The Effect of Project-Based Learning Model on Students' Cognitive Learning Outcomes and Collaborative Skill of Excretion System Concept

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Abstract: This research is quasi-experiment research which aims to: 1) Knowing the effect of implementing Project Based Learning toward students' cognitive learning outcomes on the human excretory system material for class XI MIA at SMA Negeri 2 Pangkep. 2) Knowing the effect of implementing Project Based Learning on students' collaborative skills on the human excretory system material for class XI MIA at SMA Negeri 2 Pangkep. This research uses a Non-Equivalent Control Group Design. Samples in this study were class XI MIA Plato and XI MIA Alexander Graham Bell. Data collection techniques were used in the form of learning outcomes tests and collaborative skills questionnaires by conducting observations and documentation. The data were collected by giving a pretest and posttest, which were then analyzed through descriptive and inferential analysis. The hypothesis test using the N-Gain Independent Sample t-Test. The results of this study indicate that: 1) students' cognitive learning outcomes in the experiment class have an average score of 85.17, while the control class is 73.03. Based on the results of hypothesis testing, a significant value was obtained, namely $0.000 < = 0.05$. 2) students' collaborative skills in the control class have an average score of 76.66%, while the control class is 59.33. Based on the results of hypothesis testing, a significant value was obtained, namely $0.000 < = 0.05$. By looking at the results of hypothesis testing, Project Based Learning affects students' cognitive learning outcomes and collaborative skills of class XI at SMA Negeri 2 Pangkep.

Keywords: Collaborative skill; Learning outcome; PJBL

Introduction

Education is a form of effort that is carried out consciously and planned to intend to create active learning conditions so students can improve their inner abilities to have spiritual, religious, intelligence, noble character and skills that are needed by society, nation and state (UU No. 20 of 2003 concerning Sisdiknas). In the 21st-century education system, education specifically aims to develop the abilities possessed by students, especially in the field of skills in solving everyday problems (Adi, 2018). According to Ruqoyyah et al. (2020) that the skills that students must develop in 21st century are critical thinking, creative thinking, communication and collaborative skills. In addition,

Hidayat et al. (Hidayat et al., 2019) state that education is a process of self-control of students so that they can equate themselves with the conditions of their environment.

Achieving these educational goals, teaching and learning activities are needed both inside and outside the classroom that takes place well and of good quality. The success of teaching and learning activities in the classroom and outside the classroom can be seen from the achievement of student learning outcomes in various aspects such as cognitive, affective and psychomotor of students (Rusman, 2017; Wahyuni, 2012). However, in reality, the low learning outcomes of students are still a big problem faced by the Indonesian state in the world of education (Supardi. et al., 2012). Low learning

outcomes indicate an inappropriate interaction between students and teachers during the learning process. One example is that students are still less active during the learning process, and the learning strategies used by the teacher are still not precise (Sutiah, 2016). As a characteristic of learning activities, namely the occurrence of positive, regular, active and directed changes (H. B. Rahayu, 2019).

Students in the 21st century are need to have a good collaboration skill with other students because this will form an active classroom atmosphere and allow students to know themselves and others so that they can help each other in achieving learning goals (Suprapto et al., 2021). This is because in learning, students do not only involve interactions between stimulus and response but also involve skills in complex thinking (Dewi et al., 2020; Umbara, 2017).

Based on the results of initial observations at SMA Negeri 2 Pangkep, it was found that the average grade XI MIA students obtained in Biology subjects are still much below the standard score. This is because students need help understanding the material taught by teachers who still use the conventional learning model. Conventional learning is the dominant lecture method. In addition, during the learning process, it was seen that students' activeness in building collaboration with other students was still very lacking. This behavior shows that students' collaborative skills still need to improve.

Overcoming these problems, updating the learning process in schools is necessary. One of the updates that can be done is to change the way teachers teach by using appropriate learning models according to the material being taught. The learning model used as a solution by the researchers is Project Based Learning model in the biology learning process.

Project Based Learning in its application will make students more active and can improve students' collaborative skills because, during the learning process, students will produce projects related to the material studied and made together (Markamah, 2020; Ngabidin, 2021). The Project Based Learning model will use projects that have been created as learning media (Hikmah, 2020; Panggabean et al., 2021). So that students will get meaningful learning, and it will be stored in their long-term memory (Kurniawan et al., 2019; Mulyono et al., 2020). This will increase student learning outcomes (Sakilah. et al., 2020). This is reinforced by the Sholekah (2020) and Rafsanzani et al. (2020), which states that learning science with Project Based Learning can improve student learning outcomes. In addition, research has been conducted by Sulfiani (2021), who states that the collaborative ability of students in classes taught using Project Based Learning is significantly higher than class that was taught using conventional learning models.

Based on the description above, the researcher is interested in conducting study with the title "The Effect of Project-Based Learning Model on Students' Cognitive Learning Outcomes and Collaborative Skill of Excretion System Concept".

Method

This type of research is quasi-experiment research involving two classes with different treatments. The experiment class used Project Based Learning and the control class used the conventional model. Nonequivalent Control Group Design is used in this research. These two classes will be given a pre-test before learning process. After the experiment class was taught using the Project Based Learning and control class with the conventional learning model, and then given a post-test in each class to find out changes that happened (Zakiyatun et al., 2017). The following table 1 show the research design.

Table 1. Research Design Nonequivalent Control Group Design

Class	Pretest	Treatment	Posttest
Experiment Class	O1	X1	O2
Control Class	O3	X2	O4

Description:
O1   : Pretest in the experiment class
O3   : Pretest in the control class
X1   : Treatment of the Project Based Learning
X2   : Treatment of conventional learning models
O2   : Posttest in the experiment class
O4   : Posttest in the control class

This research takes place at SMA Negeri 2 Pangkep, located at Jl. US. Dg. Kalebbu No. 2, Segeri, Segeri District, Pangkajene Regency and Islands in the 2021/2022 academic year. This study's population were all class XI MIA students at SMA Negeri 2 Pangkep with 114 students divided into 4 classes. After that, two classes were selected by purposive sampling, so that we got XI MIA Alexander Graham Bell as the experiment class and XI MIA Plato as the control class with 29 students each.

The variables used in this study are independent and dependent variable. The independent variable in this study is the project-based learning and variable dependent is the student's cognitive learning outcomes and collaborative skills. Cognitive learning outcomes data were taken in the form of multiple choice tests with 30 questions about the excretory system. Meanwhile, collaborative skills data was taken in the form of a collaborative skills questionnaire, totaling 30 statements with a closed questionnaire type. The indicators of

collaborative skills used are adapted from Putri et al. (2021) in which there are five indicators, namely shared responsibility in groups, working actively and contributing, skills in compromising with others in carrying out various roles or activities.

The data analysis technique in this study used descriptive statistical analysis and inferential statistical analysis which consisted of three tests, namely homogeneity test, normality test and hypothesis testing.

Result and Discussion

Descriptie Statistical Analysis Descriptive

Statistical analysis was used IBM SPSS version 25 to show the characteristics of the distribution of scores for cognitive learning outcomes and collaborative skills of students in each class carried out by researchers at SMA Negeri 2 Pangkep in the experiment and control classes, so the data on cognitive learning outcomes and skills were obtained. Student collaboration is as follows.

Results of observation of teacher and student activities

The results of observations of teacher activities in the experiment class and in the control class carried out during the learning process, which took place in 3 meetings, are presented in table 2:

Table 2. Data on the Percentage Results and Criteria for Teacher Activity in the Experiment and Control Class

Meeting	Experiment		Control	
	Percentage (%)	Criteria	Percentage (%)	Criteria
I	96	Very Good	89	Very Good
II	96	Very Good	93	Very Good
III	98	Very Good	96	Very Good

Table 2 shows that the percentage of teacher activity in the experiment class treated with the Project Based Learning obtained indicates that teacher activity is in the very good category. Likewise, teacher activities are in the very good category in the control class with the application of conventional learning models.

Meanwhile, the results of observations of student activities in the experiment class and in the control class carried out during the learning process that took place in 3 meetings are presented in table 3. Table 3 shows that the percentage of student activity in the experiment class is taught with Project Based Learning, which indicates that student activity is in the very good category. While in the control class, with the application of conventional learning models, student activities are in a good category.

Table 3. Data on the Percentage Results and Criteria for Student Activity in Experiment Class and Control Class

Meeting	Experiment		Control	
	Percentage (%	Criteria	Percentage (%	Criteria
I	80	Good	65	Good
II	85	Very Good	70	Good
III	87	Very Good	74	Good
Average	84	Very Good	70	Good

Description of cognitive learning outcomes of experiment and controlled class

Students Cognitive learning outcomes obtained by experiment class and control class students by giving pretest and posttest after being analyzed, the research data obtained statistically can be seen in table 4.

Table 4. Descriptive Statistic Value of Cognitive Learning Outcomes Students in Experiment Class and Control Class

Statistic	Class			
	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Sample Size	29	29	29	29
Average	40.5	85.1	41.6	73.0
Std. Deviation	13.2	8.7	13.8	8.8
Maximum	13	67	13	57
Minimum	73	100	73	90

Based on Table 4, it can be seen that the experiment class before treatment obtained an average value of 40.55 with the lowest score of 13 and the highest score of 73. Then after the treatment was given, the average value was 85.17, with the lowest score of 67 and the highest score is 100. In the control class before treatment, students obtained an average score of 41.69, with the lowest score of 13 and the highest score of 73. Then after the treatment was given with the conventional learning model, the average score was 73.03, with the lowest score was 57 and the highest score was 90.

The student learning outcomes are grouped into four categories, then the distribution of frequency and percentage is obtained as in Table 5.

Table 5. Distribution of Frequency and Percentage Pretest and Posttest Cognitive Learning Outcomes in Experiment Class

Interval Value	Category	Experiment			
		Pretest		Posttest	
		f	%	f	%
92-100	Very Good	0	0	7	24.1
82-91	Good	0	0	13	44.8
72-81	Enough	1	3.4	5	17.2
<72	less	28	96.6	4	13.8

Table 5 shows that in the experiment class, before being taught, only one person (3.4%) was in the good category, while 28 people (96.6%) were in the less category. However, after the project based learning was applied, the scores in the very good category were seven people (24.1%). In the good category, 13 people (44.8%), in the good category, there were five people (17.2%), and in the less category, there were four students (13.8%).

Table 6. The Distribution of Frequency and Percentage of Pretest and Posttest Cognitive Learning Outcomes in Control Class

Interval Value	Category	Control			
		Pretest		Posttest	
		f	%	f	%
92-100	Very Good	0	0	0	0
82-91	Good	0	0	5	17.2
72-81	Enough	2	6.9	10	34.5
<72	less	27	93.1	14	48.3

While in the control class, before being taught with traditional learning model, there were two people (6.9%) in the good category, while 27 people (93.1%) were in the poor category. Meanwhile, after the learning was carried out, the scores in the enough category were five people (17.2%), in the good category, there were ten people (34.5%), and in the less category, there were 14 people (48.3%).

Description of students' collaborative skills in experiment and control class

Collaborative skills obtained by students in the experiment class and control class by giving pretest and posttest after being analyzed, the data obtained from the research results statistically are shown in table 7.

Table 7. Descriptive Statistics Value of Students' Collaborative Skills Experiment and Control Class

Statistic	Class			
	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Sample Size	29	29	29	29
Maximum	103	124	98	99
Minimum	74	107	70	74
Average	86	115	87	89
Percentage	57.3%	76.6%	58%	59.3%
Criteria	Enough	Strong	Enough	Enough

Based on Table 7, it shows that students in the experiment class before being given treatment had collaborative skills in the "enough" category with an average score of 86 with a percentage of 57.3%. Then after the treatment was given the students had collaborative skills in the strong "category" with an average score of 115 with a percentage of 76.6%. While

in the control class before being given treatment, students had collaborative skills in the good category with an average score of 87 with a percentage value of 58%. Meanwhile, after treatment, students have collaborative skills in the strong category with an average score of 89 and a percentage of 59.3%.

Furthermore, if the percentage value of each student's collaborative skills is grouped into four indicators of collaborative skills that are used as aspects of the assessment, the analysis data is obtained as in table 8 and table 9.

Table 8. Description of the Average Percentage of Questionnaire Scores Indicator of Collaborative Skills Pretest and Posttest Experiment Class

Indicator	Experiment			
	Pretest		Posttest	
	%	Criteria	%	Criteria
Share Responsibility	63.7	Strong	77.6	Strong
Work Actively	59.7	Enough	76.6	Strong
Compromise	52.9	Enough	74.1	Strong
Perform Various Roles	53.3	Enough	78.8	Strong
Average	57.4	Enough	76.8	Strong

Table 9. Description of the Average Percentage of Questionnaire Scores Indicator of Collaborative Skills Pretest and Posttest Control Class

Indicator	Control			
	Pretest		Posttest	
	%	Criteria	%	Criteria
Share Responsibility	65.9	Strong	66.0	Strong
Work Actively	59.7	Enough	62.9	Strong
Compromise	53.0	Enough	54.4	Enough
Perform Various Roles	54.0	Enough	54.1	Enough
Average	58.2	Enough	59.4	Enough

Table 10. Normality Gain Value (N-Gain) Students' Cognitive Learning Outcomes.

	Experiment Class			
	Pretest	Posttest	N-Gain	Criteria
Average Value	40.5	85.1	0.7	High
Total Students				29
	Control Class			
	Pretest	Posttest	N-Gain	Criteria
Average Value	41.6	73	0.5	Medium
Total Students				29

Based on Table 8 and 9, it shows that students in the experiment class before being given treatment had an average percentage score per indicator, namely 57.4% or in the sufficient category, where the highest percentage was based on indicators, including the "Shared Responsibility" indicator while the percentage the lowest score is the "Performing Various Roles" indicator. Meanwhile, after learning process, the average percentage score of the questionnaire of each indicator is

76.8% with a strong category, where the highest percentage is based on the indicator "Performing Various Roles" while the lowest percentage is the "Compromising" indicator.

Normality test table N-Gain for students' cognitive learning outcomes above, it can be seen that the average N-Gain of the experiment class is 0.7 which is included in the high category. While the average score of N-Gain in the control class is 0.5 which is included in the medium category. Test calculation N-Gain for collaborative skills can be seen in table 11.

Table 11. Normality Gain (N-Gain) Students' Collaborative Skills

	Experiment Class			
	Pretest	Posttest	N-Gain	Criteria
Average Value	86	115	0.4	Medium
Total Students				29
	Control Class			
	Pretest	Posttest	N-Gain	Criteria
Average Value	87	89	0.0	Low
Total Students				29

Normality test table N-Gain for students' collaborative skills above, it can be seen that the average N-Gain of the experiment class is 0.45 which is included in the medium category. While the average score of N-Gain in the control class is 0.02 which is included in the low category

Hypothesis testing

Hypothesis testing is used to answer existing hypotheses. To test the hypothesis using the IBM SPSS version 25 application with the N-Gain Independent Sample T-Test test with a significant level of 0.05. The results of significant values in this study can be seen in table 12.

Table 12. Hypothesis Test Results of Student Cognitive Learning Outcomes and Collaborative Skills

Statistic	Cognitive Learning Outcomes	Collaborative Skill
Sig.	0,000	0,000
N-Gain Independent Sample T-Test	sig < 0.05	sig < 0.05
Conclusion	H0 rejected H1 accepted	H0 rejected H1 accepted

Based on the hypothesis test, it can be seen that the sig obtained in both the cognitive learning outcomes data and students' collaborative skills all shows the value of, which is 0.000<0.05. Thus, it can be concluded that the test results prove that the hypothesis is accepted, meaning that there is an influence of the Project Based Learning on the cognitive learning outcomes and collaborative skills of students on the human excretory system material for class XI MIA at SMA Negeri 2 Pangkep.

Based on the results of descriptive statistical analysis and inferential statistics that have been obtained, it can be seen that the cognitive learning outcomes and collaborative skills of students in the experiment class who are given treatment using the Project Based Learning are better than the learning outcomes and collaborative skills of students in the given control class. Treatment using conventional learning models. This can be seen from the high increase in posttest scores from pretest obtained by students both in the experiment class and in the control class.

The results obtained are in line with the results of research conducted by Apriany (2020) that the acquisition of student learning outcomes in the experiment class with the application of the Project Based Learning is much better than the control class with the application of the conventional model. Furthermore, according to Khanifah (2017) and Indiasmita (2020), based on research that has been conducted, it is stated that students who are treated with the application of the Project Based Learning have high collaborative skills compared to students who are not treated with the Project Based Learning.

The activeness of students in the learning process is one of the factors that causes the high average cognitive learning outcomes and collaborative skills of students in the experiment class compared to the control class. The learning process in the control class, students tend to be less enthusiastic in receiving the material when the conventional model is given, especially the lecture method compared to the experiment class which is applied is the Project Based Learning which makes students more enthusiastic and more active during the learning process (Pasaribu et al., 2020; Rahmawati et al., 2019). According to Sujana et al. (2020) and Panjaitan (2019) that one of the advantages of implementing the Project Based Learning is that students will become more active with a pleasant classroom atmosphere.

The activeness of students in the experiment class occurs because of the implementation of the Project Based Learning directs students to create a project related to the concept being studied. Where before making the project, students are first given a problem related to the material being studied then students look for solutions to the problem in the form of a project that is relevant to the given problem (Effendi. et al., 2019). From this, the learning process that takes place becomes more meaningful and will ultimately affect student learning outcomes (Lubis, 2020; Sahil et al., 2021). The activeness of these students is also evidenced by the results of observations made during learning which shows student activity in the experiment class has an

average percentage value of 84% with a very good category compared to the control class which is only 70%. Then this is also supported by teacher activities where the experiment class obtained an average percentage score of 97% in the good category and the control class with an average percentage of 93% in the good category.

In essence, the Project Based Learning is a learning model that emphasizes student-centered teaching through project assignments. With project activities students will be given the opportunity to work independently by developing their own information and knowledge (Nuraeni, 2019). In this case students are no longer dictated by the teacher regarding the material that must be known, but the students themselves will try to find and get the information needed. So that the implementation of this learning model will make students improve their own knowledge with active and complex student involvement during learning.

According to Sujana et al. (2020) that project work in the application of the Project Based Learning is a form of natural approach taken by teachers and is seen as being able to encourage students to construct their personal knowledge and skills during the learning process. To prove the statement of the proposed hypothesis, it is necessary to do an inferential test. Based on the hypothesis test carried out with the help of the N-Gain Independent Sample T-Test test, the value of $p = 0.000 < 0.005$, which means H1 accepted. Based on these results, it can be concluded that there is an effect of the Project Based Learning has an influence on cognitive learning outcomes and collaborative skills of students on the excretory system material for class XI MIA at SMA Negeri 2 Pangkep. The results obtained are supported by Aisyah's research (2020) with research results showing that student learning outcomes treated with the Project Based Learning in the experiment and control class with traditional learning models showed hypothesis test results $0.000 < 0.005$.

The research that has been carried out is also supported by Rahayu et al. (2019) with the results obtained showing that the collaborative skills of students who are given treatment with the Project Based Learning in the experiment class and control class with the conventional learning model show the results of hypothesis testing $0.000 < 0.005$.

The success of the research carried out, of course, was achieved thanks to the role of good teachers and students during the learning process, where in carrying out this research many obstacles were encountered, especially during the learning process. These obstacles such as the difficulty of students in getting materials for making projects, product completion takes a long time and a small number of students feel they are not suitable to work together in a group. However, this was resolved

and overcome by the researchers by discussing and providing explanations to students as well as providing motivation and guidance so that the learning process can run according to the planned scheme.

Based on the research data obtained and statistical analysis that has been carried out, it can be concluded that the learning process on the excretory system material with the application of the Project Based Learning has a positive influence on the cognitive learning outcomes and collaborative skills of students in class XI MIA at SMA Negeri 2 Pangkep. So that the Project Based Learning can be used as an alternative learning model to be applied in the learning process so that the learning outcomes obtained by students are maximized and also increased collaborative skills in students of class XI MIA at SMA Negeri 2 Pangkep.

Conclusion

Based on the research that has been conducted and the research data that has been analyzed, it can be concluded that: Students' cognitive learning outcomes on the human excretory system concept with the implementation of the Project Based Learning have an average score of 85.1 with learning outcome standard completeness reaching 86.2%. Thus, Students' collaborative skill on the concept of the human excretory system with the implementation of the Project Based Learning have an average percentage value of 76.66% with a strong category. It could be concluded that there is an effect of the Project Based Learning on the cognitive learning outcomes and collaborative skill of students of class XI MIA human excretory system at SMA Negeri 2 Pangkep with the results of hypothesis testing showing the value of sig, $0.000 < 0.05$.

Author Contributions
Slfahmi Mursalim conceptualize the research idea, designed the study, Davis collected the data and performed the experiments under the guidance of Nurdiyanti. Nurdiyanti and Wira Yustika Rukman as a supervision of the project, contributed to the literature review and provided critical feedback on the manuscript. Muhammad Wajdi provided technical support and manuscript editing. All authors participated in the writing and revision of the manuscript.

Conflicts of Interest
The authors declare no conflict of interest.

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