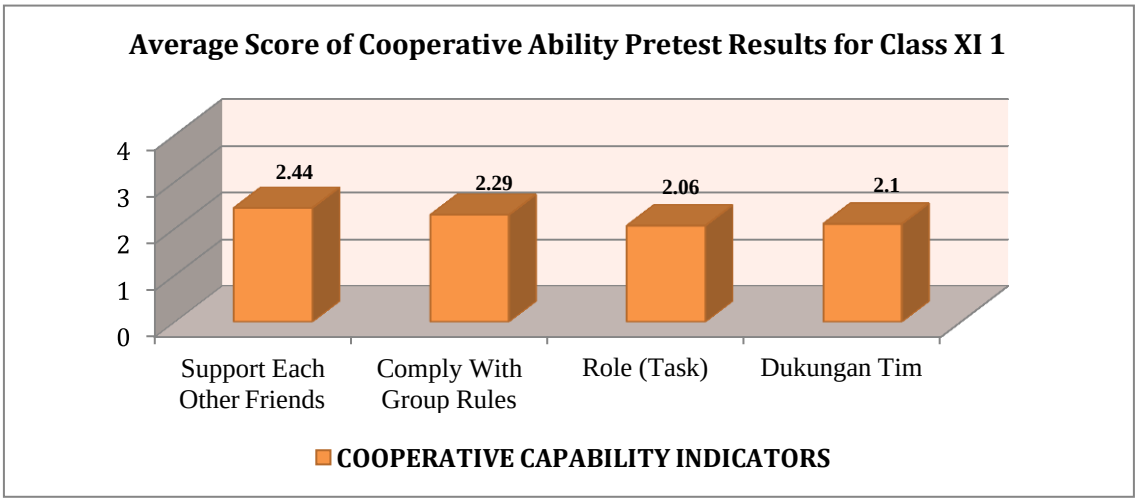

Figure 1. Graph of students' Cooperative Ability Questionnaire Pretest Scores before using the learning model Project-Based Learning (PjBL)

Figure 1 depicts students' cooperative ability scores before learning using the project-based learning model. Based on four indicators of cooperative ability which are summarized in 12 questionnaire statements on a Likert scale with five criteria, namely, a score of 5 means very often, a score of 4 means often, a score of 3 means sometimes, a score of 2 means never, and a score of 1 means never. Before the research was carried out, 31 students obtained the following total scores. The indicator score for mutual support among friends is 2.44. The score for complying with group regulations is 2.29. The role (task) indicator score is 2.06. Theteam support indicator score is 2.10. Based on the average pretest score, from the four indicators of cooperative ability, students obtained a score for each indicator of 2 (rounded),

which means that the indicators support each other among friends, obey group rules, roles (tasks), and team support in the category "ever" done.

Table 3. Student Cooperative Ability Scores After the Experiment

Category	Criteria	Frequency
Tall	X ≥ 45	9
Currently	27 - 45	22
Low	X ≤ 27	0
Average Score		43.45

The average score of students' cooperative abilities after using the Project-Based Learning (PjBL) cooperative learning model was 43.45. Based on the results of the cooperative ability questionnaire after the experiment, the highest score was X ≥ 45 and the lowest score was Scores in the medium category ranging from 27 – 45 were obtained by 22 students and scores in the high category, namely scores above 45, were obtained by 9 students. This proves that the project-based learning model has an influence on students' cooperative abilities. Before the experiment was carried out, none of the students got a score in the high category and after the experiment, none of the students got a score in the low category. The results of the posttest questionnaire given to students showed that students' cooperative abilities had increased after using the project-based learning model in physics learning. The descriptive statistics of the posttest test data are explained in table 4.

Table 4. Descriptive Statistics of Posttest Cooperative Ability with SPSS 21

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PostTest Cooperative Ability	31	36	50	43.55	3,182
Valid N (listwise)	31				

Bassed posttest data processing on cooperative abilities with the SPSS 21 application , from a total sample of 31 students the highest score was 50 and the lowest score was 36 with a median score of 44. Meanwhile, the score obtained most often by students (mode) was 44.55. The average value (mean) is 43.55 and the standard deviation value is 3.182. This calculation was carried out to see how cooperative the students' abilities were before using the Project-Based Learning (PjBL) learning model. This can be seen through the average, middle value, frequently occurring values, and standard deviation. The posttest score variation index was obtained at 14.04%, which means that students experienced an increase in cooperative abilities of 5.38% after studying physics using the Project-Based Learning (PjBL) learning model . The posttest questionnaire scores based on the four indicators of cooperative abilities obtained by students are summarized in Figure 2.

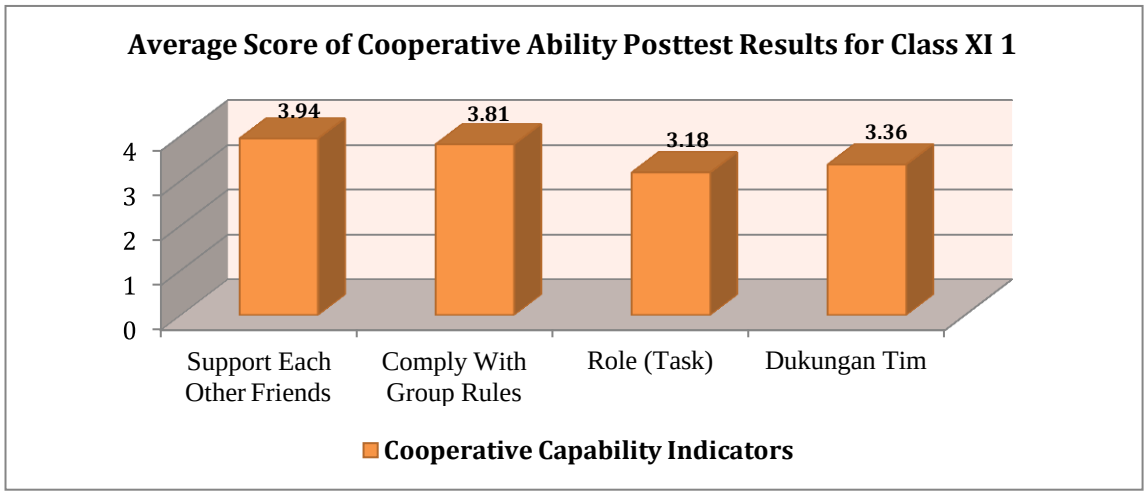

Figure 2. Posttest Score Graph of Students' Cooperative Ability Questionnaire before using the Project-Based Learning (PjBL) learning model

Figure 2 depicts students' cooperative ability scores after learning using the project-based learning model. Based on four indicators of cooperative ability summarized in 12 questionnaire statements on a Likert scale with five criteria, namely, a score of 5 means very often, a score of 4 means often, a score of 3 means sometimes, a score of 2 means never, and a score of 1 means never. After conducting research, 31 students obtained the following total scores. The indicator score for mutual support among friends is 3.94. The score for complying with group regulations is 3.81. The role (task) indicator score is 3.18. The team support indicator score is 3.36. Based on the posttest average score , from the four indicators of cooperative ability, students obtained a score for each indicator respectively of 4, 4, 3, 3 (rounded), which means that the indicator supports each other with fellow friends and obeys group rules in the category "often " done. Meanwhile, the role (task) and team support indicators in the "sometimes" category are carried out.

Table 5. Student Physics Learning Result Scores Before the Experiment

Category	Criteria	Frequency
Tall	X ≥ 62.45	5
Currently	37.55 -62.45	9
Low	X ≤ 37.55	17
Average Score		46,26

The average score for students' physics learning outcomes before using the Project-Based Learning (PjBL) cooperative learning model was 46.26. Based on the physics learning results test questions before the experiment was carried out, the highest score was X ≥ 62.45 and the lowest score was X ≤ 37.55. In administering the pretest on the learning outcomes test, 5 students got high criteria, 9 students got medium scores, and 17 students got low scores. In table 5, it can be seen that the score obtained most by students was the score with low criteria with a total of 17 students, while the score obtained the least by students was the score with high criteria with a total of 5 students. This shows that students' physics learning outcomes in parabolic motion using vector analysis are still relatively low. The descriptive statistics of the pretest test data are explained in table 6.

Table 6. Descriptive Pretest Statistics on Physics Learning Results with SPSS 21

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PreTest Physics Learning Results	31	0	80	47,74	21,089
Valid N (listwise)	31				

pre-test data processing on physics learning results with the SPSS 21 application , from a total sample of 31 students the highest score was 80 and the lowest score was 0 with a mean value of 39.59. Meanwhile, the score obtained most often by students (mode) was 32.44. The average value (mean) is 47.74 and the standard deviation value is 21.089. This calculation was carried out to see how much students' physics learning outcomes were before using the Project-Based Learning (PjBL) learning model. This can be seen through the average, middle value, frequently occurring values, and standard deviation. The pretest score variation index was obtained at 15.40%, which means that students' physics learning outcomes are still relatively low. The pretest scores based on the six indicators of physics learning outcomes obtained by students are summarized in Figure 3.

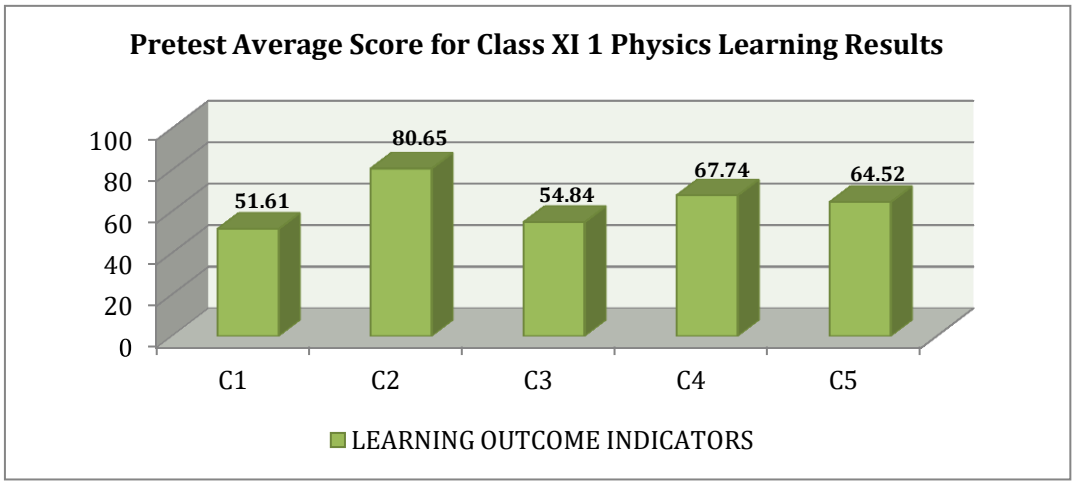

Figure 3. Pretest Score Graph of Students' Physics Learning Results before using the Project-Based Learning (PjBL) model

Figure 3 depicts the score of students' physics learning outcomes before learning using the project-based learning model. Based on the five indicators of physics learning outcomes, which are summarized in 5 questions, from 31 students the average score for indicator C1 was 51.61, indicator C2 was 80.65, indicator C3 was 54.84, indicator C4 was 67.74, and the C5 indicator is 64.52.

Table 7. Student Physics Learning Outcome Scores After the Experiment

Category	Criteria	Frequency
Tall	X ≥ 62.45	28
Currently	37.55 -62.45	2
Low	X ≤ 37.55	1
Average Score		80.96

Average score Student physics learning outcomes after using the Project-Based Learning (PjBL) cooperative learning model were 80.96. Based on the test questions on physics learning results after the experiment, the highest score was X ≥ 62.45 and the lowest score was X ≤ 37.55. In administering the posttest on the learning outcomes test questions, 28students got high criteria, 2 students got medium criteria, and 1 student got low scores. In table 7, it can be seen that the score obtained most by students is the score with high criteria with a total of 28 students, while the score obtained the least by students is the score with low criteria with the number of 1 student. This shows that students' physics learning outcomes in parabolic motion material with vector analysis have increased after using the project-based learning model . The descriptive statistics of the posttest test data are explained in table 8.

Table 8. Descriptive Posttest Statistics on Physics Learning Results with SPSS 21

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PostTest Physics Learning Results	31	28	92	81,81	13,260
Valid N (listwise)	31				

Based on posttest data processing on physics learning results with the SPSS 21 application, from a total sample of 31 students the highest score was 96 and the lowest score was 32 with a mean score of 88.64. Meanwhile, the score obtained most often by students (mode) was 89.9. The average value (mean) is 84.71 and the standard deviation value is 13.936. This calculation was carried out to see how much students' physics learning outcomes were after using the Project-Based Learning (PjBL) learning model. This can be seen through the average, middle value, frequently occurring values, and standard deviation. The posttest score variation index was obtained at 27.32%, which means that students' physics learning outcomes have increased. Posttest scores based on six indicators of physics learning outcomes obtained by students are summarized in Figure 4.

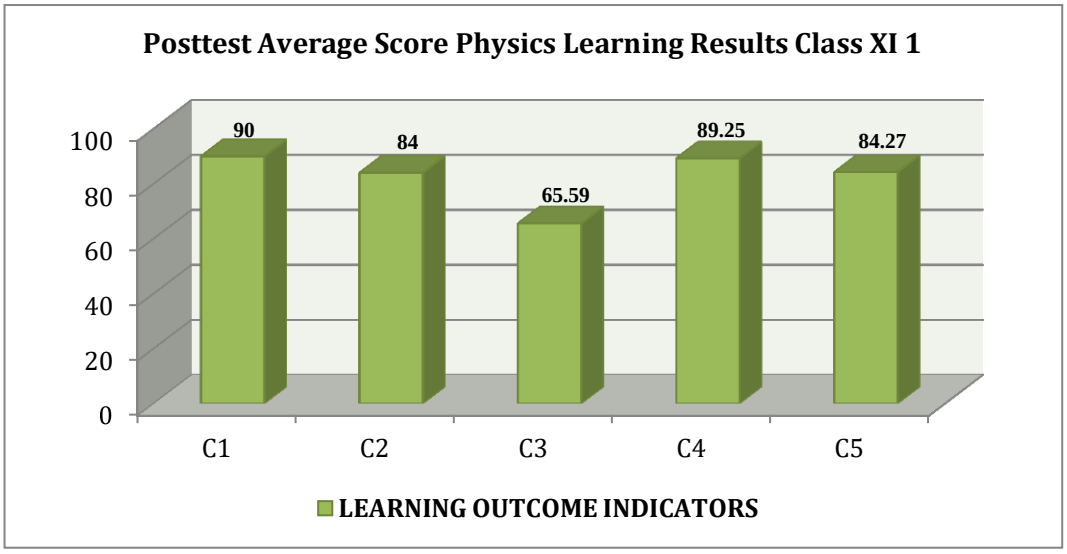

Figure 4. Posttest Score Graph of Students' Physics Learning Results after using the Project-Based Learning (PjBL) model

Figure 4 depicts the scores of students' physics learning outcomes after learning using the project-based learning model. Based on the five indicators of physics learning outcomes, which are summarized in 25 questions, the 31 students obtained an average score for indicator C1 was 90, indicator C2 was 84, indicator C3 was 65.59, indicator C4 was 89.25, and indicator C5 was 84.27.

Inferential Analysis

Inferential analysis functions to test the hypothesis formulated through the paired t-test and N-Gain test. To determine hypothesis testing, this study uses a significance level of sig > 0.05 to accept the hypothesis and < 0.05 to reject the hypothesis. The prerequisite test uses a paired t-test , the data analyzed must be normally distributed and homogeneous (Sugiyono, 2016). The results of the analysis are presented as follows.

Normality test

One of the requirements for quantitative analysis is using parametric statistics, namely the assumption that the sample data that has been analyzed is normal. The normality test used in this research is the Kolmogorov-Smornov test because the number of samples tested is 31, which means N < 50. To see whether the data is normally distributed, this test will compare the significance value to 0.05. Decision criteria in the normality test in SPSS 21 are as follows.

a. If the significance value is ≥ 0.05 then the data is normally distributed
b. If the significance value is ≤ 0.05 then the data is not normally distributed

Normality test results with the help of the SPSS 21 application in the experimental class, data on cooperative ability scores and physics learning outcomes are presented in table 9.

Table 9. Kolmogorov-Smornov Normality Test Results with the SPSS 21 application

One-Sample Kolmogorov-Smirnov Test

		Pre test Cooperative ability	Post test of cooperative abilities	Pre Test Physics Learning Results	Post Test Physics Learning Results
N		31	31	31	31
Normal Parameters [a, b]	Mean	26.87	43.55	47.74	81.81
	Std. Deviation	4,478	3,182	21,089	13,260
Most Extreme Differences	Absolute	,100	,174	,192	,243
	Positive	,081	.124	,192	,221
	Negative	-.100	-.174	-.171	-.243
Kolmogorov-Smirnov Z		,556	,966	1,067	1,354
Asymp. Sig. (2-tailed)		,917	,308	,205	,051

a. Test distribution is Normal.

b. Calculated from data.

Table 10. Kolmogorov-Smornov Normality Test Results

Score	N	Sig.	Interpretation
Cooperative ability pretest	31	0.917	Normally Distributed Data
Cooperative ability posttest	31	0.308	Normally Distributed Data
Pretest physics learning outcomes	31	0.205	Normally Distributed Data
Posttest physics learning results	31	0.051	Normally Distributed Data

From the SPSS 21 application calculations using the Kolmogorov-Smornov normality test and normality test calculations, it proves that the cooperative ability pretest score is 0.917 ≥ 0.05 , the cooperative ability posttest is 0.308 ≥ 0.05, the physics learning result pretest score is 0.205 ≥ 0.05 , and the posttest score for physics learning outcomes is 0.051 ≥ 0.05. It can be concluded in table 10 that the data on students' cooperative abilities and student physics learning outcomes obtained by researchers has a significance value greater than 0.05, which means that the sample data is normally distributed and the conditions for continuing parametric statistical analysis are met.

Homogeneity Test

To see whether the experimental class posttest data has the same variance (homogeneous) or not, a homogeneity test is carried out. The test for homogeneity of two variances on the results of the pretest and posttest data used was the Levene test with the SPSS 21 application . Decision criteria in the homogeneity test in SPSS 21 (Arifin, 2017) is as follows.

a. If the significance value is ≤ 0.05 then the data is homogeneous
b. If the significance value is ≥ 0.05 then the data is not homogeneous

The results of the homogeneity test with the help of the SPSS 21 application in the experimental class, cooperative ability score data and physics learning results are presented in table 11.

Table 11. Levene Homogeneity Test Results with the help of the SPSS 21 application

Test of Homogeneity of Variance

		Levene Statistics	df1	df2	Sig.
cooperative abilities	Based on Mean	4,733	1	60	,034
	Based on Median	4,887	1	60	.031
	Based on Median and with adjusted df	4,887	1	59,002	.031
	Based on trimmed mean	4,665	1	60	,035
Physics learning outcomes	Based on Mean	10,804	1	60	,002
	Based on Median	7,386	1	60	,009
	Based on Median and with adjusted df	7,386	1	55.107	,009
	Based on trimmed mean	11,883	1	60	,001

Table 12. Levene's Homogeneity Test Results

Variable	N	Sig.	Interpretation
Cooperative Ability	31	0.034	Data is Homogeneous
Physics Learning Outcomes	31	0.002	Data is Homogeneous

Based on SPSS 21 application calculations using the Levene homogeneity test and homogeneity test calculations, the pretest and posttest scores for cooperative ability are 0.034 < 0.05, followed by pretest and posttest scores for physics learning outcomes of 0.002 < 0.05. This can be concluded in table 12 that the data on students' cooperative abilities and the data on physics learning outcomes obtained by researchers have a significance value of less than 0.05, which means that the sample data is homogeneous and has quite different variance between the two data, namely pretest and posttest data.

Hypothesis testing

After carrying out the normality test and homogeneity test, we got the results that the data was normally distributed and the data was homogeneous. The next step is a parametric statistical test using the paired t-test and n-gain test. For data on students' cooperative abilities and data on normal students' physics learning outcomes , the paired t-test hypothesis test will be used because the data tested is normally distributed . Decision criteria in the homogeneity test in SPSS 21 (Arifin, 2017) are as follows.

a. If the significance value is ≥ 0.05 then Ha is rejected and Ha is accepted
b. If the significance value is ≤ 0.05 then Ha is accepted and Ho is rejected

Paired t-test

Table 13. Test paired t-test with SPSS 21 application

Paired Samples Test

		Paired Differences					Q	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre test Cooperative ability - Post test cooperative ability	-16,677	4,736	,851	-18,414	-14,940	-19,608	30	,000
Pair 2	pretest physics learning results - PostTest Physics Learning Results	-34,065	18,587	3,338	-40,882	-27,247	-10,204	30	,000

Based on the calculation results of the SPSS 21 application , data on students' cooperative abilities and data on physics learning outcomes, students obtained paired t-test scores with a significance of 0.000 ≤ 0.005 with the presence of $t_{count} \geq t_{table}$, which means rejecting Ho_1 accepting Ha_1 and rejecting Ho_2 accepting Ha_2 . So it is proven in this hypothesis test that there is an influence of the project-based learning model on cooperative abilities and there is a positive influence of the project-based learning model on physics learning outcomes.

N-Gain Test

N-Gain test aims to determine the increase in cooperative abilities and physics learning outcomes as well as determine the effectiveness of using a method in one group pretest posttest design research after being given treatment . In this research, the N-Gain test results for cooperative ability were 0.49 and the N-Gain test results for physics learning outcomes were 0.64. Both N-Gain test results produce a gain index in the medium category. Next, the data will be tested to see how effective the project-based learning model is on students' cooperative abilities and physics learning outcomes. The results of the n-gain test with the help of the SPSS 21 application are as follows.

Cooperative Ability

Table 14. N-Gain test of cooperative ability with the SPSS 21 application

cooperative abilities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 40% = Ineffective	8	25.8	25.8	25.8
	40-55% = Less Effective	11	35.5	35.5	61.3
	56-75% = Quite Effective	12	38.7	38.7	100.0
	Total	31	100.0	100.0	

Based on SPSS calculations 21 of 31 samples of cooperative ability data stated that the project-based learning model was ineffective for 8 students, less effective for 11 students, and quite effective for 12 students. So it can be concluded that the project-based learning model is "less effective" in improving students' cooperative abilities. This can be concluded as in Figure 5.

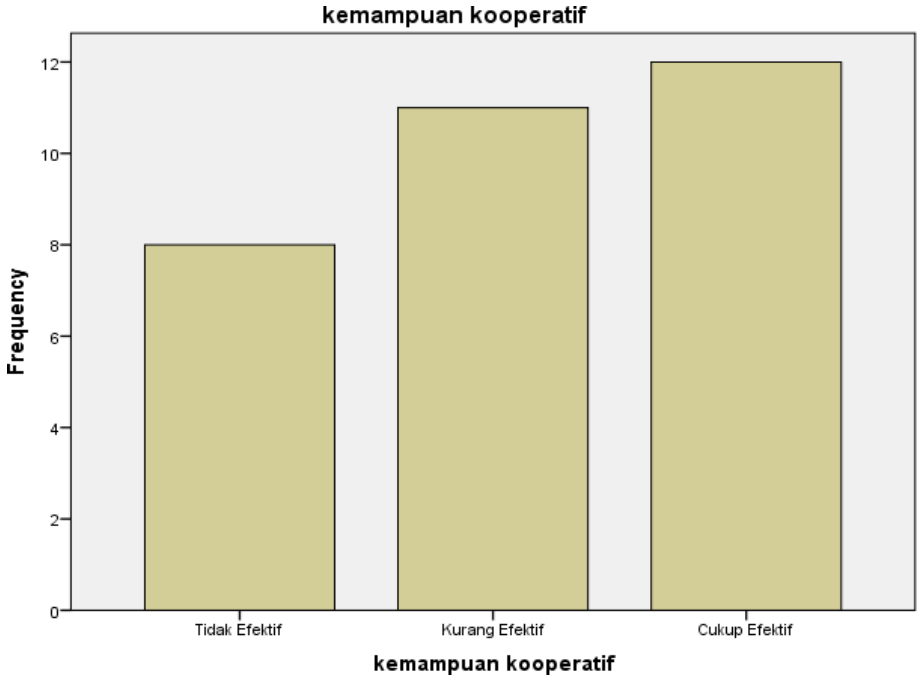

Figure 5. N-Gain Test Results for Cooperative Ability with the SPSS 21 application

Physics Learning Outcomes

Table 15 . N-Gain Test Physics learning outcomes with the SPSS 21 application

Physics Learning Outcomes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 40% = Ineffective	3	9.7	9.7	9.7
	40-55% = Less Effective	5	16.1	16.1	25.8
	56-75% = Quite Effective	13	41.9	41.9	67.7
	>76% = Effective	10	32.3	32.3	100.0
	Total	31	100.0	100.0	

Based on SPSS calculations 21 of 31 samples of physics learning results data stated that the project-based learning model was ineffective for 3 students, less effective for 5students, quite effective for 13 students, and effective for 10 students. So it can be concluded that the project-based learning model is "quite effective" in improving students' physics learning outcomes. This can be concluded as in Figure 6.

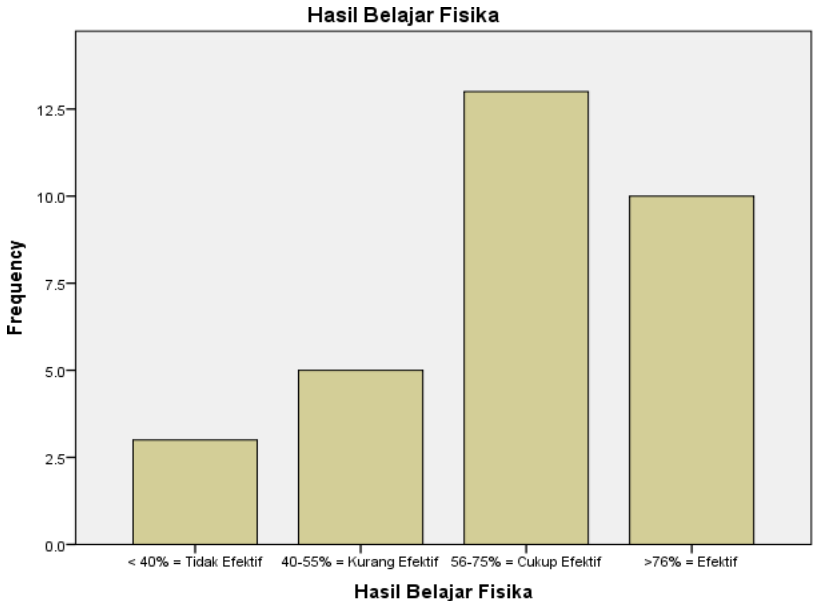

Figure 6. N-Gain Test Results for physics learning outcomes with the SPSS 12 application

DISCUSSION

Parabolic motion is physics material that requires the presentation of theoretical concepts and visualization so that students' understanding is more concrete (Azmi et al., 2012) . To make the concept of parabolic motion more concrete, supporting media needs to be provided but involving student collaboration, namely project-based learning. One of the subjects of physics that is considered difficult by students is parabolic motion material, because in presenting parabolic motion material the teacher only does demonstrations and lectures. This is because the price of experimental equipment is quite expensive, so that parabolic motion experiment equipment is not available in several schools (Adnan & Muchlas,2013) . Therefore, the researcher chose parabolic motion material with vector analysis as the physics competency being tested and the Project-Based Learning learning model as the focus of the research, and the project chosen was making a water rocket using simple tools.

In this research, the project that students will work on together is the water rocket project. This project is related to the material being tested, when a water rocket is launched it produces a trajectory that forms a projectile motion (parabola). Therefore, the process of making a water rocket project from looking for sources, discussing with the group, looking for materials, making a rocket, testing, measuring the farthest distance, measuring the highest point are the stages that researchers will use as components of assessing group collaboration in the project and capabilities. individual student cooperation. Meanwhile, rockets launched simultaneously by several teams or groups will be analyzed as a basis for knowledge, why one rocket and another rocket have different furthest trajectories, different highest points, and have different initial velocities. By carrying out this project students will better understand the basic concept of parabolic motion.

Students' cooperative abilities after using the project-based learning model have increased. This can be seen from the average pretest score given before being given treatment which is lower than the average posttest score given after being given treatment. The highest pretest score was 34 and the lowest score was 17 with a standard deviation of

4.478. The highest posttest score is 50 and the lowest score is 36 with a standard deviation of 3.182. Thus the test results The n-gain of cooperative ability is 0.49 with a significance of 49.79%, which means it is in the medium category (influential) but "less effective" is used. This is because students cannot build cooperative abilities in a short time. It takes persistencein carrying out project-based learning and quite a long time. This is in line with the weaknesses of the project-based learning model presented by (Sudrajat & Hernawati, 2020) . The comparison of students' cooperative ability scores on the four indicators in the class XI 1 pretest-posttest test can be seen in Figure 7.

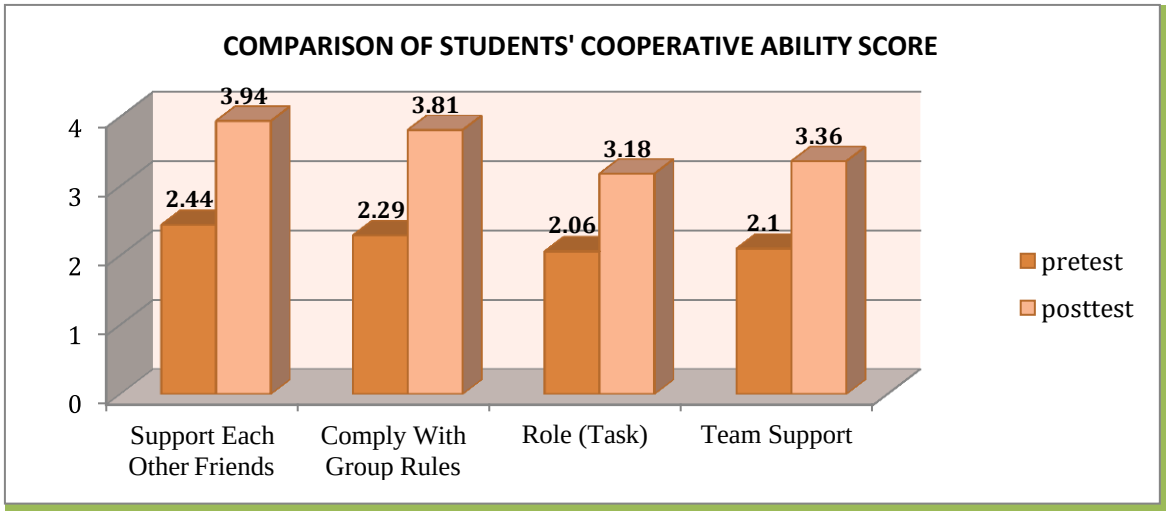

Figure 7. Comparison of Pretest and Posttest Cooperative Ability Scores

Students' physics learning outcomes after using the project-based learning modelhave increased as seen from the average score of the pretest given before being given treatment which is lower than the average score of the posttest given after being given treatment. The highest pretest score is 80 and the lowest score is 0 with a standard deviation of 21.089. The highest posttest score is 92 and the lowest score is 28 with a standard deviation of 13.260. Thus the test results The n-gain for physics learning outcomes is 0.64 with a significance of 61.81%, which means it is used in the moderate (influential) and "quite effective" categories. The comparison of student physics learning achievement scores on the five indicators in the class X PMIA 1 pretest-posttest test can be seen in Figure 8.

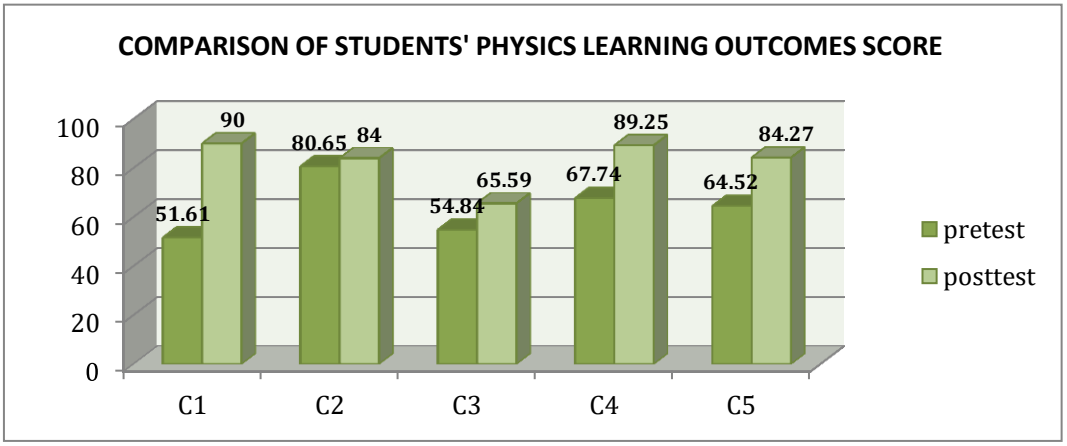

Figure 8. Comparison of Pretest and Posttest Scores on Physics Learning Results

CONCLUSION

Based on the research results, it can be concluded that there is a significant effect of using the Project-Based Learning learning model on cooperative abilities with the calculation of the N-gain test for cooperative abilities of 0.49 with a percentage of 49.79%, calculated by the t-test namely $t_{count} \geq t_{table}$ (2.00100 ≤ 16.78 ≥ 2.66176), paired t-test namely 0.000 < 0.005 which mean There are differences in the results of the analysis of students' cooperative ability tests before and after using the project-based learning model .

Apart from that, there is also a significant influence of the use of the Project-Based Learning learning model on physics learning outcomes with the N-gain test calculation of physics learning outcomes of 0.64 with a percentage of 69.17% , t-test calculation namely $t_{count} \geq t_{table}$ (2.00100 ≤ 7.22 ≥ 2.66176), paired t-test namely 0.000 < 0.005 which mean There are differences in the results of the analysis of students' physics learning outcomes tests before and after using the project-based learning model.

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