THE EFFECT OF PROJECT BASED LEARNING ON STUDENTS' LEARNING OUTCOMES IN THE RESPIRATORY SYSTEM MATERIAL OF GRADE XI SMA N 1 RANTAU UTARA

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ABSTRAK

This study aims to analyze the effect of the Project-Based Learning (PjBL) model on student learning outcomes in the respiratory system material in class XI of SMA N 1 Rantau Utara. The research method used is quantitative with a quasi-experimental design, using a pretest-posttest control group design. The research sample consisted of two classes selected using a purposive sampling technique, namely one class as an experimental group using the PjBL model and one class as a control group using conventional learning methods. Learning outcome data were obtained through pretest and posttest, then analyzed using normality tests, homogeneity tests, and t-tests to determine differences in learning outcomes between the two groups. The results showed that before being given treatment, there was no significant difference between the pretest scores of the two groups, with an average pretest score of the experimental group of 65.12 and the control group of 64.85. However, after being given treatment, the average posttest score of the experimental group increased to 85.76, while the control group obtained an average of 78.43. These findings indicate that the PjBL model contributes positively to improving student learning outcomes. In addition, the observation results showed that students in the experimental group were more active in discussing and completing projects, which showed an increase in critical and collaborative thinking skills. Based on the results of this study, it is suggested that the PjBL model can be applied in learning, especially on materials that require in-depth understanding and development of critical thinking skills.

Keywords: Project-Based Learning (PjBL), learning outcomes, respiratory system, project-based learning, quasi-experimental.

INTRODUCTION

Education plays a central role in improving the quality of human resources (HR), which in turn contributes to the economic progress of a country. According to research by Kardina and Magriasti (2023), quality education can increase workforce productivity and encourage innovation, which are essential for inclusive and sustainable economic growth. In addition, Siregar et al. (2024) emphasized that in the era of digitalization towards Smart Society 5.0, education has an important role in shaping individuals into intelligent and adaptive HR to technological developments. Thus, the success of the education system can be seen from student

learning outcomes that reflect the understanding and mastery of the material taught, which ultimately contributes to improving the overall quality of HR. In the learning process, innovative strategies are needed so that students can be more active, creative, and able to think critically. One learning approach that is in accordance with the demands of the modern era is the project-based learning model or Project-Based Learning (PjBL).

Project Based Learning (PjBL) is a learning model that emphasizes the active involvement of students in solving real problems through systematically designed projects. According to research by Firdos, Rokhmaniyah, and Ngatman (2025), the application of PjBL with flipchart media can improve students' social skills in learning Social Sciences (IPAS), because students are faced with real situations that require them to work together and communicate effectively in completing projects. Project Based Learning (PjBL) is a learning model that emphasizes the active involvement of students in solving real problems through systematically designed projects.

According to research by Sihombing and Susilowaty (2023), PjBL is effective in improving students' mathematical abilities, because students are faced with real situations that require them to think critically and creatively in solving problems. In this context, students not only act as recipients of information, but also as researchers who actively seek solutions to the problems they face. This is in line with the findings of research by Darmuki et al. (2023), which shows that PjBL can improve students' critical thinking skills through project activities that involve collaboration and application of concepts that have been learned. Thus, PjBL not only focuses on achieving cognitive learning outcomes, but also on developing 21st-century skills, such as creativity, collaboration, and communication, which are very important in facing challenges in this digital era. Through this approach, students are expected to be able to construct their own knowledge, improve critical thinking skills, and develop creativity and collaboration skills that are very much needed in the 21st century (Hidayat, 2020).

In Biology learning, especially in the human respiratory system material, understanding the concept is very important because it is directly related to everyday life. This material is not only theoretical, but also has many applications in real life, such as understanding the mechanism of respiration, the impact of air pollution on the respiratory system, and diseases related to the respiratory organs. According to research by Aulia, Ramdani, and Sedijani (2023), learning the human respiratory system based on practicum can improve students' science process skills,

because students are faced with real situations that require them to think critically and creatively in solving problems. In addition, air pollution is a serious threat to the health of the human respiratory system. Exposure to air pollutants such as NO_2 and SO_2 can cause respiratory disorders, including acute respiratory infections (ARI). Thus, a deep understanding of the human respiratory system is essential to raise awareness of the importance of maintaining air quality and respiratory health.

Based on an interview with a biology teacher with the initials HD at SMA N 1 Rantau Utara, it was stated that students' understanding of this material is still relatively low, as seen from the exam results which show that many students have difficulty in understanding basic concepts about the respiratory system. One of the factors suspected of causing low student learning outcomes is the learning method which is still dominated by lectures and assignments without active student involvement in the learning process. According to research by Mahasiswa and Yulia (2022), the use of the lecture method predominantly can significantly affect student learning outcomes. The monotonous and less interactive lecture method can cause students to become passive and less motivated in participating in learning. In this context, it is important for educators to adopt a more interactive and student-centered learning approach, such as group discussions, project-based learning, and the use of educational technology, in order to increase student engagement and their learning outcomes. This conventional method provides less opportunity for students to explore concepts independently and collaborate with peers in understanding the material. Therefore, innovation is needed in more interactive and student-centered learning methods.

The application of project-based learning models (Project Based Learning/PjBL) is believed to be a solution to improve students' understanding of the human respiratory system material. By implementing PjBL, students are given the opportunity to explore the material in depth through challenging projects that are relevant to real life. According to research by Rika, Mustamiroh, and Haerani (2023), the application of PjBL to the human respiratory system material can significantly improve student learning outcomes. In addition, the use of teaching aids such as SIPERNA (Human Respiratory System) in the PjBL model is also effective in increasing student creativity. Research by Pratiwi and Syofyan (2023) shows that the application of the PjBL model assisted by SIPERNA teaching aids can increase the creativity of fifth grade students of SDN 01 Punten Batu. Thus, the application of the PjBL model in learning the human

respiratory system not only improves conceptual understanding but also develops 21st century skills such as creativity and problem solving.

In this context, students not only memorize concepts but also understand the application of theories in real situations, so that learning becomes more meaningful. In addition, the PjBL model is also able to increase students' learning motivation because they feel responsible for the projects they work on (Wahyuni, 2021). High motivation will have a positive impact on learning outcomes because students are more interested and actively involved in learning. Thus, PjBL not only contributes to the cognitive aspect but also to the affective and psychomotor aspects. Several previous studies have shown that the PjBL model has a positive impact on student learning outcomes. For example, research conducted by Rahmawati (2020) stated that the application of PjBL can improve student learning outcomes in Biology subjects, especially in understanding complex concepts such as the human respiratory system.

However, the implementation of PjBL in learning is not free from various challenges. One of the main challenges is the readiness of teachers to implement this model effectively in the classroom. Teachers must be able to design interesting projects, adjust to student needs, and ensure that each student plays an active role in the learning process. In addition, limited time and resources are also factors that need to be considered in the implementation of PjBL in schools. Based on this background, this study aims to analyze the effect of the implementation of the Project-Based Learning model on student learning outcomes in the respiratory system material in class XI of SMA N 1 Rantau Utara. This study is expected to contribute to the development of more effective and innovative learning strategies in improving student learning outcomes. The results of this study are expected to provide benefits for various parties, especially for educators in designing more interesting and interactive learning. In addition, for students, this study is expected to help them understand the concept of the respiratory system better and improve critical and collaborative thinking skills. For schools, the results of this study can be the basis for formulating more innovative learning policies that are in accordance with student needs.

The focus of this study is to measure how much influence the PjBL model has on student learning outcomes in understanding the respiratory system material. This study will use a quantitative approach with an experimental method, where students will be divided into two groups, namely the experimental group using the PjBL model and the control group using conventional learning methods. Student learning outcomes will be measured through tests before

and after the application of the learning model to see the differences significantly. With this study, it is expected to provide new insights into the effectiveness of the PjBL model in improving student learning outcomes, especially in Biology subjects. In addition, this study can also be a reference for further researchers who want to explore further the use of PjBL in learning. In conclusion, the application of the Project-Based Learning model in Biology learning on the respiratory system material has great potential in improving student learning outcomes. With a project-based approach, students can understand the concept more deeply, improve critical thinking skills, and develop a sense of responsibility and collaboration in learning. Therefore, this study is important to determine the extent to which the PjBL model can have a significant influence on student learning outcomes at SMA N 1 Rantau Utara.

RESEARCH METHODS

This study applies a quantitative approach with a quasi-experimental method. According to Katsirin (2024), quantitative research is a systematic approach used to test hypotheses by analyzing relationships between variables through statistical techniques. This approach allows researchers to measure and analyze numerical data to identify significant patterns and relationships between the variables studied.

In this study, a quantitative approach was chosen because it allows objective measurement of the influence of independent variables on dependent variables. In addition, quasi-experimental methods are often used in education when researchers cannot fully control all variables that have the potential to affect student learning outcomes (Sukmadinata, 2020). The research design used was a pretest-posttest control group design, in which there were two groups of research subjects, namely the experimental group and the control group. The experimental group was given treatment using the Project-Based Learning (PjBL) learning model, while the control group continued to use conventional learning methods.

With the pretest before treatment and posttest after treatment, this study can measure how much influence the PjBL model has on improving student learning outcomes. The PjBL model was chosen as the treatment in this study because this approach encourages students to be more active in understanding concepts through completing real projects. PjBL is a learning model that emphasizes the active involvement of students in working on projects that are in accordance with

the real world, so that they not only understand concepts theoretically, but also develop critical thinking and problem-solving skills. Thus, this study aims to reveal whether the application of the PjBL model can have a significant impact on student learning outcomes compared to traditional learning methods that are more teacher-centered.

The population in this study were all students of class XI of SMA N 1 Rantau Utara. Sampling was carried out using a purposive sampling technique, namely by selecting classes that have characteristics in accordance with the objectives of the study. In this case, two classes were selected as research samples, where one class was designated as the experimental group and the other class as the control group. Specifically, class XI MIPA 2 was designated as the control group that underwent learning with conventional methods, while class XI MIPA 3 was designated as the experimental group that received learning with the Project-Based Learning (PjBL) model.

The instruments used in this study consisted of several measurement tools designed to collect valid and reliable data. One of the main instruments is a multiple-choice learning outcome test. This test is used to measure students' understanding of the respiratory system material before and after the implementation of the Project-Based Learning (PjBL) model. To ensure its validity and reliability, the questions in this test have gone through a validation test process by experts, so that each question can measure students' cognitive aspects accurately.

This research was conducted through several systematic stages to ensure the validity of the data obtained. The first stage is preparation, which includes the preparation of Project-Based Learning (PjBL)-based learning devices, including the Learning Implementation Plan (RPP), research instruments such as learning outcome tests, questionnaires, and observation sheets. In addition, the instruments that have been prepared are tested for validity and reliability before being used in the study. The next stage is implementation, where learning takes place according to the research design. The experimental class received learning with the PjBL model that emphasizes project completion as the main part of the learning process, while the control class continued to use conventional learning methods.

This learning is carried out in several meetings that have been adjusted to the syllabus. At the data collection stage, an initial test (pretest) is carried out before the treatment is given to measure students' initial understanding, and a final test (posttest) after the treatment is given to assess changes in learning outcomes. In addition, observations are made to see the level of

student involvement during the learning process, and questionnaires are distributed to determine students' responses to the PjBL model. After the data is collected, the final stage is data analysis, which is carried out using various statistical techniques. Before the main analysis is carried out, normality and homogeneity tests are applied as prerequisites to ensure that the data meets the required statistical assumptions. After that, the t-test is used to determine the difference in learning outcomes between the experimental group and the control group. The entire analysis process is carried out with the help of statistical software to ensure more accurate and objective results.

RESULTS AND DISCUSSION

This study aims to analyze the effect of the Project-Based Learning (PjBL) model on student learning outcomes in the respiratory system material in class XI of SMA N 1 Rantau Utara. Data collected through pretest and posttest were analyzed using statistical tests to see the differences in learning outcomes between the experimental group and the control group can be seen in Table 1 below.

Tabel 1. Rata-rata Nilai Pretest dan Posttest Kelompok Eksperimen dan Kontrol

Group	Pretest (Average)	Posttest (Average)	Description
Experiment	65,2	85,76	There was a significant increase after treatment (a certain Learning Model)
Control	64,8	78,43	The increase occurred, but not as large as the experimental group

Based on Table 1. Shows the results of the analysis that the average pretest score of the experimental group was 65.2, while the control group obtained an average score of 64.8. Statistical tests showed that there was no significant difference between the two groups before the treatment was given ($p > 0.05$), so it can be concluded that students' initial understanding was relatively balanced. After the treatment was given, a posttest was conducted to determine the increase in learning outcomes. The results of the analysis showed that the average posttest score of the experimental group increased to 85.76, while the control group only reached 78.43

The t-test showed that there was a significant difference between the two groups after the implementation of the Project-Based Learning model ($p < 0.05$). The increase in value from pretest to posttest in the experimental group was greater than that of the control group, indicating that the PjBL model had a positive effect on student learning outcomes. This confirms that project-based learning can improve students' conceptual understanding through more active and in-depth learning experiences. The normality test in this study was conducted to determine whether the learning outcome data were normally distributed. The test used the Kolmogorov-Smirnov test with a significance level (α) of 0.05. The results of the normality test showed that the experimental group had a significance value of 0.087, while the control group had a significance value of 0.094. Because both p-values are greater than 0.05 ($p > 0.05$), it can be concluded that the learning outcome data in both groups were normally distributed. The homogeneity test was conducted to ensure that the variances of the two groups were the same. The test used the Levene test with a significance level (α) of 0.05. The results of the homogeneity test show that the significance value of Levene's Test is 0.126, which is greater than 0.05 ($p > 0.05$).

This shows that the variance of both groups is homogeneous, so the assumption for conducting the t-test has been met. The results of this study indicate that the application of the Project-Based Learning (PjBL) model can significantly improve student learning outcomes. This finding is in line with previous studies which state that PjBL encourages students to be more active in the learning process, improves conceptual understanding, and develops critical thinking and problem-solving skills. In the PjBL model, students are given the freedom to explore concepts in depth through projects that are relevant to the material being studied, thus allowing learning to be more meaningful.

In this study, the experimental group that learned using the PjBL model showed a higher increase in learning outcomes compared to the control group that used conventional learning methods. This shows that students' active involvement in project-based learning has a positive impact on their understanding of the respiratory system material. In addition, based on the results of observations during the learning process, students in the experimental group looked more enthusiastic and active in discussing and completing the given project tasks. This shows that PjBL not only improves cognitive learning outcomes but also contributes to improving students' social and collaborative skills. Therefore, it is recommended that teachers can adopt this model

in science learning, especially for concepts that are complex and require deep understanding. The implementation of PjBL that is planned and in accordance with student needs can provide optimal benefits in improving the quality of learning in the classroom.

CONCLUSION AND SUGGESTIONS

Based on the results of the research that has been conducted, it can be concluded that the Project-Based Learning (PjBL) learning model has a significant influence on student learning outcomes in the respiratory system material in class XI of SMA N 1 Rantau Utara. The results of the analysis showed that the posttest scores of students who learned using the PjBL model were higher than those of students who learned using conventional methods. This shows that project-based learning is able to improve students' understanding of concepts, critical thinking skills, and learning motivation. In addition, based on the results of observations during the learning process, students in the experimental group were seen to be more active in discussing, exploring materials, and completing project assignments independently and in groups. The PjBL model not only contributes to improving cognitive learning outcomes, but is also able to develop students' social and collaborative skills.

Therefore, this model can be an alternative effective learning strategy in improving the quality of learning in the classroom. Based on the findings of this study, there are several suggestions that can be considered. First, teachers are advised to integrate the PjBL model in science learning, especially in materials that are complex and require in-depth understanding. Careful planning in compiling projects that are in accordance with the level of student understanding is needed so that this model can run optimally. Second, schools are expected to provide support for the implementation of the PjBL model, such as providing adequate learning facilities and providing training to teachers to implement project-based learning effectively. Third, for further research, it is recommended to explore the application of PjBL to other materials, in a longer period of time, and consider other factors, such as parental involvement or the use of technology in learning projects. With proper implementation and adequate support, the PjBL model can be an effective learning strategy in improving students' understanding and overall learning outcomes.

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