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Effectiveness of Project-Based Learning Model With Physics Glossary Application Media On Science Learning Outcomes on Solar System Material on Students

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Abstract
This study aims to measure the effectiveness of the project-based learning model with the application of physics glossary media on student learning outcomes in the Solar System material in class VII MTs Al Uswah Bergas. This study uses a quantitative method with a quasi-experimental Control-Group Pretest-Posttest design. The research sample consisted of 32 students of class VII F as the experimental group and 32 students of class VII E as the control group, selected using purposive sampling techniques. Data analysis was carried out using the independent t-test to compare the pretest and posttest results of the two groups. The results showed a significant increase in the experimental group compared to the control group, with a higher average posttest score. The novelty of this study lies in the integration of the project-based learning model with the application of physics glossary, which provides an innovative and effective approach to improving science learning outcomes. These findings provide an important contribution to the development of technology-based learning methods in the digital era.

Keywords: Learning models; Physics; Technology

INTRODUCTION

Education is one of the main factors in producing an intelligent and highly competitive generation. In the learning process, the approach and model used by educators are crucial elements in improving student learning outcomes (Asrial et al., 2024; Syahputra et al., 2024; Tschisgale et al., 2023). One of the challenges in science learning, especially in the Solar System material, is how to present abstract concepts in an exciting and easily understood way by students (Dengel et al., 2022; Ho et al., 2023; Rizaldi et al., 2020). In this context, innovation in relevant learning media is a must.

The project-based learning model has been known as one of the effective methods for developing students' critical thinking and collaboration skills (Abulibdeh et al., 2024; Loudon, 2019; Virtanen & Tynjälä, 2019). This model invites students to learn actively through projects that are relevant to their lives (Hamzah et al., 2021; Prior, 2020; Souad & Korti, 2018). In science learning, the project-based approach provides students with the opportunity to explore the material through direct experience and problem-solving, thereby strengthening their conceptual understanding (Awwaliyah et al., 2021; Mailizar et al., 2020; Rizaldi et al., 2020).

In today's digital era, information technology plays a vital role in supporting the learning process. Digital media, such as interactive applications, have the potential to increase the appeal and effectiveness of learning (Budiarto et al., 2024; Rachmawati & Asmara, 2018; Susanto et al., 2024). The physics glossary application as a supporting media can make it easier for students to understand scientific terms that are often obstacles in science learning (Maison et al., 2022; Meulenbroeks et al., 2024; Taslidere, 2016). This application can strengthen the project-based learning model by providing relevant information quickly and easily accessed.

MTs Al Uswah Bergas is one of the educational institutions that pays great attention to learning innovation. However, the results of initial observations showed that grade VII students still need help understanding the Solar System material. One of the causes is the limited availability of exciting and interactive learning media. Therefore, the application of a project-based learning model combined with a physics glossary application media is expected to improve student learning outcomes in this material (Hamdani & Yohandri, 2020; Snyder & Snyder, 2008; Wayan Santyasa et al., 2021).

Previous studies have shown that project-based learning models have a positive impact on student learning outcomes in various subjects. For example, research by Fitchett & Heafner (2018) found that project-based learning can improve student learning outcomes by up to 30% in science subjects. In addition, research by Jingjit (2015) stated that the use of digital media, including learning applications, can increase student learning motivation. However, research that integrates project-based learning models with physics glossary applications on Solar System material still needs to be completed.

The uniqueness (novelty) of this study lies in the integration of project-based learning models with physics glossary application media in science learning. This combination is designed to provide a more interactive, engaging, and contextual learning experience for students. In addition, this study also focuses on the development of 21st-century skills, such as critical thinking, collaboration, and digital literacy, which are relevant to the needs of today's education world (Agbi & Yuangsoi, 2022; Nahar et al., 2022).

This study is expected to provide a significant contribution to the development of innovative technology-based learning strategies. The results of this study can also be a reference for educators and other educational institutions in improving the quality of science learning. Thus, the application of a project-based learning model supported by a physics glossary application media can be one solution to overcoming the challenges of science learning, especially in the Solar System material.

RESEARCH METHODS

Research Design

This study uses a quantitative approach with a quasi-experimental method. Experimental research is a research method used to test cause-and-effect relationships (causality) between variables, similar to experiments, but without randomization in grouping research subjects (Wela et al., 2020; Wulandari, 2020). The research design applied is a Control-Group Pretest-Posttest. In this design, there are two groups consisting of an experimental group and a control group. The experimental group received treatment in the form of project-based learning with physics glossary application media, while the control group used conventional learning methods. Tests were conducted before (pretest) and after (posttest) treatment in both groups to determine the effectiveness of the treatment given.

Research Target/Subject

A research population is a group of individuals, objects, or entities that have certain characteristics and are the main target of a study (Asrulla et al., 2023). The population in this study were all students of class VII MTs Al Uswah Bergas in the second semester. The total number of class VII students in this school is 221 students, divided into six classes, namely classes VII A to VII F. The research sample was taken using a purposive sampling technique, considering the homogeneity of students' initial abilities based

on the previous average daily science scores. The research samples obtained can be seen in the following table:

Table 1. Distribution of research samples

No	Class	Group	Number of students
1	VII F	Experimental group	32
2	VII E	Control group	32

Research Procedure

The research procedure can be seen in Figure 1 below.

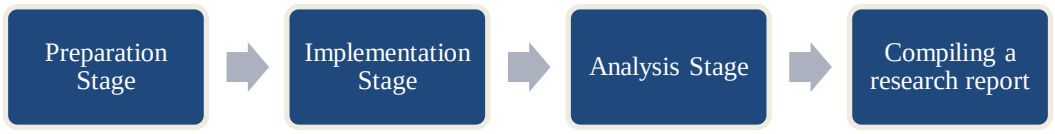

Figure 1. Research procedure

Instruments, and Data Collection Techniques

The research instrument used was a science learning outcome test consisting of 25 multiple-choice questions. This instrument has been tested for validity and reliability before being used. The test was given to students at the pretest stage to measure initial abilities and post-test to determine learning outcomes after treatment was given. In addition, observation sheets were used to monitor the implementation of project-based learning.

Data analysis technique

The data obtained were analyzed using an independent t-test statistical test to compare the pretest and posttest scores between the experimental group and the control group. The analysis process includes: Calculating the mean value and standard deviation of the pretest and posttest of each group. Before conducting an independent t-test statistical test, an assumption test is first carried out. An assumption test is a step in data analysis to ensure that the data meets certain requirements or assumptions required to use a particular statistical method (Alita et al., 2021). Assumption tests are carried out to increase the validity and reliability of research results. Testing for normality and homogeneity of data is an assumption test for statistical testing. The use of an independent t-test to test the significance of differences in learning outcomes between the experimental group and the control group.

RESULTS AND DISCUSSION

The results of the research that have been obtained are first analyzed by the assumption test. The results of the normality assumption test can be seen in table 2 below:

Table 2. results of the normality test

Group	Class	Signifikansi (p-value)	Distribusion
Experimental	Pretest	0,200	Normal
	Posttest	0,150	Normal
Control	Pretest	0,082	Normal
	Posttest	0,093	Normal

Based on table 2, the results of the normality test in the experimental group of the pretest class with a sig. of 0.200, the normality test of the experimental group of the posttest class was 0.150, the normality test of the control group in the pretest class was 0.082, the normality test of the control group of the posttest

class was 0.93. From the results of the normality test that has been carried out, it can be concluded that the data is normally distributed because the sig. value obtained is > 0.05.

After obtaining the results of the normality test, the homogeneity assumption test is continued, which is presented in table 3 below.

Table 3. homogeneity test results

Class	Signifikansi (p-value)	Distribusi
Pretest	0,250	Homogenitas
Posttest	0,138	homogenits

Based on table 3, the results of the homogeneity test that have been carried out obtained results in the pretest class of 0.250 and in the posttest class of 0.138 so it is concluded that the data is distributed homogenously because the significance value is> 0.05.

After the normality and homogeneity assumption tests are met, the data can be analyzed using the t-test hypothesis as seen in table 4 below.

Table 4. Independent t-test results

Learning Outcome		Mean	df	t-count	t-table	Sig. (2-tailed)
Posttest	Control	67,3548	61	6,356	1,670	0,000
	Experiment	80,8750				

The table above shows that the significance value is 0.000, which means that there is a significant difference between learning outcomes in class 100 control or class E and class F Experiment. Test criteria, if tcount> ttable or -tcount <-table and P value (sig) <0.05 then Ho is rejected and Ha is accepted. The t-test table shows the posttest learning outcomes of students as follows: large tcount (6.356)> table (1.670) and P value (sig) (0.000) <0.05. It is proven that the use of physics glossary application media in the project-based learning model is effective on science learning outcomes in the solar system material for class VII students of MTs Al Uswah.

The results of the study showed that the application of the project-based learning model with the physics glossary application media had a significant effect on student learning outcomes in the Solar System material. Based on the results of the pretest and posttest, there was a higher increase in the experimental group compared to the control group. This shows that the use of the project-based learning model can increase student involvement in the learning process. At the same time, the physics glossary application helps students understand complex physics concepts more effectively.

The increase in learning outcomes in the experimental group shows that project-based learning encourages students to be more active in exploring the material independently or in groups (Resch et al., 2022). This method provides space for students to develop critical thinking and collaboration skills. Meanwhile, the physics glossary application acts as a supporting medium that helps students access information quickly and easily (Szymkowiak et al., 2021). This combination makes learning more exciting and relevant to the needs of students in the digital era.

In this study, statistical tests showed that the post-test results of the experimental group had a higher average than the control group. The results of the normality and homogeneity tests of the data support the conclusion that the data obtained meets the statistical assumptions for the t-test. The t-test proved that there was a significant difference between the learning outcomes of the two groups, which confirmed that the treatment in the form of project-based learning with physics glossary application media was effective in improving student learning outcomes.

This study supports the findings of previous studies. (Juuti et al., 2021) found that the project-based learning model can significantly improve learning outcomes because it involves students in meaningful learning activities. showed that digital media, including learning applications, contribute to increasing student learning motivation. However, this study is unique because it integrates both approaches

simultaneously, providing results that are more focused on the Solar System material and relevance to the context of science learning at the MTs level.

The novelty of this study lies in the integration between the project-based learning model and the physics glossary application media. This approach not only improves students' understanding of abstract physics concepts but also introduces them to the use of technology in learning. This study contributes to the development of innovative technology-based learning models, thus providing new alternatives for educators in delivering science subject matter effectively and interestingly (Hamzah et al., 2021).

The implications of this study are vast, especially in the development of technology-based curricula at the secondary school level. Educators can use the results of this study as a basis for designing more creative and contextual learning methods. By adopting a similar approach, schools can improve student learning outcomes while preparing them for the challenges of education in the digital age. In addition, this study also provides a foundation for developing similar applications in other subjects.

CONCLUSION

This study concludes that the project-based learning model with the application of physics glossary media is effective in improving student learning outcomes in the Solar System material in class VII MTs Al Uswah Bergas. The results of data analysis showed a significant increase in the posttest scores of the experimental group compared to the control group. The project-based learning model encourages active student involvement in the learning process, while the application of the physics glossary helps students understand abstract concepts more easily. The uniqueness of this study lies in the integration of the project-based approach and digital media, which has not been widely applied in science learning at the MTs level. The implications of this study provide a new direction in the development of innovative technology-based learning methods, as well as encouraging educators to utilize digital media to improve the quality of learning. Thus, this approach can be a relevant and effective solution to overcome the challenges of learning in the digital era.

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