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Transforming learning outcomes: Impact of project-based learning on digestive system mastery

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ABSTRACT

One of the learning models that is currently strongly advised to be used in the learning process is Project Based Learning (PJBL). The purpose of this study is to ascertain how PJBL affects students' learning outcomes in the digestive system. Students (n=61) from Muara Enim, Indonesia's class XI Science public senior high school served as the research subjects. A quasi-experimental design with a non-equivalent control group is the study methodology employed. Project assignments, surveys, and observation sheets served as the tools. The independent sample t-test in the statistical program for social science 28 (SPSS version 28) was used to assess learning outcomes data. With a gain of 33.6 and n-gain of 0.63, the study's findings show that using the PjBL learning paradigm enhances students' learning outcomes. PjBl can increase motivation, and as it uses real-world challenges, strong curiosity will impact learning outcomes.

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INTRODUCTION

Education is one of the indicators of a country's progress. Sudjana (2000) said that the quality of education is determined by two factors, process and product in improving the quality of education, it is necessary to support the quality of educators and increase the efficiency of the learning process. Currently, learning is not only limited to understanding alone, but a learning process that emphasizes student activities to improve the quality of education (Lestari, et al., 2015). Educators who play a role in education need to prepare students to have competence in cognitive, affective, and psychomotor aspects so that they meet graduate competency standards. Educators are required to be able to apply learning strategies that provide direct experience for students because at this time the learning process is not just theories but must have experience so that students can easily remember each material.

Biology is a science that is closely related to life. Studying biology is not just about physical knowledge concepts, facts, and principles, but also about learning about knowledge in the form of ways to obtain information and habits of scientific work (Kadir & Setiawati, 2016). Biology learning emphasizes providing direct experience to develop competence so that students can understand the natural surroundings scientifically. In addition, biology learning focuses on discovery and application, so that it can help students deepen their understanding. Biology is a scientific study that has a high level of difficulty. The object of the study of biology is comprehensive, the aspects studied in living things are anatomy, morphology, and physiology. Michael (2007) states that complex biological material is physiological material. Biological material that demands an understanding of the physiological aspect is the material of the digestive system. physiology is the study of mechanical, physical, and biochemical processes that support body functions (Anwar et al., 2020). Digestive system material is conceptual and factual material (Anwar et al., 2021).

Based on the identification of problems at UPT SMA Negeri 16 Muara Enim, Indonesia one of the biology subject matters that is considered difficult by students is the digestive system material in humans. The digestive system is a complex concept that requires a lot of memorizations and a lot of terms (Bustami et al., 2020; Özsevgeç et al., 2012; Ristanto et al., 2023). In addition, most educators tend to focus only on the teacher method and not use new learning models, lack learning media like PowerPoint or student worksheets, have not integrated technology, and inefficiently use laboratories (Miarsyah et al., 2020; Ningsih et al., 2019; Ristanto et al., 2020). This condition causes students to be less active, less enthusiastic, and less concentrated on the material they are studying delivered by educators. Educators have given assignments in the form of multiple-choice questions and essays to students, but the results are not optimal (Susilowati et al., 2013). The assignments haven't given students the chance to apply what they've learned or maximized their comprehension of the subject matter (Özsevgeç et al., 2012; Ristanto et al., 2023). Learning still revolves around teachers giving students information in the form of knowledge transfer, which forces students to only listen to explanations or accept prefabricated knowledge without questioning how knowledge is acquired (Miarsyah et al., 2020; Ningsih et al., 2019). Because of this, the learning process only goes in one direction, and since pupils are generally passive, there is no feedback. Learning outcomes may be impacted by students' passivity.

The content concerning the digestive system was chosen since it addressed issues connected to digestion. This issue frequently arises in daily life (Bustami et al., 2020; Özsevgeç et al., 2012; Ristanto et al., 2023). By conducting research and observing family members, neighbors, or those who have had digestive illnesses, students can learn about these conditions and how to prevent or treat them (Susilowati, Iswari, & Sukaesih, 2013). Digestive System material demands learning competence at a high level of understanding. But today students are more likely to memorize than understand (Anwar et al., 2020). Most students have a low level of understanding of the organs that function as a place for the digestive process to take place (Prokop, Tuncer, & Chudá, 2007). There are still many students who have difficulty explaining the function of the organs in the digestive system. Digestive system material is a difficult subject because the study of its physiological processes is abstract. Physiological processes related to the digestive process cannot be sensed directly. The difficulties faced by students in many biological concepts ultimately have a negative impact on students' motivation and learning outcomes (Özcan, 2003). This difficulty is a vital problem for student learning activities to immediately find a solution to overcome it (Wood, 2007). The low learning outcomes of Indonesian students demand immediate improvement (Anwar et al., 2020)

The results of the study indicate that many Southeast Asian countries are still fixated on the educator-centered model and rarely use the learner-centered model (Mohd Noor, 2002). Considering these shortcomings, it is necessary to reform the learning model which was originally teacher-centered to become a student-centered model, one of the learning models that can improve student learning outcomes as a whole is the Project Based Learning (PjBL) model, which is a model that guides students have a dominant power in the class so that they become more active, creative, innovative and cooperative. Meanwhile, educators act as facilitators, motivators, supervisors, and evaluators (Jagantara, et al., 2014).

George (2005) project-based learning model syntax starts with essential questions, designing a plan for the project, creating a schedule making a timeline to complete the project deciding the deadline, monitoring the students and progress of the project, assessing the outcome, evaluate the experience (Wiranegara, 2019). The Project Based Learning model has characteristics that in the learning process can be carried out by individuals or ideals by designing projects to create products. This process requires students' skills in collecting data, managing time, and using technology (Tiantong & Sisken, 2013). The Project Based Learning model is a learning model that provides opportunities for contextual learning for students to apply their perceptions in a real atmosphere so that learning outcomes can be more accepted (Magdalena, 2016). Project Based Learning is seen as in line with the objectives of the 2013 curriculum. The project-based learning model is a recommended learning model based on the need for competency development and the characteristics of biological material (Permendikbud Number 22, 2016).

Based on research by the National Training Laboratory (2006), the results show that the PjBL model has the potential to respond to 21st-century educational guidance (Nurohman, 2010). The main objective of the PjBL model is to facilitate learners to acquire 21st-century skills (Condliffe et al., 2017). The Project Based Learning model helps investigations in solving real problems so that learning is more effective (Turgut, 2015) The PjBL model can develop students' knowledge and understanding to improve learning outcomes (Emalfida, Sarong, & Hasanuddin, 2016).

The project-based learning can stimulate motivation, and the learning process and improve learning outcomes through problems in everyday life (Doppelt, 2005). The Project Based Learning model was chosen because this model can increase the involvement of students in complex problems in real life. The PjBL learning model can develop students' knowledge to improve learning outcomes, following the objectives of the 2013 curriculum. The project-based learning (PjBL) model in the era of the Industrial Revolution 4.0 gives birth to agents of change as a valuable national asset and must be prepared to ensure sustainable development (Geacelyn, et al., 2021). The research objective is to find out whether project-based learning can improve student learning outcomes on the material of the digestive system.

METHODS

Research Design

This research is quantitative research using a quasi-experimental method. Quasi-experiments have the characteristics that there is a control group (Sugiyono, 2014). The design of this study used the Nonequivalent control group design in Table 1.

Table 1.
Nonequivalent Control Group Desain

Group	Pre-test	Treatment	Post-test
Experiment (X)	P1	P	P2
Control (Y)	P3	C	P4

Class XI science-1 as an experimental class received treatment through project-based learning, and a sample class XI science-2 as a control class received treatment with the lecture method.

Population and Samples

The population in this study was a public senior high school, in Muara Enim, Indonesia. This study was all students of class XI science public senior high school 16 of Muara Enim, which consisted of two classes, namely class XI science -1 as many as 31 people, XI science -2 as many as 30 people, a

total of 61 people.

Instrument

A pre-test and a post-test were employed as research tools in this investigation. There are thirty multiple-choice questions on the test. A project observation sheet that covered the project's planning, execution, and reporting phases was used to conduct the observations. There are thirty questions with five possible answers on the survey.

Procedure

The research process is divided into three stages: planning, conducting, and concluding. conducting a preliminary study and preparing research to set up project-based learning scenarios. Research implementation. The first step in putting project-based learning into practice is pre-testing. The experimental class is then given treatment or treatment of the project-based learning. After that, a posttest was given. Data processing and analysis, hypothesis testing, conclusion formulation, and findings reporting now constitute the completion of the investigation.

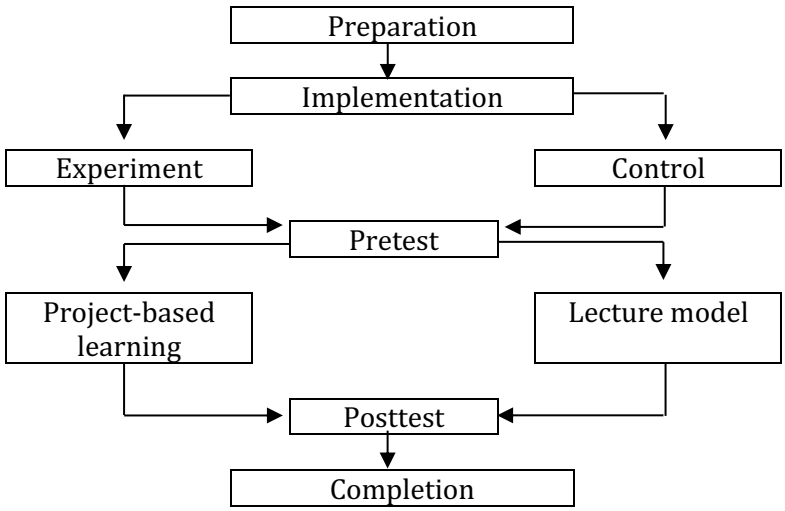

Figure 1. The research procedure

Data Analysis Techniques

1. Analysis of Cognitive Learning Outcomes

   Data Analysis of cognitive learning outcomes test data by looking at pre-test and post-test scores. then perform normality test, homogeneity test, and hypothesis test. If the significance is <0.05 at the 5% significance level, then H_0 is rejected and H_1 is accepted, which means that the application of the PjBL has a significant effect on the learning outcomes of class XI science high school students on the digestive system.
2. Analysis of Psychomotor Learning Outcomes

   Data Analysis of project assessment observation data was seen from the indicators that emerged during the learning process using the PjBL learning model. Observations were made at the planning, implementation, and reporting stages and then the total project value was calculated using the following formula:

$$N = \frac{Preparation + Implementation + Completion}{3}$$

3. Analysis of Learning Implementation

   Analysis of Observational Data The results of observations made to measure the implementation of learning that took place by applying the PjBL were then analyzed. The questionnaire data analysis used a Likert scale technique consisting of two classification statements with five alternative answers.

RESULTS DISCUSSION

1. Cognitive Aspect Learning Outcomes

After doing the research, it was found that the value of the learning outcomes of the cognitive aspects of the students showed a comparison between the experimental class that applied the project based learning model and the control class that applied the lecture method, where the pretest value of the experimental class was lower than the control class while the posttest score was experimental class is higher than the control class. This means that there is an increase in learning outcomes in the experimental class after being treated with the PjBL model. The following is a graph of the pretest and prosthetic values between the experimental class and the control class.

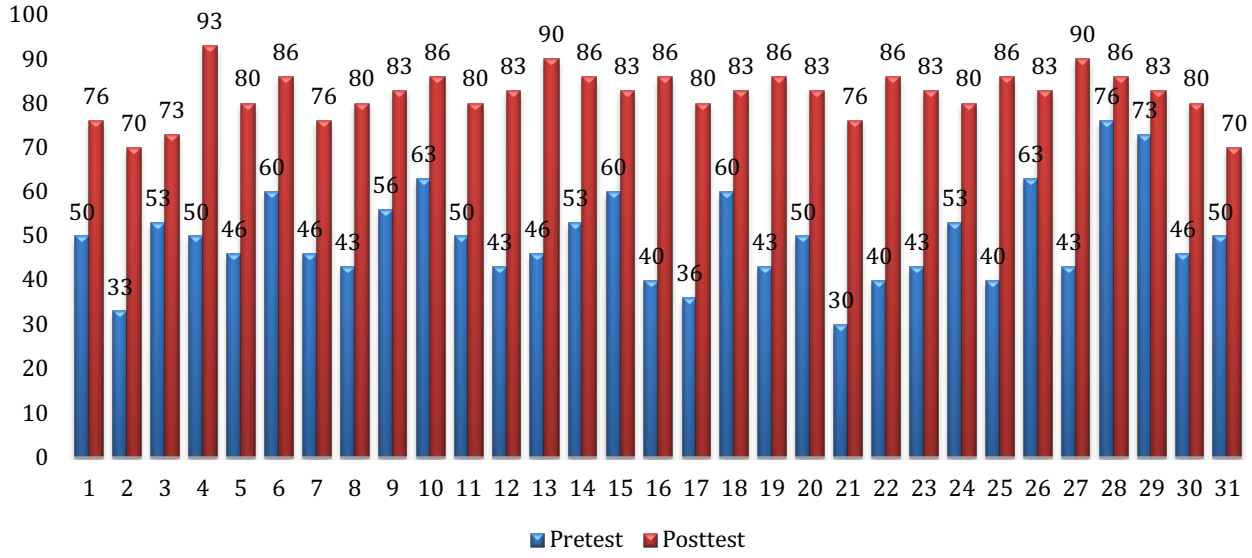

Figure 2. Experiment Class

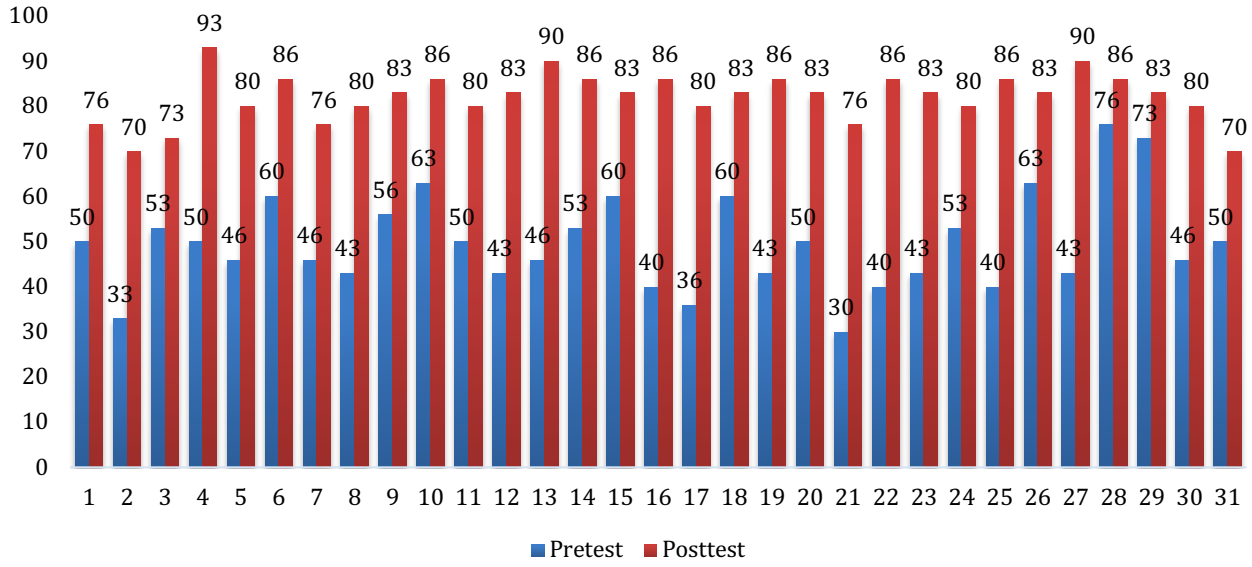

Figure 3. Control Class

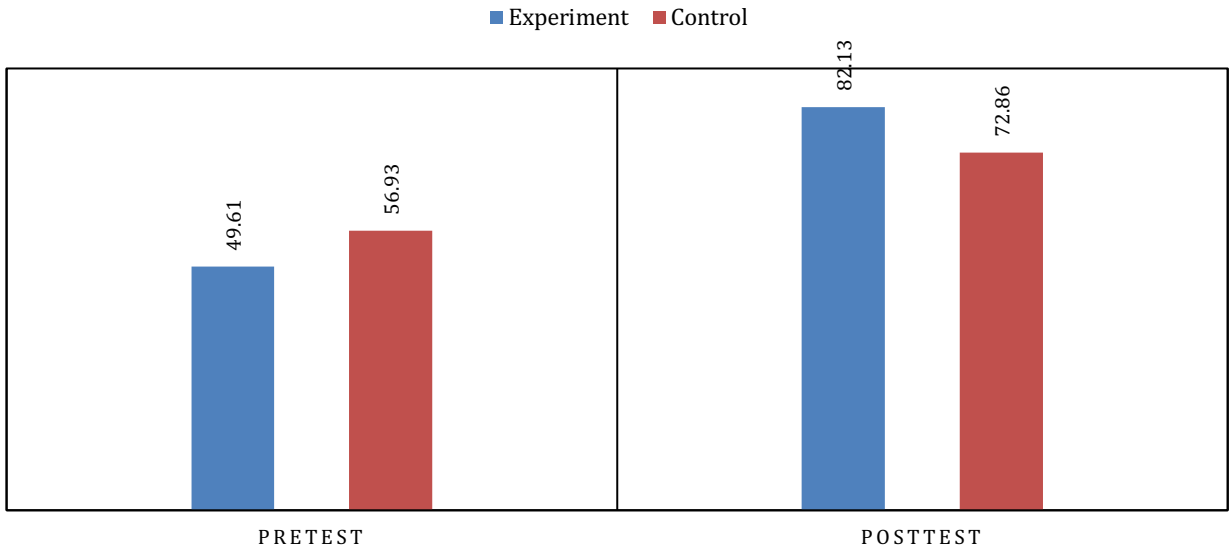

Figure 4. The Comparison

Table 2.a.
Data on student learning outcomes in public senior high school, of Muara Enim, Indonesia.

Class	Pretest	Posttest	Gain	N-gain
Experiment	49.61	82.13	33.6	0.63
Control	56.93	72.86	15.93	0.34

Table 2.b.
Statistic descriptive of pre-test and post-test

Class	Category	Pre-test		Post-test	
		Total	%	Total	%
Control	Very high	0.00	0.00	7.00	23,33
	High	7.00	23,33	20.00	66,66
	Medium	8.00	26,66	3.00	10.00
	Low	12.00	40.00	0.00	0.00
	Very low	3.00	10.00	0.00	0.00
Experiment	Very high	0.00	0.00	24.00	77,41
	High	2.00	6,45	6.00	19,35
	Medium	6.00	19,35	1.00	3,22
	Low	11.00	35,48	0.00	0.00
	Very low	12.00	38,70	0.00	0.00

In the experimental class, the difference between the posttest value and the pretest value is indicated by the gain value obtained by 33.6 with an n-gain index of 0.63. In the control class, the gain value is 15.93 with an n-gain index is 0.34. Based on the analysis of learning outcomes data through the normality test, the data in the experimental and control classes are normally distributed. The results of the homogeneity test that the variance of the experimental class pretest data and the control pretest data is homogeneous. The results of the application of project-based learning have a significant effect on student learning outcomes in biology lessons on the digestive system.

2. Psychomotor Aspect Learning Outcomes

Data applying project-based learning shows that students are actively involved in the learning process starting from the planning stage, implementation stage, and assessment stage. The following is the average value of student learning outcomes in psychomotor aspects related to skills in working on projects to design 3-dimensional models of the digestive system and herbal drink products for digestive disorders.

Table 3.
Project value 1 Digestive System Model 3D

Group	Project Value			
	Planning	implementation	Reporting	Average
1	75.00	90.00	70.00	78.30
2	85.00	95.00	85.00	88.30
3	75.00	85.00	80.00	80.00
4	80.00	75.00	75.00	76.70
5	90.00	95.00	85.00	90.00

Table 4.
Project value 2 Herbal Drink for Indigestion

Group	Project Value			
	Planning	implementation	Reporting	Average
1	85.00	80.00	75.00	80.00
2	85.00	85.00	80.00	83.30
3	80.00	85.00	80.00	81.70
4	85.00	75.00	75.00	78.30
5	85.00	80.00	90.00	85.00

Table 5.
Average Project Value

Group	Average project value 1 & 2			
	Planning	Implementation	Reporting	Average
1	80.00	85.00	72.50	79.20
2	85.00	87.50	82.50	85.00
3	77.50	85.00	80.00	80.80
4	82.50	75.00	75.00	77.50
5	87.50	82.50	87.50	87.50

3. Questionnaire

This questionnaire was intended for 30 experimental class students who received the Project Based Learning (PjBL) learning model treatment at UPT SMA Negeri 16 Muara Enim. The following is a diagram of the results of student responses to learning using the Project Based Learning model.

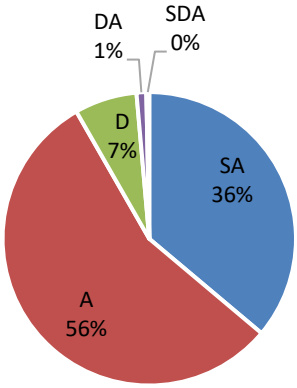

Figure 5. The questioner results

The diagram shows that students have responded well to learning biology by applying the project-based learning model. students who strongly agree with the percentage of 36% and the percentage agree 56%.

4. Observation

The results of the observations show that the implementation of the project-based learning model has been carried out well. The following is a graph of the implementation of the PjBL model based on the assessment of educators at UPT SMA Negeri 16 Muara Enim.

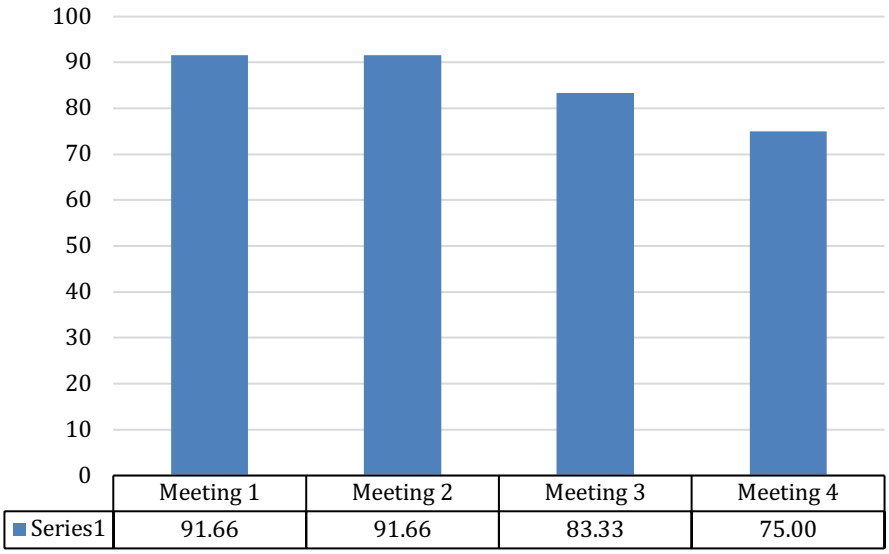

Figure 6. The Observation Result

The graph shows that at the 1st & 2nd meeting the percentage shows 91.66%, which means learning by applying the PjBL model has been carried out very well. At meeting 3 with a percentage of 83.33% and meeting 4 with a percentage of 75%

Before carrying out the learning process, a pretest or initial test is carried out first to find out to what extent the subject matter to be taught has been mastered by students (Sudijono, 2015). Then the learning process was carried out for four meetings and after the last meeting a posttest or final test was carried out to see a comparison of students after being given learning using a project-based learning model. Student learning outcomes after being given learning using the project-based learning (PjBL) model showed an increase.

Based on the results of the analysis, the students' posttest scores increased when compared to the pretest and obtained an average gain of 33.6 and an n-gain of 0.63 in the medium category. Based on the results of the t-test analysis, a significance value of 0.001 < 0.05 indicates that learning using the project-based learning (PjBL) model has a significant effect on student learning outcomes on the digestive system material in class XI IPA 1 at UPT SMA Negeri 16 Muara Enim.

This proves that learning using a project-based learning (PjBL) model can improve student learning outcomes on the material of the digestive system. with the implementation of the Project Based Learning model able to guide students in understanding concepts, improve memory, increase curiosity, stimulate learning motivation, increase the efficiency of the learning process, increase student involvement, learning becomes more meaningful, students can integrate knowledge into experience. With project-based learning, students become more active, creative, innovative and cooperative and train students to interact, communicate, collaborate, participate and contribute starting from the stages of understanding problems, make decisions, research, presentation, and compiling reports (Panasan & Nuangchalerm, 2021).

These things are believed to provide experience directly to students. This is in accordance with the theory Jerome Brunner that learning is an active process in which students construct new knowledge based on experience. And in accordance with constructivism learning theory which states that efforts to build understanding or perception are based on the experiences experienced by students (Aqib, 2013). Project Based Learning (PjBL) provides students with opportunities to learn according to real life, which leads to continuous or permanent knowledge (Gülbahar & Tinmaz, 2006;Kaushik, 2020).

The PjBL model can stimulate motivation, and high curiosity will thus affect learning outcomes because it uses problems related to everyday life (Doppelt, 2005; Guo et al., 2020)). Project Based

Learning model is able to improve student learning outcomes. There is a significant difference between the control class and the experimental class. The posttest value of the experimental class was higher than the value of the control class. (Çakici & Turkem, 2013). Project Based Learning has been proven to support learning to be more effective than the lecture method. Several studies and studies in schools have concluded that the application of the PjBL model has a positive effect on learning outcomes (Condliffe et al., 2017; Turgut, 2008)). Currently, the base learning project is one of the models that is highly recommended for the learning process. Through PJBL students can learn to solve problems and be creative with the projects they create. The constructed framework of key characteristics can be useful in promoting research-based implementation and design of project-based learning science education and in teacher training related to it. (Markula & Aksela, 2022; Tsybulsky & Muchnik-Rozanov, 2019).Teachers should use PJBL, because it's can increase activity, and motivation and subsequently have an impact on student learning outcomes. In Project Based Learning teachers are often having to act simultaneously as designers, champions, facilitators, and managers, and students are expected to be self-directed learners who can endure the ambiguity and open-endedness of PBL projects (Novak & Krajcik, 2019; Pan et al., 2020; Viro et al., 2020)

CONCLUSION

The application of the Project-based learning model has a significant effect on student learning outcomes in digestive system material. There is a difference in learning outcomes between the experimental class and the control class, student learning outcomes in the experimental class were higher than the control class. PJBL provides a learning experience that allows students to learn about problems and how to solve them by explaining them through the projects they create. Students' direct involvement in designing and producing products has activated students so that students are enthusiastic to learn more about the learning material presented. Activities that are designed and made by themself have activated students' long-term memory so that students remember and understand lessons longer.

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