Jurnal Penelitian Pembelajaran Fisika
Vol. 17 Issue 1 – January 2026, p15-19
p-ISSN 2086-2407, e-ISSN 2549-886X
Available Online at http://journal2.upgris.ac.id/index.php/JP2F
DOI: 10.26877/jp2f.v17i1.2802

The Implementation of Experimental Methods in Static Fluid Topics Assisted by Genially E-Modules to Improve Learning Outcomes

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Received: 25 September 2025. Accepted: 29 January 2026. Published:31 January 2026.

Abstract. This study aims to determine the effect of applying the experimental method assisted by an e-module developed with the Genially platform on students' learning outcomes in static fluids. The research employed a quantitative approach with a quasi-experimental design, specifically the Nonequivalent Control Group Design. The subjects were 70 eleventh-grade students of SMA Negeri 1 Sambas in the 2024/2025 academic year, consisting of 35 students in the experimental class (XI H) and 35 students in the control class (XI F), selected using intact group sampling. The instruments included essay-based pre-test and post-test questions, as well as a validated Genially-based e-module. Data were analyzed using the Wilcoxon test, Mann-Whitney U test, and N-Gain. The results indicated a significant improvement in the experimental class with an average N-Gain of 0.64 (medium category), compared to 0.33 in the control class. The Mann-Whitney U test showed a significance value of $0.000 < 0.05$, confirming a significant difference in learning outcomes between the two classes. Therefore, the use of the experimental method assisted by the Genially e-module was proven effective in enhancing students' learning outcomes in static fluids.

Keywords: experimental method, genially e-module, quasi-experimental

1. Introduction

Physics learning has an important role in developing students' critical thinking skills, problem-solving abilities, and scientific attitudes. Physics is not merely related to memorizing formulas, but rather emphasizes conceptual understanding that can be applied in daily life [1]. An ideal physics learning process is one that provides opportunities for students to discover facts, construct concepts, and develop theories, enabling them to face problems both in learning contexts and in real situations within their environment [2].

However, classroom learning practices are generally still dominated by conventional methods that position the teacher as the center of learning. Monotonous lecture methods make students less actively involved, resulting in low learning motivation and suboptimal learning outcomes [3]. This condition is reinforced by data presented in research [4], which show the low average national physics examination scores, with the 2016–2019 averages still categorized as low, ranging from 43.67 to 54.83. These low achievements indicate the need for more innovative learning strategies to improve students' understanding and learning outcomes.

One of the materials often considered difficult is static fluids. Students frequently experience misconceptions, for example, assuming that an object's mass affects buoyant force, whereas buoyant force is determined by the volume of the object submerged [5]. The concept of hydrostatic pressure is also often misunderstood, as students assume that pressure depends solely on an object's mass. These difficulties cause students to be less able to connect physics concepts to solve problems or apply them in everyday life.

To overcome these problems, the experimental method becomes a relevant alternative. The experimental method requires students to experience directly, conduct experiments, seek truth, and draw conclusions based on firsthand experience [6]. Thus, students do not merely passively receive information, but actively observe, measure, and analyze phenomena. Several previous studies have demonstrated the effectiveness of the experimental method in improving physics learning outcomes. proved that there was a significant difference between the experimental class and the control class after the implementation of the experimental method in static fluid material[5]. Alridha and Martanti also found that learning through experiments, including virtual experiments, was able to improve cognitive achievement compared to conventional learning[7][8].

In addition to methods, learning media also play an important role. The selection of appropriate media can increase students' motivation and interest in learning. One innovative and potential medium is an electronic module (e-module) based on Genially. E-modules allow the integration of text, images, videos, and interactive animations, making the learning process more engaging[9]. Previous research has shown that Genially-based e-modules can increase learning interest and learning outcomes. Permatasari assessed the Genially e-module as feasible in terms of content, appearance, and language[10]. Ni'mah et al. found an increase in learning interest of 17.94% after the use of the e-module, while Fatma and Ichsan showed a significant improvement in learning outcomes, with the average post-test score reaching 77.75, higher than the pre-test score of 44.00[11][12].

In the context of static fluid learning, the use of the experimental method assisted by a Genially e-module is believed to provide a more concrete, interactive, and enjoyable learning experience. The Genially e-module can visualize abstract concepts such as buoyant force and hydrostatic pressure through dynamic animations as well as the integration of PhET simulations, thereby helping students understand concepts more easily[13][14]

However, research on the implementation of the experimental method assisted by a Genially e-module in physics learning, particularly on static fluid material, is still limited. Therefore, this study was conducted to fill this gap.

Based on the background described above, the objective of this study is to determine the significant effect of implementing the experimental method assisted by a Genially e-module on students' learning outcomes in static fluid material in Grade XI at SMA Negeri 1 Sambas. Specifically, this study aims to: (1) analyze the improvement in learning outcomes before and after instruction in the experimental and control classes, (2) compare students' learning outcomes between the experimental class using the experimental method assisted by a Genially e-module and the control class using conventional methods, and (3) examine the effectiveness of implementing the experimental method assisted by a Genially e-module in improving physics learning outcomes on static fluid material.

2. Method

This study employed a Quasi Experimental Design with a Nonequivalent Control Group Design [15]. This design involved two groups: an experimental group that received treatment using the experimental method assisted by a Genially e-module (X_1), and a control group that received conventional instruction (X_2). Measurement of learning outcomes was conducted through pre-tests (O_1, O_3) and post-tests (O_2, O_4).

Table 1. Nonequivalent Control Group Design of the Study.

O_1	X_1	O_2
O_3	X_2	O_4

In this study, both the experimental and control classes were first given a pre-test to determine students' initial abilities, where O_1 represented the pre-test for the experimental class and O_3 represented the pre-test for the control class. Subsequently, the experimental class received treatment in the form of the implementation of the experimental method assisted by a Genially e-module (X_1), while the control class received treatment through conventional learning methods (X_2), Afterward, both classes were given a post-test to determine students' learning outcomes after the treatment, namely O_2 for the experimental class and O_4 for the control class.

The population of the study consisted of all Grade XI students of SMA Negeri 1 Sambas in the 2024/2025 academic year, totaling 283 students. The sample was determined using the intact group sampling technique, namely Class XI F (control, 35 students) and Class XI H (experimental, 35 students). Data were collected through learning outcome tests in the form of pre-tests and post-tests on static fluid material. The pre-test was used to determine initial ability, while the post-test was used to measure the improvement in learning outcomes after treatment.

The research instruments consisted of a learning outcomes test in the form of 8 essay questions (pre-test and post-test), a Genially-based e-module as interactive learning media for the experimental class, and a learning module as a teacher's guide covering components of objectives, learning steps, the roles of teachers and students, and integration of the e-module. Instrument validity was indicated by the learning test validated by three experts, with the majority of the items declared valid. The e-module was validated by two lecturers with a score of 86%, categorized as highly feasible, while the learning module was validated by three experts with a score of 82.22%, categorized as feasible. Reliability was tested using Cronbach's Alpha through SPSS with a result of 0.955 (≥ 0.60), indicating that the instrument was reliable.

Data analysis was carried out through several stages, namely descriptive analysis by calculating the mean and standard deviation of the pre-test and post-test scores, normality testing using the Shapiro–Wilk test with the criterion that data are normally distributed if sig. > 0.05, and homogeneity testing using Levene's Test with the criterion that data are homogeneous if sig. > 0.05. Hypothesis testing was conducted using the Paired Sample T-Test for differences within one group and the Independent Sample T-Test for comparisons between groups if the data were normally distributed, while non-parametric tests (Wilcoxon and Mann–Whitney U Test) were used if the data were not normally distributed. Learning effectiveness was calculated using the N-Gain [16] with categories of high (≥ 0.70), medium (0.30–0.70), and low (≤ 0.30).

3. Result and Discussion

This study was conducted at SMA Negeri 1 Sambas in the second semester of the 2024/2025 academic year, involving two classes, namely Class XI H as the experimental class and Class XI F as the control class, each consisting of 35 students. Both classes received different treatments: the experimental class used the experimental method assisted by a Genially e-module, while the control class was taught using conventional lecture-based methods.

Table 2. Descriptive Statistics of Students' Pre-test and Post-test Results in the Experimental and Control Classes.

Statistics	Class			
	Experimental		Control	
	Pre-test	Post-test	Pre-test	Post-test
Mean	31.43	75.86	31.36	53.43
Score Improvement	44.43		22.07	
Standard Deviation	15.52	5.94	11.3	16.95
Minimum Score	12.5	62.5	15	17.5
Maximum Score	72.5	95	55	75
Score Variance	240.91	35.27	127.7	287.164

The results of the study indicate an improvement in learning outcomes in both classes; however, the improvement in the experimental class was more significant. The average pre-test score of the experimental class was 31.43 and increased to 75.86 in the post-test, while the control class only increased from 31.36 to 53.43. The Wilcoxon test showed a significance value of 0.000 ($p < 0.05$) in both classes, indicating a significant difference between the pre-test and post-test scores. Nevertheless, the experimental class demonstrated a higher level of improvement.

The comparison of post-test scores between the experimental and control classes using the Mann–Whitney test resulted in a significance value of $0.000 < 0.05$. This indicates a significant difference in learning outcomes between the two groups, with the experimental class achieving better results. In

addition, the N-Gain calculation showed that the experimental class obtained an average of 0.64 (medium category), while the control class only reached 0.33 (medium category). These results confirm that the use of the experimental method assisted by a Genially e-module is more effective than conventional methods.

The findings of this study demonstrate that the implementation of the experimental method assisted by a Genially e-module has a positive effect on improving physics learning outcomes, particularly in static fluid material. These results are consistent with the nature of science education, which emphasizes the integration of products, processes, attitudes, and applications [17]. Students in the experimental class had the opportunity to be actively involved through direct experimentation and were supported by the interactive features of the e-module that guided practical activities.

From the perspective of constructivist theory, these findings indicate that students construct their knowledge independently through meaningful learning experiences. Interactive features in the Genially e-module, such as animations and simulations, help students explore abstract concepts more concretely [18]. This is in line with Bruner's view, which emphasizes the importance of discovery learning, where students pass through enactive, iconic, and symbolic stages to understand concepts [19].

Compared to conventional methods, learning outcomes in the control class still showed improvement, but at a relatively low level. This is because lecture-based learning emphasizes one-way information delivery, thus providing less encouragement for students' active involvement. In contrast, the experimental approach combined with digital media has proven to be more effective in enhancing conceptual understanding in physics.

This study is consistent with previous research stating that the use of interactive learning media based on Genially can help improve students' learning outcomes [20][21]. Although applied to different subjects and educational levels, the results of this study indicate that Genially e-modules can make learning more engaging and assist students in understanding the material. Thus, this study reinforces previous findings that the utilization of Genially-based e-modules can have a positive impact on the learning process.

4. Conclusion

Based on the results of the study, it can be concluded that the implementation of the experimental method assisted by a Genially e-module has a significant effect on students' learning outcomes in static fluid material in Grade XI at SMA Negeri 1 Sambas. The improvement in learning outcomes is reflected in the increase of the average pre-test score from 31.43 to 75.86 in the post-test in the experimental class, with the Wilcoxon test results indicating a significant improvement. In addition, there is a significant difference in learning outcomes between the experimental and control classes, where the average post-test score of the experimental class (75.86) is higher than that of the control class (53.43), in accordance with the Mann–Whitney U test results showing a significance value of 0.000 (< 0.05). The N-Gain calculation results also reinforce the effectiveness of the learning, with an average of 0.64 (medium category) in the experimental class compared to 0.33 in the control class. Thus, it can be affirmed that learning using the experimental method assisted by a Genially e-module is more effective than conventional learning in improving students' understanding and learning outcomes in static fluid material.

Acknowledgments

The authors would like to express their gratitude to Mr. Firdaus, M.Sc., Ms. Erwina Oktavianty, M.Pd., and Ms. Adha Jumiati, S.T. as validators of the test instruments and learning module, as well as Mr. Lanang Maulana Aminullah, M.Sc., and Ms. Erwina Oktavianty, M.Pd. as validators of the Genially-based e-module. Appreciation is also extended to Ms. Adha Jumiati, S.T. as the Grade 11 Physics teacher, and to SMA Negeri 1 Sambas for granting permission and supporting the implementation of this research, as well as to all students of Classes XI F and XI H who participated in the study.

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