



RESEARCH ARTICLES

The Influence of Project Based Learning Models on Student Learning Outcomes

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ABSTRACT

This study aims to determine the influence of the Project Based Learning learning model assisted by ArcGIS software media in geography learning on the learning outcomes of grade X students at SMA Negeri 2 Kalianda. The purpose of this study is based on the low learning outcomes of students who have not been able to achieve the Minimum Completeness Criteria (KKM), so a strategy is needed in the form of a learning model that can help improve student learning outcomes. This study uses a quantitative approach with quasi-experimental methods and an unequal control group design. The subjects in this study are class X students of SMA Negeri 2 Kalianda which were determined using purposive sampling. The research instruments used are in the form of pretest and posttest question sheets to see and assess student learning outcomes. Data analysis in the study was carried out using t-test and N-gain test to determine the influence of the applied learning model on learning outcomes. The results showed that there was a significant difference in posttest scores after the application of the Project Based Learning model. The average posttest score in the experimental class was 83.75 while the average posttest in the control class was 70.42. The Project Based Learning model assisted by ArcGIS software media has a positive and significant influence on the geography learning outcomes of grade X students at SMA Negeri 2 Kalianda.

Keywords: Project Based Learning; ArcGIS; Learning Outcomes; Geography



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1. INTRODUCTION

Educational institutions and teachers in the era of independent learning must be able to prepare for changes and improvements in dynamics in accordance with changes and developments in science and technology. Geography as one of the subjects that is a science with study objects including natural and social phenomena, of course has an important role in the learning process for students. Geography can develop the intellectual abilities of students who study it, increase curiosity, and the ability to observe nature and its environment (Santoso, 2020).

However, based on the results of observations, several facts were obtained that the learning outcomes of students in geography are still very low, in which case learning outcomes refer to the abilities acquired after completing a series of learning processes (Sejati et al., 2023) Student learning outcomes are said to be low, because students who have not been able to achieve the Minimum Completeness Criteria (KKM) scores. The low learning outcomes of geography students are shown by the data on the value of learning outcomes in the assessment of students' daily geography exams in one of the

geography subject materials, namely basic knowledge of mapping. Based on data obtained from observation and preliminary research at SMA Negeri 2 Kalianda, it shows that there is still an incompleteness in student learning outcomes with the KKM that has been determined.

Table 1. Students' Daily Exam Scores in Geography Subject Mapping Basic Knowledge Material

Quantity		Completeness			
Classes	Quantity	Finished ≥ 75		Incomplete < 75	
		Frequency	Percentage	Frequency	Percentage
X.1	36	3	8,33%	33	91,67%
X.2	33	2	6,06%	31	93,94%
X.3	35	9	25,71%	26	74,9%
X.4	35	7	20%	28	80%
X.5	36	5	13,89%	31	86,11%
X.6	35	10	28,58%	25	71,42%
X.7	35	11	31,42%	24	68,58%
X.8	34	9	26,48%	25	73,52%
X.9	35	8	22,86%	27	77,14%
X.10	35	12	34,28%	23	65,72%
X.11	36	11	30,56%	25	69,44%

Source: Geography Teacher Documentation of SMA Negeri 2 Kalianda 2024/2025

Based on table 1, it is known that the results of daily repetition of basic knowledge of mapping materials in class X show that there is still a lack of good mastery of geography learning materials so that students cannot achieve KKM. The problem of low learning outcomes in learning can also occur due to the use of inappropriate learning models.

In an effort to achieve learning goals, there are several important things that must be considered. These important things include teaching materials, learning strategies, and learning assessments or evaluations. Learning strategies refer to the methods or methods applied by the teacher, including the use of models that are in accordance with the subject matter, because the use of the right model will also arouse students' interest in the material presented (Monika et al., 2022). One of the strategies in learning as conveyed in the sentence above is the learning model. The learning model consists of various types, one of which is the Project Based Learning learning model. This learning model makes students the main subject in the learning process, with a focus on learning activities that produce a product as the final result of learning. This means that students are given the right to choose their own learning activities, carry out joint learning projects to achieve results in the form of products. Therefore, the success of this learning is greatly influenced by the active participation of students during learning (Nababan et al., 2023).

The Project Based Learning learning model is very suitable for use in learning. The Project Based Learning model can provide opportunities for learners to collect and combine the knowledge gained, then innovate to gain new experiences and ultimately create meaningful products (Dewi et al., 2024). The application of the Project Based Learning learning model also has systematic stages in its implementation, which consists of six stages (Subiyantoro, 2025), namely: (1) Formulating guiding questions, (2) Project planning, (3) project implementation, (4) monitoring and feedback, (5) preparation of final products, (6) presentations, and (7) reflection. The Project Based Learning learning model has advantages such as encouraging students' interest in learning, making students able to do assignments and training students in solving problems (Sari et al., 2022). In addition, Project Based Learning also facilitates students to investigate, solve problems, be student-centered, and produce real products in the form of useful project results (S. A. Rahman & Ramli, 2024).

The selection of the Project Based Learning model on this basic mapping knowledge material was combined with the use of ArcGIS software media tools. ArcGIS is one of the software frameworks used in Geographic Information Systems (GIS) with capabilities ranging from digital mapping to spatial analysis

(Priambodo et al., 2023). ArcGIS software, which can be used to create maps digitally based on basic mapping knowledge, is expected to improve understanding of concepts, generate interest in learning, and overall improve student learning outcomes.

2. LITERATURE REVIEW

2.1 Theory Constructivism

Constructivist learning theory assumes that learning is not just doing activities, but also the process by which humans create and organize their own knowledge based on their personal experience (Lathifah et al., 2024). This theory views learning as a dynamic process, in which knowledge is not only received but constructed. In constructivist learning theory, students play an active role in shaping their knowledge. The theory of constructivism states that knowledge is not always conveyed by teachers to students, but rather that students must actively participate in the learning process, so that they cognitively develop their knowledge structure according to their level of cognitive maturity (Azzahra et al., 2025). This concept emphasizes that effective learning needs to pay attention to the stages of cognitive development of students so that the material presented can be understood properly (Mandar & Sihono, 2025).

2.2 Model Project Based Learning

The Project Based Learning learning model is a student-centered learning model with a constructivist approach, where students play an active role in planning, developing, and completing real projects related to daily life (Nurazizah et al., 2025). This learning model is inquiry-based, where students explore various real problems through projects, both individually and in groups, so that they are presented in the form of complex and structured tasks where students begin with the main questions that encourage reflection, strengthen literacy, and produce the final product (Budiharto & Fitriana, 2025). Models *Project Based Learning* integrate critical thinking, communication, collaboration, and creativity skills, and support the Independent Curriculum through strengthening the Pancasila Student Profile by increasing student participation in contextual and meaningful projects through group work and is also effective in building collaboration skills while improving learning outcomes (Isnaini & Wijayanto, 2026).

2.3 Learning Outcomes

Learning outcomes are the results that have been obtained by students after they participate in learning activities. The results obtained by the student can be in the form of abilities related to knowledge, attitudes, and skills after he or she receives the learning experience (Rahman, 2024). Robert M. Gagne stated that learning is a change that occurs in human abilities after continuous learning, not only as a result of the growth process. Gagne believes that learning is influenced by external factors and internal factors that interact with each other (Basyir et al., 2022). In other words, learning outcomes are a reflection of achievements in the learning process that show the level of success of students after participating in teaching and learning activities (Norama & Yunus, 2026).

3. METHODS

3.1 Research Design

This study uses a quantitative approach with quasi-experimental methods and an unequal control group design. In this design, neither the experimental group nor the control group were randomly selected (Soesana et al., 2023). In the design of this study, it was carried out by giving treatment to the experimental group and providing the control group as a comparison (Abdullah et al., 2022).

3.2 Participants

The population can be large or small, depending on the desired parameters, whereas the study sample is part of the population group that is planned to be studied in order to generalize the research

conclusions (Zulfikar et al., 2024). The population in this study is all students of class X at SMA Negeri 2 Kalianda which consists of 12 classes. Then, the research sample was selected using two classes, namely X.2 as the experimental class and X.5 as the control class selected by purposive sampling technique.

3.3 Instruments

This study has two variables, namely independent and dependent variables. The independent variable in this study is the Project Based Learning learning model, a model that makes students the main subject and the focus of learning activities that produce a product as the final result of learning consisting of seven stages, namely: determining basic questions or guiding questions, project planning, project implementation, student monitoring and project progress and providing feedback, product preparation, presentation, and reflection. The application of the Project Based Learning model is measured through observation during the learning process by looking at the implementation of each step in the Project Based Learning model.

Meanwhile, the dependent variable in this study is the learning outcomes of students. Student learning outcomes will be measured by an instrument which is a multiple-choice question test. The multiple-choice test in this research question discusses the basic knowledge of mapping learning material consisting of 20 questions. A multiple-choice test in this study was used to see if there was an effect on student learning outcomes before and after treatment in the form of the application of the Project Based Learning model. Multiple-choice tests will be carried out at the beginning of learning (pretest) and at the end of learning (posttest).

3.4. Data Analysis

3.4.1. Normality Test

The normality test in this study aims to find out whether the result data *Pretest* and *posttest* in the experimental class and the normally distributed control class. The criterion for decision-making in this normality test is if the value is significant or the probability value is <0.05 , which means that the data is not distributed normally. However, on the other hand, if the value is significant or the probability value is >0.05 , which means that the data is normally distributed (Fitri et al., 2023).

3.4.2. Homogeneity Test

The Homogeneity Test is a test regarding variants and is used to find out whether or not the two sample groups have the same variant, with the aim of understanding the variant and some populations are the same or not this test is usually performed as a prerequisite in Independent analysis. The similarity test of two variants is used to test whether the distribution of the data is homogeneous or not, i.e. by comparing the two variants (Annisak et al., 2024).

3.4.3. T-test

The t-test is used to find out if two samples are from the same population and average. The t-test can be applied to a single sample used to compare two mean values (Waluyo et al., 2024). The t-test used in this study is the type of *Independen sample test* which aims to find out the difference in the mean of the two groups.

3.4.4. Uji N-Gain

The N-Gain test is used to assess the effectiveness of the application of teaching materials in improving student learning outcomes after being given learning treatment (Purwati & Ningrum, 2025). The calculation is based on a comparison between the pretest score and the posttest score obtained by the student. An N-Gain score test is applied if the results of the pretest and posttest show a significant difference in mean conditions before and after treatment (Yusiana & Prasetya, 2022).

4. RESULTS AND DISCUSSION

Learning with the application of the Project Based Learning Model assisted by ArcGIS software media in the experimental class based on the results of the observation sheet took place optimally and in a structured manner. Teachers are able to carry out learning by preparing the class well, conveying learning objectives clearly, and using media or tools in the form of ArcGIS software that have been determined to support student understanding. In addition, teachers play an active role as facilitators who provide direction and feedback during the learning process, so that students can understand the material more deeply and effectively.



Figure 1. Learning with ArcGIS software

Source: Researcher Documentation (2025)

Descriptive Analysis

This research began with the provision of a pretest in both classes, to find out the initial ability of students before being given learning treatment. Based on the data from the pretest results, the experimental class obtained an average score of 60.97 with a maximum score of 80, and a minimum score of 40. Meanwhile, the control class had an average score of 56.53 with a maximum score of 80, and a minimum score of 35. Then in the posttest, the average score of the experimental class applied by the Project Based Learning model reached 83.75, with a minimum score of 65 and a maximum score of 100. Meanwhile, the control class obtained an average score of 70.42 with a minimum score of 50 and a maximum score of 95, so that the difference between the two classes was 13.33%. The difference in learning outcomes occurred because the experimental class applied a Learning Project-Based learning model. This condition causes the improvement of learning outcomes in the experimental class to be more optimal compared to the control class that does not apply the Project Based Learning model

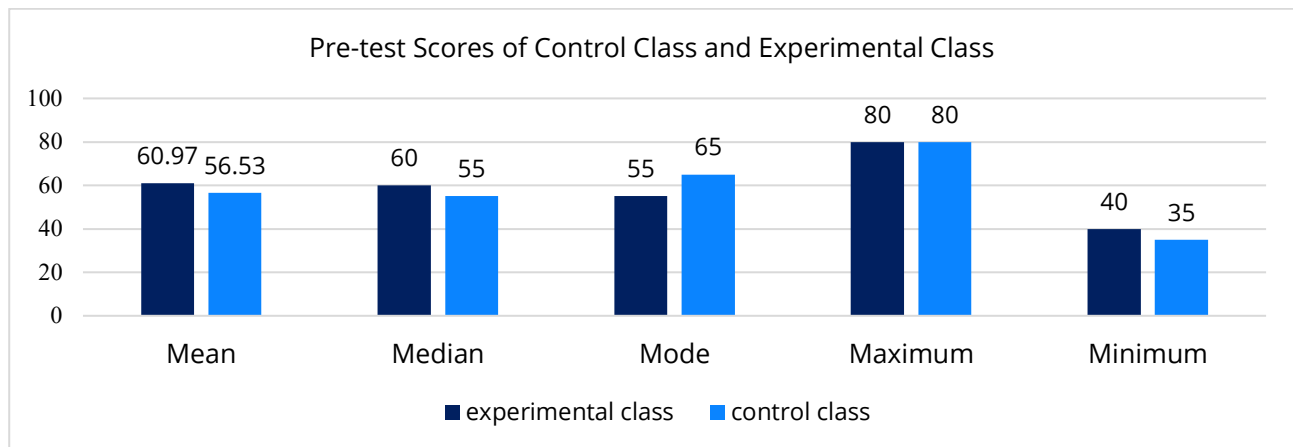


Figure 2. Experimental Class and Control Class Pretest Scores

Source: Researcher Documentation (2025)

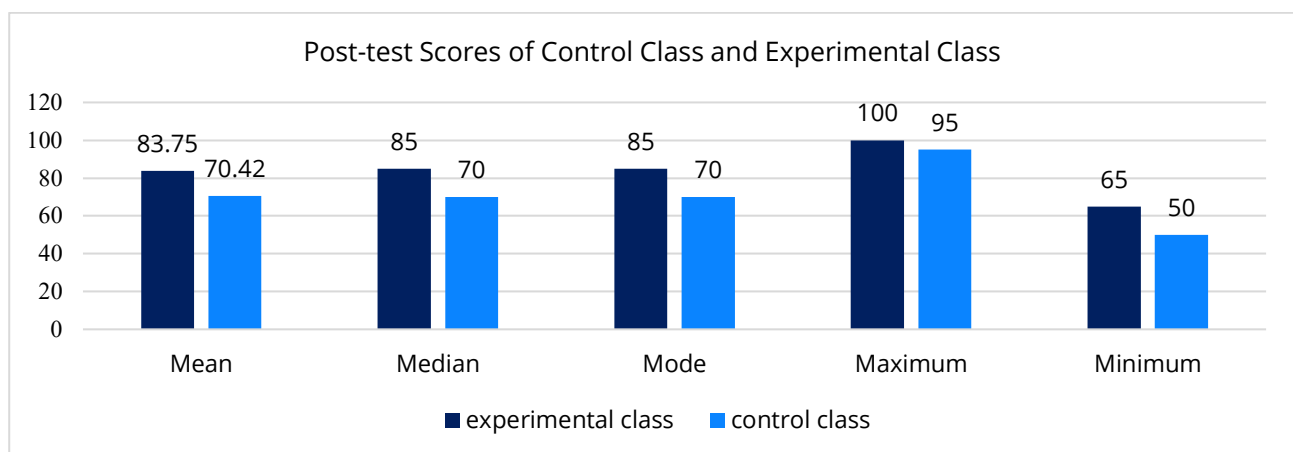


Figure 3. Experimental Class and Control Class posttest scores

Source: Researcher Documentation (2025)

The improvement in learning outcomes was also supported by the results of the N-gain test analysis. Based on the results of the N-gain test, the result of the N-gain score for the experimental class was 0.58 with a percentage of 58.14%, which was with moderate criteria. Meanwhile, for the control class, an N-gain score of 0.28 was obtained with a percentage of 28.60%, which was with more or less criteria. In addition to the results of the N-gain test, effect size calculations were also carried out to see the magnitude of the influence of the Project Based Learning learning model on student learning outcomes using the help of the Effect Size Calculator (Cohen's D) program which obtained an effect size of 1.2 which is in the large category.

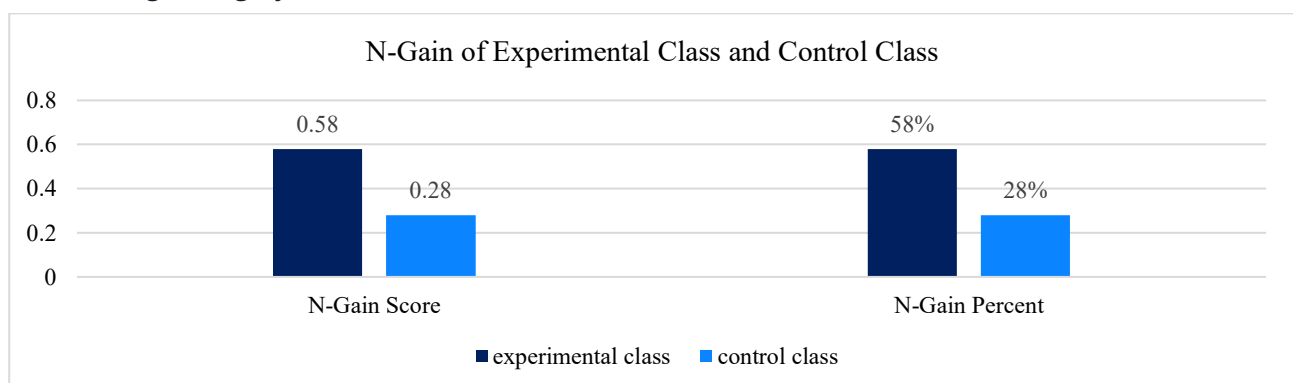


Figure 4. Experimental Class and Control Class N-Gain Test Results

Source: Research Papers (2025)

Data Analysis

Prerequisite Test

Before testing the hypothesis, first conduct a prerequisite test which includes a normality test and a homogeneity test. The normality test was carried out using the Shapiro-Wilk method. Based on the test results, the significance value of the experimental class pretest was 0.113 and the control class was 0.78. Meanwhile, the significance value of the post-experimental class was 0.203 and the control class was 0.207, so it was concluded that the data were distributed normally.

Table 2. Pretest Normality Test Results

Normality Test						
Kolmogorov-Smirnova				Shapiro-Wilk		
Classes	Statistics	df	Sig.	Statistics	df	Sig.
Pre-Experiment	.127	36	.151	.951	36	.113
Pre Control	.150	36	.040	.946	36	.078

Source: Research Results (2025)

Table 3. Posttest Normality Test Results

Normality Test						
Kolmogorov-Smirnova				Shapiro-Wilk		
Classes	Statistics	df	Sig.	Statistics	df	Sig.
Post Experiment	.122	36	.195	.959	36	.203
Post Control	.150	36	.040	.959	36	.207

Source: Research Results (2025)

Furthermore, a homogeneity test was carried out to determine the similarity of data variance between the experimental class and the control class. Based on the results of the homogeneity test analysis using SPSS 27, the significance value of the homogeneity test in the experimental class pretest and the control class was 0.066. Meanwhile, the posttest of the experimental class and the control class was 0.564, so the research data was declared to have homogeneous variance.

Table 4. Homogeneity Test

Tes Homogenitas Varians				
	Levene Statistics	Df1	Df2	Sig.
Pretest	3.500	1	70	.066
Posttest	.335	1	70	.564

Source: Research Results (2025)

Hypothesis Test Results

Uji T Pretest

The first hypothesis test, the pretest t-test, in this study aims to find out if there is a difference in the pre-test results between the experimental class and the control class before being given different learning treatments. Based on the results of the analysis of the Facility Equity t-test with the help of SPSS 27, a significance value of 0.132 was obtained. The value of the t-test analysis shows that a value of >0.05 indicates that the value is greater than 0.05. This means that there is no difference in the pretest results between the experimental class and the control class before receiving the learning treatment.

Table 5. Experimental Class and Control Class Pretest T Test

Independent Sample Test										
		Levene Test for Equality of Variance							T-test for Equivalence from Sarana	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
Results	The same variance is assumed	3.500	.066	1.523	70	.132	4.444	2.918	-1.376	10.265
	Equal variance is not assumed			1.523	67.053	.132	4.444	2.918	-1.381	10.270

Source: Research Results (2025)

Uji T Posttest

Furthermore, the second hypothesis test is a posttest t-test which aims to test whether there is a difference in geography learning outcomes between the experimental class and the control class after the experimental class receives treatment in the form of the application of the Project Based Learning learning model assisted by ArcGIS software media. Based on the results of hypothesis testing using the posttest t-test with the help of the SPSS version 27 program, a significance value of 0.000 was obtained, which is smaller than 0.05. The results of this test show that the application of the Project Based Learning learning model assisted by ArcGIS software media in the experimental classroom has a positive effect on improving student learning outcomes.

Table 6. Experimental Class and Control Class Posttest T Test

Independent Sample Test										
		Levene Test for Equality of Variance							T-test for Equivalence from Sarana	
		F	Let's say.	t	df	Sig. (2-tailed)	Average Difference	Std. Error Difference	95% Confidence Interval of Difference	
Results	The same variance is assumed	.335	.564	6.303	70	.000	13.333	2.115	9.115	17.552
	Equal variance is not assumed			6.303	67.865	.000	13.333	2.115	9.112	17.554

Source: Research Results (2025)

Discussion

The implementation of learning using the Project Based Learning model assisted by ArcGIS software media in this study was carried out systematically, in accordance with the stages and stages of learning that had been planned, starting from determining basic questions, project planning, project implementation, student monitoring and providing feedback, preparation of final products,

presentations to reflection. In the application of the Project Based Learning learning model, students are given the opportunity to manage learning activities independently and collaborate in completing projects so as to produce a product (Hauko et al., 2025). The application of the Project Based Learning model assisted by ArcGIS software media makes students more active because they are directly involved in the implementation of the project. Project-based learning increases student participation in determining key aspects of the project they are working on. In addition, through the implementation of projects that have real goals, students show a sense of connectedness, a sense of responsibility for learning outcomes, and a greater motivation to give full attention to all stages of the learning process (Nasrulloh & Amal, 2024)

The results of this study are also in line with research by (Widiatikasyanti et al., 2025) which states that it is based on the theory of constructivism, which emphasizes the active role of students in building knowledge independently through hands-on experience and collaborative interaction. By providing students with the opportunity to directly engage in a meaningful learning process through planning, drafting, observing, and developing real products, these activities not only cater to the cognitive aspect, but also play a role in developing collaboration, communication, and problem-solving skills. The application of the Project Based Learning learning model can improve student learning outcomes through various factors in the learning process, one of which is discussion activities in the classroom and by using projects as learning activities. This statement is reinforced by research (Tanggela et al., 2023) which shows that the Project Based Learning model makes the project a center of learning activities that encourage students' enthusiasm in receiving material, as well as fostering the ability to search and build knowledge independently.

The Project Based Learning model also assists students in applying theory to practice. In the Project Based Learning model, students apply the concepts learned in class to the implementation of real projects, so that the learning process requires students to understand and organize information well (Aliman et al., 2025). In addition, the Project Based Learning model in its implementation also provides opportunities for students to make decisions in determining, implementing, and completing certain projects, which is accompanied by monitoring activities by educators on student activity during the project completion process (Asidiqi, 2024).

The results of this study are also in line with previous research by (Furqan et al., 2025) which revealed that the results of the study showed that students not only remembered the learning material, but were also able to apply the knowledge gained so as to lead them to a deeper understanding and improvement of learning outcomes. This is also evidenced by the increase in scores in the post-test. The improvements that have occurred show that the application of the Project Based Learning learning model is effective in improving students' geography learning outcomes.

The results of this study are also in line with the theory of constructivism used in the research. Constructivist theory has a strong relationship with the project-based learning model because both view learning as a dynamic process, in which knowledge is not only passively received, but actively constructed by learners. In the perspective of constructivism, learners build new understandings based on their previous experiences, interactions, and knowledge. In line with this, this ArcGIS software-assisted Learning Project provides an opportunity for students to directly engage in learning activities through meaningful project completion. The application of the Project Based Learning model based on constructivism theory is able to create meaningful learning and increase students' conceptual understanding more deeply so that student learning outcomes are improved.

Thus, based on the results of research that has been conducted and supported by the theory in the research, it can be concluded that the Project Based Learning learning model has been proven to be effective in improving student learning outcomes. The application of the Project Based Learning model is able to present a systematic and directed learning structure. This Project Based Learning learning model also has the advantage of producing a more meaningful, interesting, and effective learning process. The results of this study also strengthen the findings of previous research which revealed that the use of the Project Based Learning learning model is effective in improving learning outcomes and can be used as an option to improve student learning outcomes.

5. CONCLUSION

The application of the Project Based Learning model in this study shows that all stages of learning have been carried out in a systematic, structured, and directed manner in accordance with the planned learning series. Students also show an increase in activeness in learning, because students are not only recipients of material, but are also required to be active, discuss, collaborate, and directly involved in every stage of the digital map making project using ArcGIS software-assisted media. The results of the study showed that the application of the Project Based Learning learning model assisted by ArcGIS software media had a significant influence on the geography learning outcomes of grade X students at SMA Negeri 2 Kalianda. This is proven through hypothesis testing using a parametric statistical test, i.e. the t-test for Equality of Means, which shows that there is a significant difference in learning outcomes between the experimental class and the control class. In addition, this influence is also strengthened by a significant difference in learning completeness, where the average number of students who achieve the Minimum Completeness criteria in the experimental class using the Project Based Learning learning model is higher than the control class using the conventional model.

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