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Effects of E-Module Integrated Problem Based Learning Model of Fluid Material on Student's Learning Outcomes

Amelia Agustin[1], Hidayati[2*], Fatni Mufit [3], Renol Afrizon[4]

[1,2,3,4]Department of Physics Universitas Negeri Padang,Padang,Indonesia.

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Correspondence
E-mail : hidayati@fmipa.unp.ac.id
Phone : 089617020242

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ABSTRACT

Improving students' physics learning outcomes is one of the primary goals of implementing the Independent Curriculum, which emphasizes active, independent, and student-centered learning, However, students learning outcomes on fluid materials remain relatively low because the teaching materials commonly used in schools have not fully facilitated active learning and problem-solving activities. To address this issue, the use of Problem-Based Learning (PBL)-based E-Modules is proposed as an alternative solution to create more meaningful and independent learning experiences. This study aims to analyze the effect of the use of Problem Based Learning (PBL)-based E-Modules on physics learning outcomes of grade XI students of SMA Negeri 14 Padang on fluid materials. The research uses a quasi-experimental method with a Posttest-Only Control Design. The research sample consisted of 71 students divided into experimental classes and control classes. The experimental class uses PBL-based E-Modules, while the control class uses teaching materials commonly used in schools. The research data includes learning outcomes of cognitive, affective, and psychomotor aspects obtained through tests and observation sheets. The results showed that the average learning outcomes of students in cognitive, affective, and psychomotor aspects in the experimental class were higher than in the control class. These findings show that the use of Problem Based Learning-based E-Modules is effective in improving students' physics learning outcomes on fluid materials. The use of PBL-based E-Modules provides benefits in creating more active, meaningful learning, and supports the development of students' knowledge, attitudes, and skills in learning fluid material.

INTRODUCTION

Education is a fundamental aspect that plays a strategic role in improving the quality of human resources. Education not only equips students with knowledge, but also develops the skills, attitudes, and thinking abilities needed to deal with the development of science and technology. The government implements the Independent Curriculum as one of the efforts to improve the quality of learning in schools. The Independent Curriculum provides flexibility

to teachers in designing learning that suits the needs and characteristics of students. Through this curriculum, students are expected to be able to learn actively, independently, and be able to develop the competencies needed in the 21st century (Hidayatullah et al ,2023).

Furthermore, the independent curriculum places students as the main subject in the learning process, while the teacher functions as a facilitator who supports students in developing knowledge independently (Pertiwi, et al 2022). The implementation of learning in the independent curriculum needs to be supported by teaching materials that are appropriate to students' characteristics and learning needs (Kemendikbud, 2024). Teaching materials are all forms of learning resources that are systematically organized based on learning outcomes to support the learning process and improve students' independence (Camelia, et al 2023). One of the teaching materials widely used in schools is the module, which is designed to facilitate students in understanding the material independently. According Hidayati and Syakila (2024), modules as teaching materials can improve the learning process because they provide opportunities for students to learn systemically, independently, and in a more directed manner. Along with technological advancements, the development of digital teaching materials has become increasingly important to create more flexible, interactive, and meaningful learning experiences.

One form digital teaching material that can support learning activities is the electronic module (E-Module). E-Module are electronic teaching materials that can be used as independent learning resources and present learning materials flexibly and interactively (Marto, 2021). E-Modules are arranged in electronic formats and can incorporate various multimedia features such as animations, audio, videos, and interactive navigation to facilitate students' understanding of learning materials. Moreover, E-Modules are more practical because they can be accessed anytime and anywhere through digital devices (Lestari & Parmiti, 2020). The use of E-Modules in physics learning has also been reported to improve students' competencies because it enables students to learn independently and actively through the utilization of digital technology (Yulkifli & Apriani, 2022). In addition, E-Modules designed according to appropriate learning models can help students understand learning materials more systematically and contextually, thereby supporting the achievement of learning objectives (Satria, et al., 2025).

Besides innovative teaching materials, the implementation of appropriate learning models also plays an important role in increasing student engagement and optimizing learning outcomes. Students centered learning provides opportunities for students to construct knowledge independently through active involvement in the learning process (Puspita et al., 2025). One learning model that is in accordance with the characteristics of the independent Curriculum is Problem Based Learning (PBL). The PBL model places students at the center of learning through the presentation of problems related to real life situations (Desnita, et al 2021). The implementation of the PBL model can improve students' critical thinking, analytical, and creativity skills because it encourages them to actively participate in the problem-solving process (Bahja, et al 2025). Furthermore, the implementation of the Problem-Based Learning (PBL) model in E-Modules can support the development of students' skills and promote more active and meaningful learning experiences (Rahmayani, 2023).

The integration of E-Modules and the PBL approach is theoretically beneficial in improving students learning outcomes. E-Modules facilitate self-regulated learning by allowing students to access learning materials independently according to their learning pace and needs. Arends, (2012) stated that the Problem-Based Learning (PBL) approach

encourages students to actively construct knowledge through investigation, discussion, and problem-solving activities. The combination of this characteristic provides meaningful learning experiences, promotes conceptual understanding, and develops higher order thinking skills. Therefore, integrating PBL into E-Modules is expected to improve students' academic achievement and overall learning outcomes in physics.

However, students' physics learning outcomes remain a major concern, particularly in materials that involve abstract concepts and analytical reasoning, such as fluid mechanics. Based on the Final Assessment results of Grade XI students at SMA Negeri 14 Padang in the 2024/2025 academic year, the average scores of classes XI F1, XI F2, and XI F4 were 66.63, 52.00 and 53.55, respectively. The scores were still below the school's Minimum Mastery Criterion, which was set at 75. These findings indicate that many students still experience difficulties in understanding physics concepts and applying them to solve problems. Therefore, innovative teaching materials and learning models are needed to facilitate active learning and improve students learning outcomes particularly in fluid material.

Several previous studies have demonstrated the potential of PBL based E-Modules in physics learning. Sari (2023) through a preliminary study entitled *Electronic Module Based on Problem Based Learning Model to Improve Students Concept Understanding,* reported that the developed PBL based E-Module on fluid material has fulfilled students and teachers needs and was considered feasible for facilitating conceptual understanding. However, the study was limited to the product development and needs analysis stages and did not empirically investigate the effective of the E-Module in improving students learning outcomes. Furthermore, Akmala (2025) found that the implementation of PBL based physics E-Modules significantly improved students critical thinking skills, problem solving, abilities, and learning outcomes compared with conventional learning, similarly, Nurjana and Wahyuni (2025) reported that the implementation of the PBL model on static fluid material significantly enhanced students learning outcomes and encouraged active participation and critical thinking during the learning process.

Although previous studies have reported positive findings regarding PBL-based E-Modules and the implementation of the PBL model, most studies have primarily focused on product development, validity, and practicality aspects or have only examined the implementation of the PBL model without integrating it with digital teaching materials. Empirical evidence regarding the instructional effectiveness of validated PBL-based E-Modules in improving students' physics learning outcomes, particularly within the implementation of the Independent Curriculum and specifically on fluid material, remains limited. Moreover, previous studies generally focused on only one aspect of learning outcomes and did not comprehensively evaluate cognitive, affective, and psychomotor learning outcomes. Therefore, further studies are still needed to provide empirical evidence regarding the effectiveness of PBL-based E-Modules in improving students' physics learning outcomes comprehensively.

This study offers a novel contribution by evaluating the instructional effectiveness of a validated Problem Based Learning-based E-Module on fluid material within the implementation of the Independent Curriculum. Unlike previous studies that mainly emphasized product development and feasibility testing, this study empirically investigates the influence of the E-Module on students' cognitive, affective, and psychomotor learning outcomes through a quasi-experimental design. In addition, this study utilizes a Computer-Based Test (CBT) as a digital evaluation medium to support more efficient and technology-

integrated assessment processes. Therefore, the findings of this study are expected to provide empirical evidence regarding the effectiveness of integrating PBL-based digital teaching materials into physics learning and contribute to the implementation of the Independent Curriculum. Based on the aforementioned background, this study aims to analyze the effect of using a Problem Based Learning-based E-Module on the physics learning outcomes of Grade XI students at SMA Negeri 14 Padang on fluid material.

METHODS

This study employed a quantitative approach using a quasi-experimental method with a posttest-only control group design. This design was selected to examine the effect of the Problem Based Learning (PBL)-based E-Module on students' physics learning outcomes while minimizing the potential influence of pretest exposure on students' learning performance. Since the participants were assigned to existing intact classes and random assignment was not feasible, a quasi-experimental design was considered the most appropriate approach for achieving the research objectives. The study involved two groups, namely an experimental group and a control group, in which only the experimental group received the instructional treatment. Both groups were administered the same posttest after the intervention to evaluate students' learning outcomes. The research design used in this study is presented in Table 1.

Table 1. Posttest-Only Control Group Design

Group	Treatment	Posttest
Experimental	X	O_1
Control	-	O_1

As illustrated in Table 1, this study employed a posttest-only control group design involving an experimental group and a control group. The design enabled the researchers to compare students' learning outcomes after the instructional intervention without administering a pretest. Both groups completed the same posttest at the end of the learning process to assess students' cognitive learning outcomes. The posttest results were then compared to determine the effect of the instructional treatment. This design was considered appropriate for evaluating the effectiveness of the Problem Based Learning (PBL)-based E-Module in improving students' learning outcomes.

The research was conducted at SMA Negeri 14 Padang during the second semester of the 2025/2026 academic year. To minimize threats to internal validity, both the experimental and control groups were taught during the same period by the same physics teacher, using identical learning objectives, instructional time, and assessment instruments. The only difference between the two groups was the instructional treatment. The experimental group received instruction using the Problem Based Learning (PBL)-based E-Module, whereas the control group was taught using the teaching materials regularly implemented at the school. This arrangement ensured that any differences in students' learning outcomes could be attributed primarily to the implementation of the PBL-based E-Module.

The population of this study consisted of all Grade XI Phase F students of SMA Negeri 14 Padang who enrolled in physics classes during the 2025/2026 academic year. The sample comprised 71 students distributed into one experimental class and one control class. The sample was selected using purposive sampling because the classes met predetermined criteria

relevant to the research objectives, including comparable academic ability, similar learning schedules, and equivalent classroom characteristics. The experimental class consisted of students who participated in learning using the Problem Based Learning (PBL)-based E-Module, whereas the control class received instruction using the conventional teaching materials commonly implemented in the school.

The research procedure is carried out through three main stages, namely the preparation, implementation, and completion stages. In the preparation stage, the researcher manages research licensing, determining sample classes, preparing learning tools, and developing and testing research instruments. The implementation stage is carried out by providing treatment in the form of learning using E-Module-based problem-based learning (PBL) in the experimental class, while the control class received learning using teaching materials that are commonly used in schools. Learning activities were carried out during six meetings on fluid materials. During the learning process, observations were made on the affective and psychomotor aspects of the students. Furthermore, at the completion stage, the final test was given (post-test), processing and analysis of research data, as well as drawing conclusions based on the results obtained by researchers. The stages of research that are carried out systematically aim to obtain valid data and in accordance with the research objectives (Sugiyono, 2017).

The research data consisted of student learning outcomes in the cognitive, affective, and psychomotor domains. According to Arikunto (2018), research instruments are tools used to collect data so that researchers' work becomes easier and the results obtained are more complete systematically. Therefore, the instruments used in this study include an objective test in the form of multiple choice to measure cognitive learning outcomes, an attitude observation sheet to measure affective learning outcomes, and a performance assessment sheet to measure psychomotor learning outcomes. Before being used in research, the test instrument is first tested for validity, reliability, difficulty, and differentiation to ensure the quality of the instrument as research measuring tool.

The data that has been collected is analyzed using inferential statistics. Before hypothesis testing is carried out, analysis prerequisites are first carried out in the form of normality tests and homogeneity tests to ensure that the data meets the assumptions of parametric analysis. After the data is declared to be normally distributed and homogeneous, hypothesis testing is carried out using a t-test to determine the effect of using E-Module-based (Sugiyono, 2017)Problem Based Learning on the students' physics learning outcomes. The test was carried out at a significance level of $\alpha = 0.05$ as commonly used in quantitative research to determine the acceptance or rejection of the research hypothesis

RESULTS AND DISCUSSION

Results

Analysis of Cognitive Learning Outcomes

The learning outcomes of the students' knowledge aspects are measured through the provision of a final test (posttest) after the learning of fluid material is carried out. This test is used to identify the level of mastery of students' concepts after participating in learning using E-Modules based on problem-based learning (PBL). Furthermore, the posttest data were statistically analyzed to determine the effect of using Problem-Based Learning (PBL) based E-

Modules on students' knowledge learning outcomes. The results of the posttest data analysis for the experimental and control classes are presented in detail in Table 2.

Table 2. Knowledge Learning Outcome Analysis

Statistical Parameters	Experiments	Controls
Average score	84.806	78.343
Default deviation	8.602	8.331
Variants	73.990	64.408
Maximum value	99	92
Minimum score	66	59
Normality test value L_0	0.139	0.128
Normality test value L_t	0.148	0.150
Homogeneity test values F_h	1.066	
Homogeneity test values F_t	1.770	
Test scores t_{hitung}	3.221	
Test scores t_{tabel}	1.995	

The first analysis result relates to the effect of the Problem Based Learning (PBL)-based E-Module on students' cognitive learning outcomes. The purpose of this analysis is to investigate the effect of using the PBL-based E-Module on the cognitive learning outcomes of two sample groups, namely the experimental class that used the PBL-based E-Module and the control class that received conventional learning. A summary of the comparison of students' cognitive learning outcomes in the experimental and control classes is presented in Table 2. Based on the data in Table 2, there is a clear difference in the cognitive learning outcomes between the two groups, indicating that students who learned using the PBL-based E-Module achieved better cognitive performance than those who did not use the E-Module. However, this difference alone cannot be used to conclude that the PBL-based E-Module had a significant effect on students' cognitive learning outcomes.

Before hypothesis testing, prerequisite tests were conducted. The results of the normality test showed that $L_0 < L_t$, indicating that the cognitive learning outcome data in both groups were normally distributed. Furthermore, the homogeneity test revealed that $F_h < F_t$, indicating that the variances of the two groups were homogeneous. Since the data met the assumptions of normality and homogeneity, a two-independent-sample t-test was conducted to test the research hypothesis. The results of the hypothesis testing showed that the obtained t-value was outside the acceptance region of the null hypothesis. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted. These findings indicate that the use of the Problem Based Learning (PBL)-based E-Module had a significant positive effect on students' cognitive learning outcomes in fluid material.

Analysis of Affective Learning Outcomes

Examination of affective aspects was carried out during the learning process. Observations were made at each meeting to determine the development of students' attitudes while participating in learning using E-Modules based on Problem based learning (PBL). The indicators of attitudes that are measured include discipline, honesty, responsibility, cooperation, and confidence. The results obtained were then analyzed descriptively to provide an overview of the achievement of the students' affective aspects in the experimental

class and the control class. The data from the research on the affective aspects of students can be seen in Figure 1.

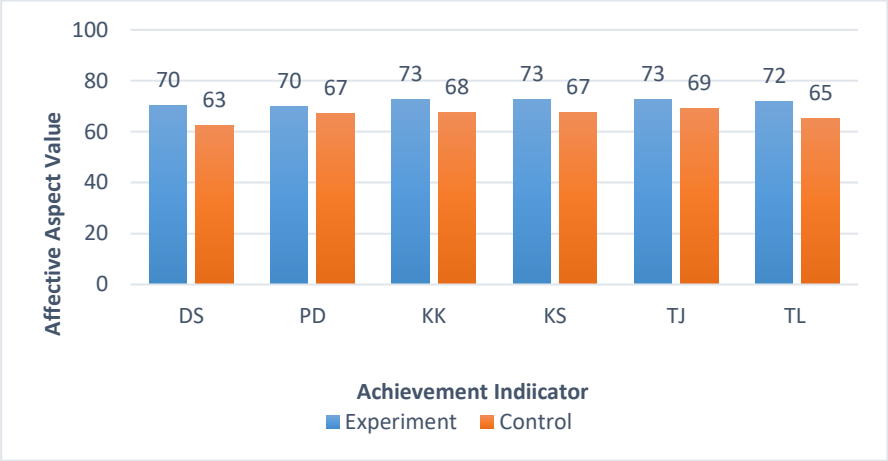

Figure 1. Learning Outcomes of Affective Aspects

The data presented in Figure 1 show the average scores of students' affective learning outcomes for each achievement indicator in both the experimental and control classes. Based on the figure, the experimental class consistently obtained higher scores than the control class across all observed indicators, namely discipline, cooperation, seriousness, responsibility, and tolerance. These findings indicate that the implementation of the Problem Based Learning (PBL)-based E-Module was able to promote positive learning attitudes and encourage greater student engagement during the learning process. The higher affective scores in the experimental class may be attributed to the characteristics of the PBL approach, which requires students to actively participate in discussions, collaborate with their peers, and take responsibility for solving contextual problems. Furthermore, the use of interactive E-Modules allowed students to learn independently while maintaining their motivation and participation throughout the learning activities. Therefore, the integration of the PBL model and E-Modules contributed positively to the improvement of students' affective learning outcomes in fluid material.

To further determine whether the differences in affective learning outcomes between the experimental and control classes were statistically significant, inferential statistical analyses were conducted. Prior to hypothesis testing, prerequisite tests, including normality and homogeneity tests, were conducted to ensure that the data met the assumptions for parametric statistical analysis. The results of these prerequisite tests are presented in Table 3.

Table 3. Analysis of Learning Outcomes of Affective Aspects

Statistical Parameters	Experiments	Controls
Average score	71.701	66.904
Default deviation	4.057	5.169
Variants	16.462	26.720
Normality test value L_0	0.108	0.055
Normality test value L_t	0.148	0.150
Homogeneity test values F_h	1.623	
Homogeneity test values F_t	1.770	
Test scores t_{hitung}	4.360	
Test scores t_{tabel}	1.995	

Based on the data presented in Table 3, it can be seen that the average attitude learning outcomes of students in the experimental class were higher than those in the control class. This difference in the average scores indicates that the use of Problem-Based Learning (PBL)-based E-Modules tended to produce better attitude learning outcomes. However, the difference in the average scores alone cannot be used as a basis for concluding that the use of PBL-based E-Modules had a significant effect on students' attitude learning outcomes. Prior to hypothesis testing, prerequisite tests, including normality and homogeneity tests, were conducted. These prerequisite tests were performed to ensure that the data met the assumptions required for parametric statistical analysis, allowing the hypothesis testing to be conducted appropriately.

The results of the normality test showed that the value $L_0 < L_t$, so that the data on the learning outcomes of attitude aspects in both groups was distributed normally. Furthermore, the results of the homogeneity test showed that the values $F_h < F_t$ indicated that the variance of the two groups was homogeneous. Since both conditions have been met, hypothesis testing can be continued using an independent two-sample t-test. The results of the hypothesis test $st_{hitung} > t_{tabel}$ how that the value so that the null hypothesis is (H_0) rejected and the alternative hypothesis is (H_1) accepted. Thus, it can be concluded that the use of E-Modules is based on Problem Based Learning (PBL) has a significant influence on learning outcomes of students' attitudes towards fluid materials.

Analysis of Psychomotor Learning Outcomes

Assessment of psychomotor aspects is carried out during the learning process. Observations are made at each meeting to find out the development of students' skills during learning using E-Module-based Problem Based Learning (PBL). Indicators of observed skills include reading data, collecting data, analyzing data, communicating analysis results, and drawing conclusions. The results of the assessment obtained were then analyzed descriptively to provide an overview of the achievement of the psychomotor aspects of students in the experimental class and the control class. The data from the assessment of students' psychomotor aspects can be seen in Figure 2.

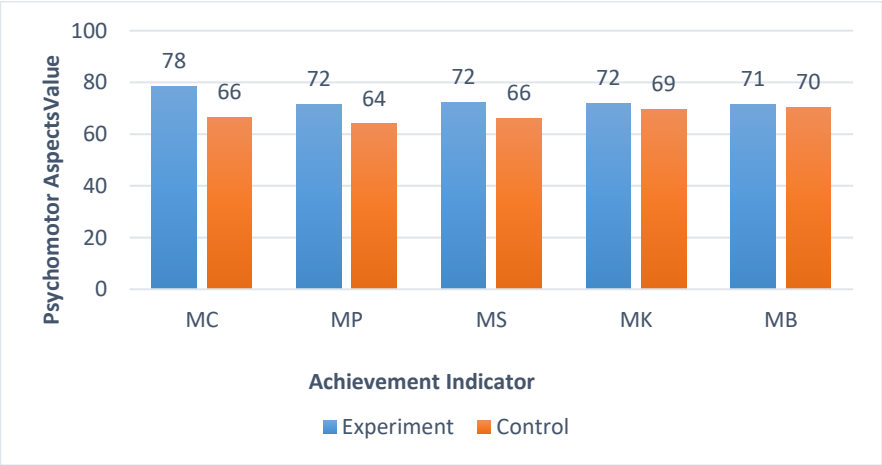

Figure 2. Learning Outcomes of Psychomotor Aspects

The data presented in Figure 2 show the average scores of students' psychomotor learning outcomes for each achievement indicator in the experimental and control classes. Based on the figure, the experimental class consistently achieved higher scores than the

control class across all observed indicators, including preparing tools and materials, carrying out procedures, making observations, communicating results, and drawing conclusions. These findings indicate that the use of the Problem Based Learning (PBL)-based E-Module was able to facilitate students' practical skills and encourage active involvement during the learning process. The higher psychomotor achievement in the experimental class may be attributed to the characteristics of the PBL approach, which engages students in problem-solving activities that require them to perform investigations, collaborate with peers, and apply concepts in practical situations. Furthermore, the interactive features provided in the E-Module enabled students to follow learning procedures systematically and independently, thereby improving their practical performance. Therefore, the integration of the PBL model and E-Modules contributed positively to the enhancement of students' psychomotor learning outcomes in fluid material.

To determine whether the differences in psychomotor learning outcomes between the experimental and control classes were statistically significant, inferential statistical analyses were conducted. Prior to hypothesis testing, prerequisite tests consisting of normality and homogeneity tests were performed to ensure that the data fulfilled the assumptions required for parametric analysis. Since the data met these assumptions, hypothesis testing was subsequently carried out using a two-independent-sample t-test. The results of these statistical analyses are presented in Table 4.

Table 4. Analysis of learning outcomes of Psychomotor aspects

Statistical Parameters	Experiments	Controls
Average score	73.102	67.190
Default deviation	3.952	4.727
Variants	15.619	22.348
Normality test value L_0	0.061	0.073
Normality test value L_t	0.148	0.150
Homogeneity test values F_h	1.430	
Homogeneity test values F_t	1.770	
Test scores t_{hitung}	5.720	
Test scores t_{tabel}	1.995	

Based on the data in Table 4, it can be seen that the average value of learning outcomes of the psychomotor aspects of students in the experimental class was higher than in the control class. However, the difference in average scores cannot be used as a basis for concluding that there is a significant influence of the use of Problem Based Learning (PBL)-based E-Modules on the learning outcomes of students' psychomotor aspects. Therefore, a prerequisite test was carried out which included a normality test and a homogeneity test before the hypothesis test was carried out.

The results of the normality test showed that the value $L_0 < L_t$,so that the data on the learning outcomes of the psychomotor aspects in both groups was distributed normally. Furthermore, the results of the homogeneity test show that the value $F_h < F_t$, which indicates that the variance of the two groups is homogeneous. Since both conditions have been met, hypothesis testing can be continued using an independent two-sample t-test. The results of the hypothesis test show that the value $t_{hitung} > t_{tabel}$, so that the null hypothesis (H_0) is rejected and the alternative hypothesis is (H_1) accepted. Thus, it can be concluded

that the use of Problem Based Learning (PBL)-based E-Modules has a significant influence on the learning outcomes of students' psychomotor aspects in fluid materials.

Discussion

The data obtained showed that the use of Problem Based Learning (PBL)-based E-Modules on fluid materials had a positive effect on the physics learning outcomes of grade XI students of SMA Negeri 14 Padang. The learning results in the knowledge aspect showed that the average posttest score of students in the experimental class was higher than that of the control class. This improvement shows that PBL-based E-Modules are able to help students understand physics concepts through structured problem-solving activities so that learning becomes more meaningful. Students not only receive information from the teacher, but are also actively involved in discovering concepts through a process of inquiry and discussion.

The results of this study are in line with the research that states that the Problem Based Learning based physics E-Module on simple harmonic vibration material is able to improve students' understanding of concepts through interactive learning. These Radjawane et al., (2022) findings are also supported by those showing that the use of PBL-based interactive E-Modules on vibration and wave materials can improve student learning outcomes because it encourages active involvement in the learning process. In addition, it stated that the PBL-based physics E-Module on business and energy materials helps students connect physics concepts with problems in daily life so that their understanding of concepts becomes better. In line with that, research has been conducted by Festiyed et al., (2022) those who say that E-Modules are effective in improving creative and critical thinking skills, as well as student learning outcomes. Thus, the use of PBL-based E-Modules on fluid materials has been proven to be effective in improving students' knowledge learning outcomes.

In addition to the knowledge aspect, this study also assesses the attitude aspect of students during the learning process. The assessment was carried out based on indicators of discipline, confidence, hard work, cooperation, responsibility, and tolerance. The results showed that the average attitude score of students in the experimental class was higher than in the control class. These results show that the use of Problem Based Learning (PBL)-based E-Modules is able to encourage students to be more active and responsible in the learning process. Through discussion and problem-solving activities contained in the E-Module, students are trained to work together, express opinions, and respect the opinions of others in solving the given problems. These findings are in line with research that Safira & Handayani, (2025) shows that the application of Problem Based Learning assisted by electronic modules has a positive effect on students' affective abilities because it increases active involvement and responsibility during the learning process. In addition, Siregar et al., (2024) research on the development of E-Modules on static fluid materials that contain local wisdom shows that E-Modules are able to support more interesting learning and increase student participation in learning activities.

In addition to the aspects of knowledge and attitudes, this study also assesses the skill (psychomotor) aspects of students during the learning process. The assessment is carried out based on indicators of reading data, collecting data, analyzing data, communicating the results of the analysis, and making conclusions. The results showed that the average skill score of students in the experimental class was higher than in the control class. These results show that the use of Problem Based Learning (PBL)-based E-Modules is able to train students to be more active in conducting investigation and problem-solving activities. During learning,

students are directly involved in collecting data, processing observations, and presenting the results of group discussions. These activities provide opportunities for students to develop science process skills necessary in physics learning. These findings are in line with research that shows that the use of Problem-Based Learning-based E-Modules can improve students' problem-solving skills through active involvement in the learning process (Anshari et al., 2025)

The findings of this study demonstrate that the implementation of a Problem-Based Learning (PBL)-based E-Module positively influenced students' physics learning outcomes in the topic of fluid mechanics. Students in the experimental class achieved better performance than those in the control class across the cognitive, affective, and psychomotor domains. These results suggest that integrating digital learning materials with the PBL approach encourages students to actively participate in learning activities, enhances conceptual understanding, and promotes the development of scientific skills and positive learning attitudes. The structured learning process provided by the E-Module enabled students to solve contextual problems independently while collaborating effectively with their peers. Consequently, students became more engaged and confident during the learning process. These findings are consistent with Arends., (2012)who emphasized that Problem-Based Learning facilitates knowledge construction through inquiry and problem-solving activities, and with previous studies by Akmala., (2025) ,which reported that PBL significantly improves students' learning outcomes and higher-order thinking skills.

Despite the positive findings, this study has several limitations that should be considered. First, the research was conducted only on the topic of fluid mechanics in two classes at one senior high school, which limits the generalizability of the findings to other physics topics or educational settings. Second, the study employed a Posttest-Only Control Group Design, making it impossible to measure students' initial abilities or learning gains over time. Third, the assessment of the affective and psychomotor domains relied on classroom observations, which may be influenced by observer subjectivity despite the use of standardized assessment rubrics.

CONCLUSION

Based on the results of the study, it can be concluded that the use of the Problem Based Learning (PBL) based E-Module significantly affects the physics learning outcomes of Grade XI students at SMA Negeri 14 Padang on fluid material. Students who learned using the PBL based E-Module achieved better learning outcomes than those who received conventional instruction. The implementation of the PBL based E-Module was found to improve students' cognitive achievement, foster positive learning attitudes, and enhance their psychomotor skills during the learning process. These findings indicate that the integration of digital teaching materials with the PBL approach can facilitate active, meaningful, and student-centered learning. The interactive features provided in the E-Module also support students independent learning and encourage their participation in problem solving activities. Therefore, the PBL based E-Module can be considered an effective instructional alternative for improving students' physics learning outcomes, particularly in fluid material. Furthermore, the findings of this study provide empirical evidence supporting the effective implementation of technology-integrated learning in the context of the Independent Curriculum, particularly in improving the quality of physics learning.

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