JPPIPA 9(5) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of Experiment-Based Discovery Learning Model on Psychomotor Learning Outcomes in Static Fluid Materials

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Received: February 23, 2023
Revised: May 23, 2023
Accepted: May 25, 202
Published: May 31, 2023

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DOI: 10.29303/jppipa.v9i5.3573

Abstract: This study aims to determine the differences in psychomotor learning outcomes of students using discovery learning models and problem-based learning (PBL) models in static fluid physics materials. The research location was conducted at SMAN 1 Boliyohuto for the 2021/2022 academic year in classes XI IPA type 1 and XI IPA type 2, each with 15 students. The research method used is quasi-experimental in the experimental class and the control class. The independent variable in this learning model is the discovery learning model. In contrast, the dependent variable is the results of students' psychomotor learning through observation sheets. Based on the analysis results, there were differences in student learning outcomes by applying the experimental-based discovery learning model to the PBL model. The control class scores were higher than the experimental class scores.

Keywords: Discovery learning; PBL; Psychomotor; Static fluid

Introduction

Physics is the most fundamental science that studies matter's behavior and structure. The field of physics is usually divided into classical physics and modern physics. Classical physics covers motion, fluids, heat, sound, light, electricity, and magnetism. Meanwhile, modern physics covers relativism, atomic structure, quantum theory, compressed matter (condensed matter), nuclear physics, elementary particles, cosmology, and astrophysics (Giancoli, 2014; Halliday et al., 2010).

Physics is a science that studies phenomena that are directly related to everyday life. Physics learning is inseparable from the experimental method in the implementation process, which always prioritizes the validity of the observed data (Abdjul et al., 2022; Mulyono, 2018; Saklressy et al., 2021). The process of learning physics and the ability to understand concepts is an absolute requirement for achieving success in learning physics. Therefore, a teacher must pay attention to the learning strategies used, such as selecting learning media, so learning objectives can be adequately achieved (Ramdhani et al., 2015).

Based on the observations made through interviews with physics subject teachers at one of the senior high schools in SMA Negeri 1 Boliyohuto, it was stated that some students still had unsatisfactory learning outcomes. In addition, students look less active and bored in the learning process because learning is less attractive. This can be caused by several factors, including applying less varied learning models. Implementing a learning system with the 2013 curriculum but not properly using laboratory tools and materials. Students become passive because of the lack of tools and laboratories to conduct experiments, even though learning physics from empirical experience in experiments is very important (Riduwan, 2019; Sakti, 2011; Widyoko, 2012).

Teachers must apply the suitable learning model to improve student learning outcomes in learning physics (I. Astra et al., 2015; Buhungo et al., 2023; Payu et al., 2023; Suliyanah et al., 2021). Using appropriate learning models can foster students' love for physics, thus fostering greater motivation to learn physics. Motivation

How to Cite:
Payu, C. S. (2023). The Effect of Experiment-Based Discovery Learning Model on Psychomotor Learning Outcomes in Static Fluid Materials. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2647–2652. https://doi.org/10.29303/jppipa.v9i5.3573

will increase students' creative thinking and facilitate understanding of physics concepts that can affect student learning outcomes (Afjar et al., 2020; Juniwati et al., 2020; Setiawan et al., 2023; Tenti, 2021).

One of the learning models that can be used to improve student learning outcomes is the discovery learning model. Discovery Learning is an appropriate learning model to be applied in physics (Amali et al., 2023; Maghfiroh et al., 2023; Ntobuo et al., 2023). Discovery learning is learning and discovering yourself. In the teaching and learning system, the teacher presents lesson material, not in the final form, but students are allowed to find and find it for themselves (Meilani et al., 2020; Mutmainna et al., 2015). The Discovery Learning learning model is superior in improving learning outcomes compared to individual or competitive learning experiences (Fitri et al., 2014; Komariyah et al., 2019).

Research with the discovery learning model has been carried out by Seda et al. (2019) and Sgro et al. (2022) concluded that the mind mapping-based discovery learning model affects student psychomotor learning outcomes. The average score for each psychomotor indicator in the experimental class is higher than that obtained from the conventional learning model.

In their research Astra et al. (2021) and Aslam et al. (2017) found the effect of the discovery learning model on student learning outcomes in ecological material assisted by microclimate research data on green open spaces based on vegetation habitus. The result on the psychomotor aspect fosters students' self-confidence. The results found by students at the learning stages made them confident in their analysis so that they could manage discussions well when presenting the percentage of findings.

Based on the description of the research that several researchers have done, it can be concluded that the application of the discovery learning model can affect student learning outcomes. Thus, research will be carried out on the effect of the experiment-based discovery learning model on psychomotor learning outcomes in static fluid material for students in class XI at SMAN 1 Boliyohuto. Students will more easily understand physics concepts through direct experience by conducting experiments. The importance of applying the experimental-based discovery learning model is expected to improve the quality and results of students' psychomotor learning.

Method

This research will be carried out using a quasi-experimental method. This method aims to compare the learning outcomes of the two classes that are treated, namely the experimental class and the control class. The experimental class will be given treatment using the experimental-based discovery learning model, and the control class will be given treatment using the problem-based learning model (PBL). The research aims to determine the effect of applying discovery learning models and PBL models (Sawitri et al., 2016).

The population in this study were all students at SMA Negeri 1 Boliyohuto class XI in the 2021/2022 academic year. The number of class XI consists of four classes. Determination of the sample in this study using cluster random sampling technique by selecting two classes in class XI IPA. The first is the control class, and the second is the experimental class. The research flowchart shown in Figure 1. This research started with cluster random sampling to the posttest.

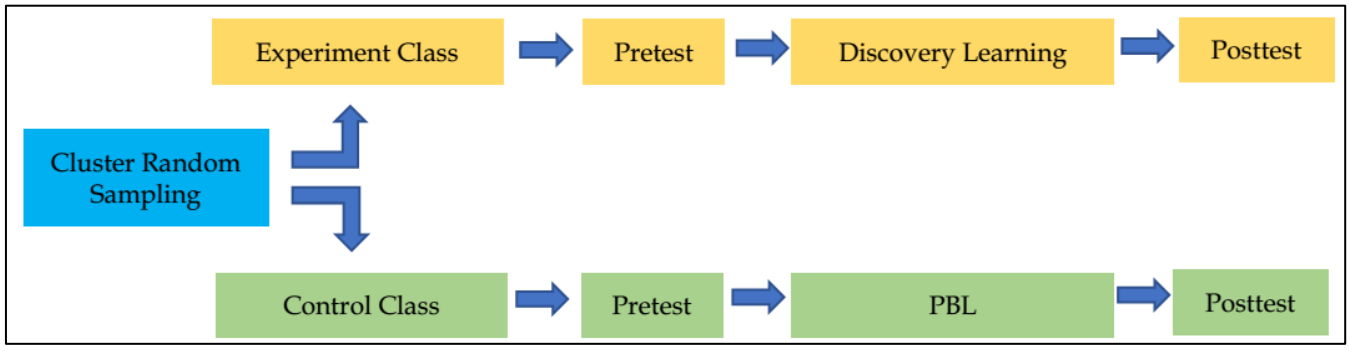

Figure 1. The research flowchart

Research variables are anything in any form determined by the researcher to be studied in obtaining this information so that a conclusion can be drawn (Sugiyono, 2019). The independent variable in this learning model is the discovery learning model. In contrast, the dependent variable is the results of students' psychomotor learning through observation sheets.

Data collection techniques use observational data collection techniques or observations using student skill

observation sheets. The research instrument was an observation sheet of skill observation to measure student learning outcomes in the psychomotor domain.

The researcher uses a psychomotor observation sheet based on the nonparticipant observation theory (Sugiyono, 2019). Psychomotor achievement indicators used were: preparation of tools and materials, making hypotheses, conducting experiments, collecting and analyzing data, concluding experimental data, group work, oral percentages, and asking questions.

Criteria for student activity during learning are said to be effective if student activity during learning is at least analyzed in the excellent category, which is analyzed based on the criteria by Ratumanan et al. (2003), shown in Table 1.

Table 1. Criteria for Psychomotor Learning Outcomes

Intervals	Criteria
0 – 20	Not much
20.1 – 40	Less
40.1 – 60	Enough
60.1 – 80	Good
80.1 – 100	Excellent

Result and Discussion

This research was conducted at SMA Negeri 1 Boliyohuto. The sample used consisted of two classes: class XI IPA type 1 as the control class and class XI IPA type 2 as the experimental class. Each class consists of 15 students. The results obtained in the experimental and control classes for each meeting the average value of the psychomotor domain can be seen in Figure 2.

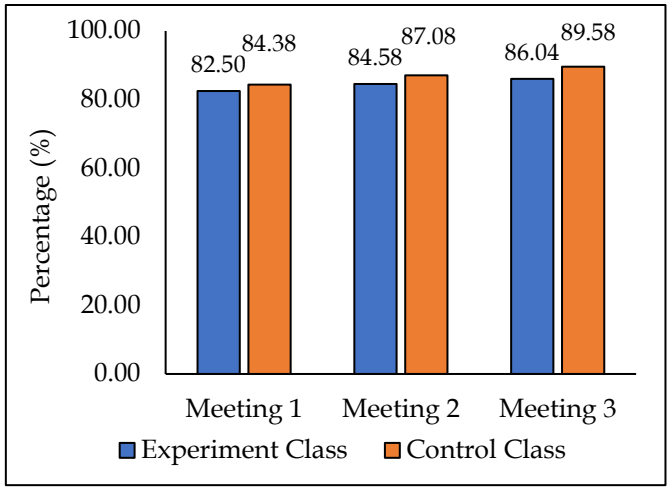

Figure 2. Average psychomotor score in each meeting

Based on the graph in Figure 2, the average psychomotor value of the control class is higher than that of the experimental class at the first, second, and third meetings. In detail, the psychomotor assessment aspects in the experimental and control classes can be seen in Figure 3.

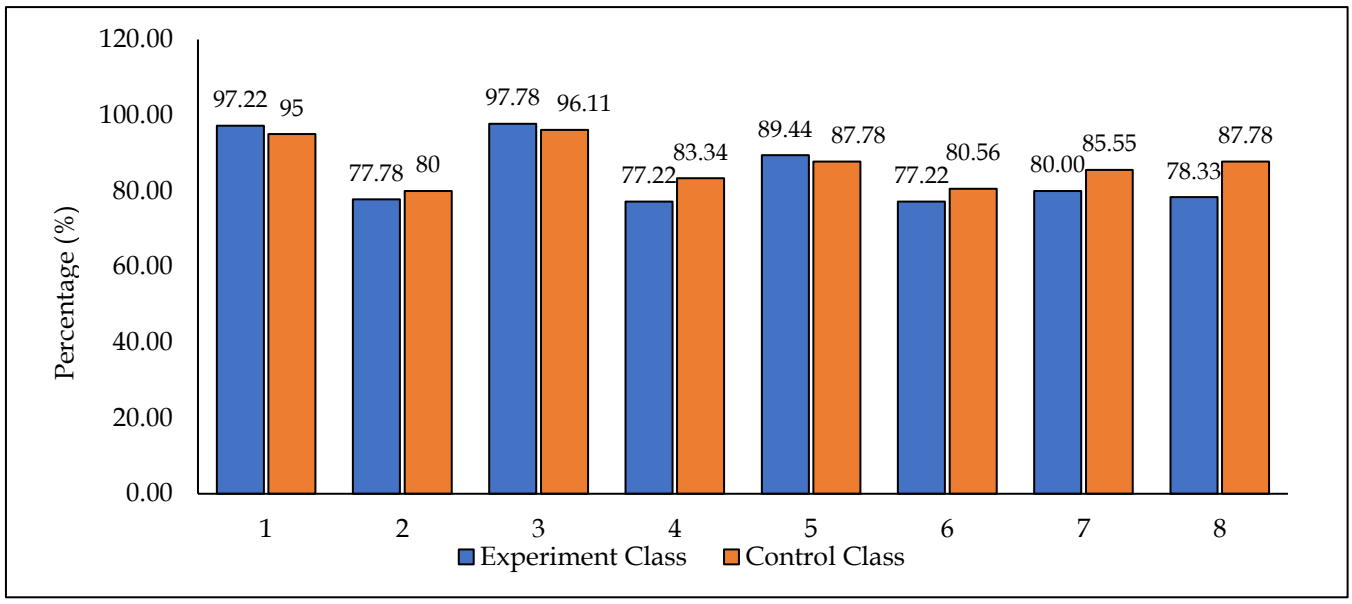

Figure 3. Average psychomotor scores at each meeting

Figure 2 and Figure 3 are the results of students' skills at each meeting and each indicator for both the experimental and control classes. The average psychomotor value of the control class was higher than the average psychomotor value of the experimental class. This is caused by the activeness or skills of students in the control class who are more active in solving problems. The difference between the worksheets of students in the experimental class and the control class is that the teacher listed the problem

formulation first in the experimental class. In contrast, in the control class, the students must write down the problem formulation based on the picture. This triggers psychomotor excellence in the control class because students will ask more questions about problem formulation, discussion in group work, analysis, and conducting experiments. This statement is based on Budiman et al. (2019) opinion that the PBL model has a higher effect than the usual learning model. Noviar et al. (2015) also stated that the application of the PBL model improved students' psychomotor learning outcomes. Furthermore, through the PBL model, Sawitri et al., (2016) requires students to be more active in solving problems, demanding high-level thinking skills and good analytical skills.

The results of this study are inversely proportional to the results of the research used as a reference in the introduction, namely research by Seda et al. (2019) and Aslam et al. (2017), which state that the discovery learning model has a more significant influence on student psychomotor. Still, it needs to be reviewed that the comparison used in this study by Seda et al. (2019) is a discovery learning model and a conventional learning model, likewise to Aslam et al. (2017). Meanwhile, this study used a comparison PBL model. Nevertheless, the experimental-based discovery learning model and PBL effectively influence students' psychomotor development. This is evidenced by the average psychomotor scores of students in both classes in the good and excellent categories, which can be seen in Table 2 and Table 3.

Table 2. Psychomotor Results for Each Class Experiment Indicator

Observed Aspect Indicator	Average (%)	Criteria
Preparation of Tools and Materials	97.22	Excellent
Creating hypotheses	77.78	Good
Experiment	97.78	Excellent
Collect and analyze data	77.22	Good
Summing up experimental data	89.44	Excellent
Group work	77.22	Good
Oral presentation	80.00	Good
Ask a Question	78.33	Good

Table 3. The Psychomotor Results of Each Control Class Indicator

Observed Aspect Indicator	Average (%)	Criteria
Preparation of Tools and Materials	97.22	Excellent
Creating hypotheses	77.78	Good
Experiment	97.78	Excellent
Collect and analyze data	77.22	Good
Summing up experimental data	89.44	Excellent
Group work	77.22	Good
Oral presentation	80.00	Good
Ask a Question	78.33	Good

Table 2 shows that the results obtained from each psychomotor indicator of students in the experimental class are in the good and excellent categories reviewed based on the criteria of Ratumanan et al. (2003), which are in the intervals of 80.1-100 (very good) and 60.1-80 (good). In the experimental class, 5 indicators are in the good category, while the other 3 aspects are in the excellent category. Furthermore, the psychomotor results of each control class indicator are seen in Table 3.

Table 3 shows that the results obtained from each psychomotor indicator of students in the control class were in the good and excellent categories reviewed based on Ratumanan et al. (2003) criteria, which were in the intervals of 80.1-100 (excellent) and 60.1-80 (good). In the control class, only aspects of making hypotheses are categorized as good, while the other 7 aspects are in the excellent category.

Conclusion

Based on data analysis on the results of research that has been carried out, it can be concluded that the use of experimental-based discovery learning models and PBL models has a positive effect on the development of students' psychomotor learning outcomes in static fluid physics lessons. It is proven that there are differences in the acquisition of scores of students in the control class and the experimental class, where the acquisition of the control class scores is higher than the experimental class scores.

Acknowledgments
Thank you to the Principal, teachers, and students at SMA Negeri 1 Boliyohuto, who have helped the writer complete this research.

Author Contributions
Citron S. Payu: Conceptualization, validation, writing—original draft preparation, methodology, data curation, formal analysis, writing—review and editing.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

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