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Design of Physics Learning Module Integrated with Problem Based Learning Model on Renewable Energy Material for Grade X Students

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ABSTRACT

Independent Curriculum provides flexibility to schools and teachers in designing learning. However, this flexibility causes differences in the allocation of learning time in some schools. In physics subjects, some Madrasah Aliyah have less time allocation per week compared to other schools, this causes students to need to be trained to learn independently. Meanwhile, Phase E physics learning outcomes require students to play an active role in providing problem solving. Therefore, a learning module integrated with the Problem-Based Learning (PBL) model is needed to support independent learning and train students' problem-solving skills. This study aims to produce a physics learning module integrated with a valid PBL model on renewable energy material for class X Madrasah Aliyah. This research uses the Research and Development (R&D) method with the 4D development model, which includes defining, designing, developing, and disseminating stages. The module validation results showed a value of 0.92 with a very valid category. This shows that the developed module has met the validity criteria and is suitable for use. The implication of this research is that the module can help students learn independently and train students to solve problems.

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INTRODUCTION

In an effort to overcome the learning crisis and assist the recovery of learning after the Covid-19 pandemic, the government through the Ministry of Education, Culture, Research and Technology launched a policy to implement the Merdeka Curriculum in 2022 (Ihsan, 2023). This curriculum aims to help learners develop a range of skills and characters summarized in the concept of the Pancasila Learner Profile. This profile contains characters and competencies designed to enable learners to face the challenges of the 21st century (Aristiawan et al., 2023). In facing the challenges of the 21st century, students must have reliability and good quality (Fitri, 2023). To realize this, efforts to improve the quality of education continue, one of which is by implementing an independent curriculum (Ledia, 2024).

One of the major changes in the independent curriculum is to give more freedom to schools and teachers in designing learning (Salamah et al., 2024). In the independent curriculum, the government only sets the learning load in the form of lesson hours (JP) per year, while the weekly time allocation is left to each education unit to be arranged flexibly during the school year (Kemendikbud, 2022). This is different from Curriculum 2013, where the time allocation for each subject has been set in detail per week, so that schools at the same level apply a uniform number of hours (Adha & Gusti, 2023).

The flexibility provided in implementing the Independent Curriculum has resulted in differences in the allocation of learning time in various schools. In some grade X high schools, Physics subjects receive an allocation of 3 JP per week. On the other hand, at MAN 3 Padang Panjang City, Physics is only allocated 2 JP per week. Rahmah's research (2024) found that this reduction in time allocation was quite common in several Madrasah Aliyah after the Independent Curriculum was implemented, especially for Physics, which previously received 3 lesson hours, now only 2 lesson hours. This condition can affect the achievement of learning objectives. With less time to learn Physics, students in MA may find it difficult to understand Physics concepts well. This happens because the limited time makes the learning process less optimal, so that students do not have enough opportunities to explore Physics material (Rahmah et al., 2024).

Due to the limited duration of learning in the classroom, teaching materials are needed that can help students learn independently, one of which is a module (Apsari, 2023). Modules are teaching materials designed to enable students to learn independently (Yerimadesi, 2024). Learning modules have self-instructional properties, which allow students to learn on their own without always depending on the presence of the teacher (Romadhon et al., 2024). By using modules, teaching and learning activities can continue to run efficiently despite the short learning time in class (Hasmiati et al., 2023). In addition, the use of modules in learning activities can help students learn at their own pace (Habibah, 2023).

In the independent curriculum, the learning outcomes that must be achieved by learners at the end of phase e are that learners have the ability to be responsive to global issues and play an active role in providing problem solving (BSKAP, 2022). To support learners to achieve this competency, the problem-based learning (PBL) model is one of the effective models applied in learning. PBL model is a learning model that can train students to think critically and practice solving problems (Feziyasti, 2024). Learning activities with the PBL model direct students to solve problems (Fitri, 2024). The PBL model allows learners to face real situations or problems that require solving, so that learners are trained to analyze, seek information, and work together in teams (Nilyani, 2023). The PBL model can help students understand concepts and subject matter through problem-solving activities. In addition to helping students understand the material, PBL also helps students develop critical and creative thinking skills, as well as communication and collaboration skills (Wardani, 2023).

In phase e Physics learning, one of the materials discussed is renewable energy (Sintiawati, 2024). Based on the analysis of the module used at MAN 3 Padang Panjang City, it was found that the module used did not meet the learning needs according to the demands of the Physics phase e learning outcomes in the independent curriculum. The module has not integrated the steps of the PBL model needed to train active students in providing problem solving. In addition, some important components such as learning instructions and evaluation have not been listed, even though both are part of the learning module standards (Depdiknas, 2008).

Seeing this condition, the development of Physics modules integrated with the PBL model on renewable energy material is needed. Therefore, this study aims to develop a valid Physics learning module integrated with PBL model on renewable energy material. This module is designed to help students learn more effectively in accordance with the steps of the PBL model, even with limited learning time in class. With this module, students are expected to learn independently and achieve the desired competencies as demanded by the Independent Curriculum.

METHODS

This study uses the Research and Development (R&D) research type with the 4D development model developed by Thiagarajan (1974). The 4D model consists of four main stages, namely Define, Design, Develop, and Disseminate. However, this research is limited to the Develop stage. The first stage is Define. At this stage, the needs and initial conditions are analyzed which become the basis for module development. The second stage is Design. At this stage, the initial design of the physics learning module is carried out. Furthermore, namely the Develop stage, this stage is the last stage carried out in this study. This stage is focused on module development and validation.

Module validation activities involved three experts from the Physics Department of FMIPA UNP. The validation data collection process was carried out using a validation sheet questionnaire instrument. The validation sheet was designed to evaluate various aspects of the module, including module components, content feasibility, presentation, language, graphics, and integration of the Problem Based Learning (PBL) model. The validators were asked to provide an assessment and score on each indicator that has been determined with a rating scale of 1-5.

To analyze the validity level of the module, researchers used the Aiken's V index analysis method. The V Aiken formula is used to calculate the validity of items by considering the validator's assessment. This calculation is done to measure the experts' agreement on the feasibility of the developed module. The calculation of the V Aiken index is done by the formula:

$$V = \frac{\sum s}{n(c-1)} \quad \dots(1)$$

$$s = r - l_o \quad \dots(2)$$

From the calculation of the V index, the level of validity of the module can be known with the following categories.

Table 1. Category V Aiken Index

Interval	Category
≤ 0,4	Less valid
0,4 < V ≤ 0,8	Moderate (Valid)
0,8 < V	Very valid

(Retnawati, 2016)

RESULTS AND DISCUSSION

Results

This research followed the steps of the 4D development model, but was limited to the Develop stage. The results obtained from each stage are as follows.

Define Stage

At this stage, a needs analysis was conducted and the problems underlying the module development were identified. This research found several main problems related to the learning process and the use of modules by students (Sumiati, 2024). Some of the problems found were that there were still incomplete important components of the module contained in the modules used by students, so that the modules used by students could not make students learn independently effectively. Some important components that have not been found in the module are learning instructions (instructions for teachers and students) and evaluation. To be able to help students learn independently, a learning module must be accompanied by learning instructions. That way students can carry out learning activities without having to rely on instructions from the teacher (Astuti, 2024). In addition to learning instructions, evaluation is also an important component in learning modules. Evaluation aims to measure the extent to which students understand the material learned independently and identify aspects that need to be improved (Sembiring, 2021).

In addition to these problems, the module also does not have learning activities that are in accordance with the steps of the PBL model that can train students to actively provide problem solving. To achieve the learning objectives of Physics in phase e, the module used by students should be integrated with the steps of the problem-based learning model. Integrating the steps of the PBL model in the module will train students to solve problems independently (Ariawan, 2022). Thus, the learning module used by students can support the achievement of competencies that must be achieved by students.

Design Stage

The design stage is carried out as a follow-up to the previous stage (define stage). Based on the defining stage, a product is needed that can help students to practice solving problems independently, namely in the form of a learning module integrated with the PBL model. The development of this module refers to the module components according to Depdiknas (2008), which includes several important components such as title, learning instructions (student/teacher instructions), competencies to be achieved, supporting information, exercises, work instructions (worksheets), and evaluation/assessment. The process of making a module. Then, some of these components are integrated with learning steps based on the syntax of the PBL model. The module cover design can be seen in Figure 1.

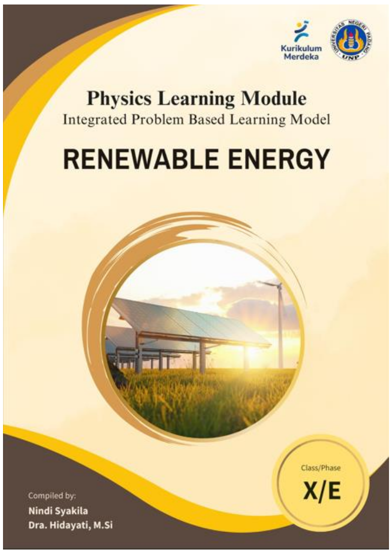

Figure 1. Module Cover

On the cover of the module, the title “Physics Learning Module Integrated Problem Based Learning Model: Renewable Energy” and is designed with simple but informative elements. At the top of the cover there is an independent curriculum logo on the left and the UNP logo on the right. The module title is written in bold, large, and clear letters, namely “Renewable Energy”, which indicates the main material discussed in the module. In the middle of the cover, an image of a solar panel is displayed, which is one of the main technologies in utilizing renewable energy. Then, at the bottom of the cover, there is information about the authors of the module, namely Syakila and Hidayati. There is also a class or phase marker "X/E", which provides information about the target users of the module, namely grade X or phase E students.

Develop Stage

At the develop stage, the focus of the research was on product validation. The module that has been made is then validated by three experts from the Physics Department of FMIPA UNP. The results of the assessment of the validator will determine the level of validity of the module that has been developed. The module validation results were carried out using an assessment instrument that included several main aspects, namely module components, content feasibility, language, presentation, graphics, and integration of the PBL model. The first validation component is the module component, the module was developed referring to the module components issued by Depdiknas in 2008. The module components assessed in the validation process are 1) title, 2) learning instructions, 3) competencies to be achieved, 4) supporting information, 5) exercises, 6) worksheets, and 6) evaluation. The results of the assessment on each module component can be seen in Figure 2.

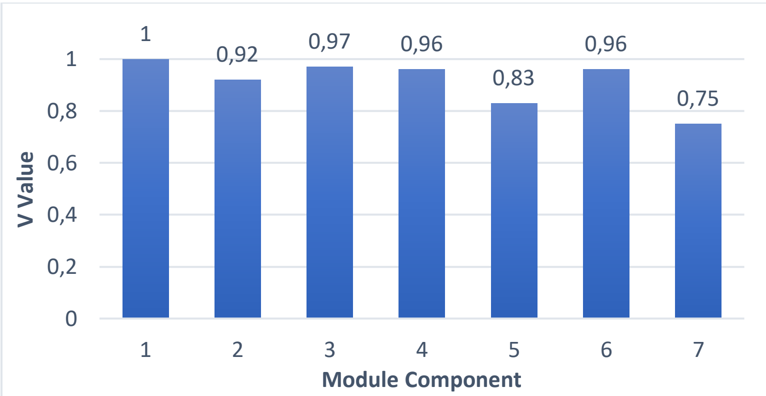

Figure 2. Module Component Assessment Results

In Figure 2, it can be seen that the V value of the module components is in the range of 0.75 to 1. The highest V value is obtained by the title component, which is 1 with a very valid category. While the lowest V value was obtained by the evaluation component, which amounted to 0.75 with the valid category. Based on these data, it can be said that the validation components in the module components are in the valid and very valid categories, where the valid category is only obtained by the evaluation component and the other six components are in the very valid category. The average value for the module component is 0.91 with a very valid category.

The second validation component is the content feasibility component. In the content feasibility component, there are six indicators assessed by the validator. These indicators include 1) suitability to CP and TP, 2) suitability to the needs of students, 3) suitability to the needs of teaching materials, 4) the truth of the substance of the material, 5) the benefits of adding knowledge insights, and 6) suitability to moral and cultural values. The results of the assessment on each indicator can be seen in Figure 3.

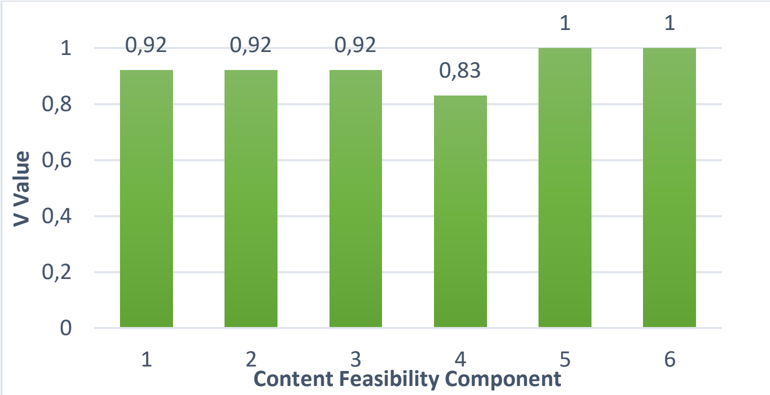

Figure 3. Content Feasibility Component Assessment Results

In Figure 3, it can be seen that the V value of each indicator of the content feasibility component is in the range of 0.83 to 1. The highest V value was obtained by two indicators, namely the benefit indicator for adding knowledge insights and conformity with morality and cultural values. Each indicator obtained a V value of 1 with a very valid category. While the lowest V value was obtained by the indicator of the truth of the substance of the material, which amounted to 0.83 with a very valid category. Based on these data, it can be said that each indicator in the content feasibility component is in a very valid category. The average value for the content feasibility component is 0.93 with a very valid category.

The third validation component is the language component. The language component consists of four assessment indicators, namely 1) readability, 2) suitability of information, 3) conformity with Indonesian language rules, and 4) effective and efficient use of language. The results of the assessment on each indicator of the language component can be seen in Figure 4.

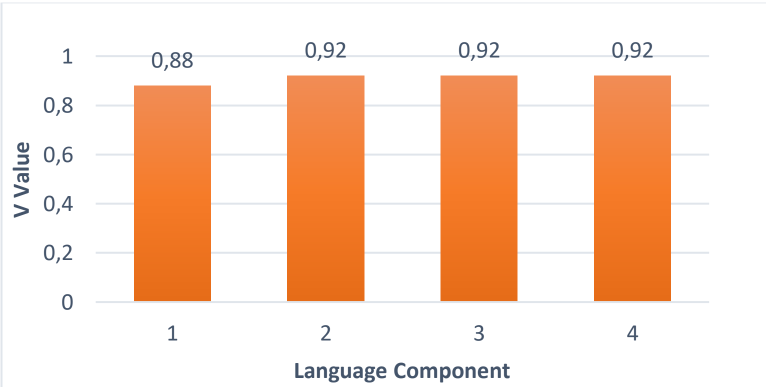

Figure 4. Language Component Assessment Results

In Figure 4, it can be seen that the V aiken value of each indicator of the language component is in the range of 0.88 to 0.92. The highest V value was obtained by three indicators, namely indicators of clarity of information, conformity with Indonesian language rules, effective and efficient use of language. Each indicator obtained a V value of 0.92 with a very valid category. While the lowest V value is obtained by the readability indicator, which is 0.88 with a very valid category. Based on these data, it can be said that each indicator in the language component is in a very valid category. The average value for the language component is 0.91 with a very valid category.

The fourth validation component is the presentation component. The presentation component consists of five assessment indicators, namely 1) clarity of purpose, 2) order of presentation, 3) provision of motivation, 4) interactivity, and 5) completeness of information. The following are the results of the assessment on each indicator of the language component which can be seen in Figure 5.

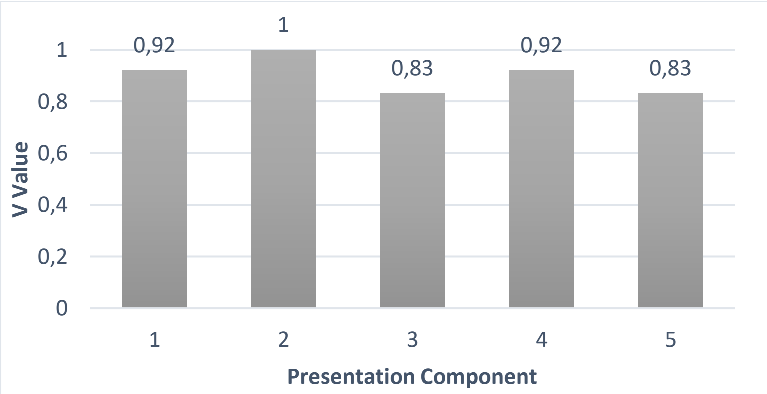

Figure 5. Presentation Component Assessment Results

Based on the data in Figure 5, it can be seen that in the presentation component the range of V values obtained by each indicator is in the range of 0.83 to 1. The highest V value is obtained by the presentation order indicator with a V value of 1 which is in the very valid category. While the lowest V value is obtained by two indicators, namely the indicator of providing motivation and completeness of information. Each indicator obtained a V value of 0.83 with a very valid category. From these data, it is known that each indicator is in the very valid category. Overall, the average validity value for the presentation component is 0.90. This value states that the presentation component falls into the very valid category.

The fifth validation component is the graphical component. This component focuses on the design and appearance of the developed module. To assess the module's graphics, there are 4 indicators that are assessed, namely 1) font usage, 2) layout, 3) illustrations, images, photos, and 4) display design. The results of the assessment of each of the indicators on the graphical component can be seen in Figure 6.

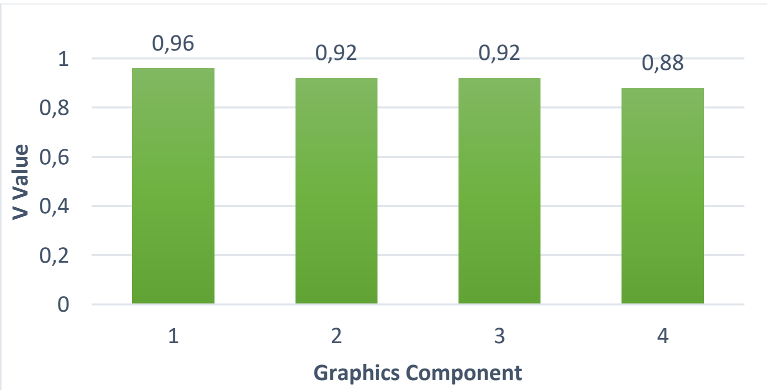

Figure 6. Graphics Component Assessment Results

The results of the assessment of the graphical component contained in Figure 6 show that each indicator has a V value in the range of 0.88 to 0.96. The highest V value is obtained by the font usage indicator which is 0.96 with a very valid category. While the lowest V value is obtained by the display design indicator which is 0.88 with a very valid category. Based on this data, it is known that the results of the assessment of all indicators in the graphical component are classified into a very valid category. The average V value on the grammatical component is obtained at 0.92, where the value is included in the very valid category.

The sixth validation component which is the last component in this assessment is the integration component of the PBL model in the module. The assessment carried out on this component is an assessment of the integration of the steps or syntax of the PBL model in the module. The syntax of the PBL model assessed in the module is 1) orienting students to the problem, 2) organizing students to learn, 3) guiding individual or group investigations, 4) developing and presenting work, 5) analyzing and evaluating the problem-solving process (Arends, 2024). The results of the assessment of the integration of the PBL model in the developed module can be seen in Figure 7.

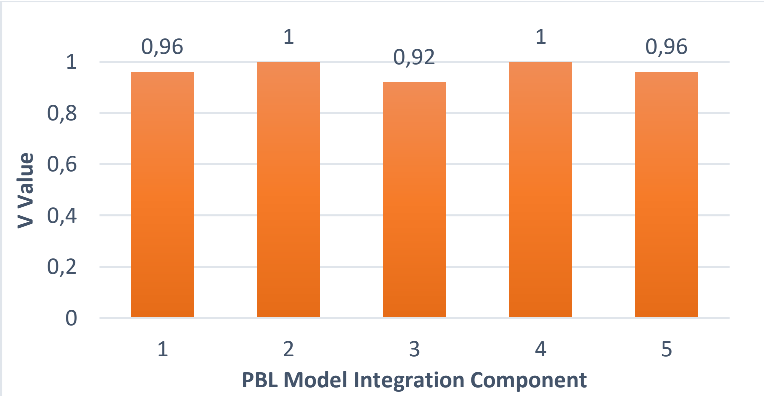

Figure 7. Assessment Results of PBL Model Integration Component

Figure 7 shows the results of the assessment of the integration component of the PBL model in the developed module. From the figure it can be seen that each indicator has a V value that is in the range of 0.92 to 1. The highest V value is obtained by two indicators, namely the indicator of organizing students to learn and the indicator of developing and presenting work. Each indicator obtained a V value of 1 with a very valid category. While the lowest V value is obtained by the indicator of guiding individual or group investigations, which is 0.92 with a very valid category. Each indicator has assessment results that are in the very valid category. The average value obtained by the integration component of the PBL model is 0.97 with a very valid category.

From all the assessment results obtained, the average V value obtained from each component of the validity assessment can be seen in Figure 8.

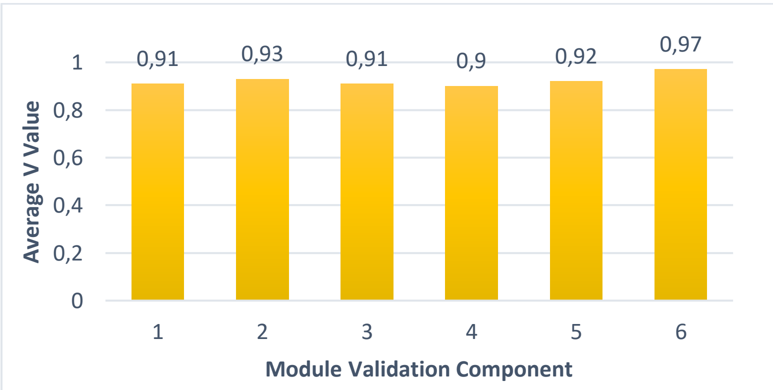

Figure 8. Graph of Average Value of Each Validation Component

Based on the bar chart presented in Figure 8, it can be seen that the average value for each component is in the range of 0.9 to 0.97. These components include 1) module components, 2) content feasibility, 3) language, 4) presentation, 5) graphics, and 6) integration of the PBL model. The component that has the highest average V value is obtained by the PBL model integration component, which is 0.97, while the lowest V value is obtained by the presentation component with an average V value of 0.9. Based on the value obtained from each validation component, the validity value of the developed module is 0.92, with a very valid category. Thus, it can be concluded that the Physics learning module integrated with the PBL model on renewable energy material is very valid and can be used by teachers and students in learning activities.

Discussion

This research was motivated by the findings at the define stage, namely the lack of allocation of Physics lesson hours in Madrasah Aliyah (MA) compared to Senior High School (SMA) in implementing the independent curriculum. This condition raises the need to provide teaching materials that can support students to learn independently. One of the efforts that can be made to support students to learn independently is to use learning modules. The use of modules in learning can make students learn independently effectively without having to depend on the teacher (Siswanto, 2020). In addition, the teaching materials used by students should be integrated with the PBL model, this is because the learning outcomes of Physics phase e of the independent curriculum require students to be active in providing problem solving. The PBL model is a model that is very suitable to be applied to train students to learn to solve problems (Qoriana, 2021). The use of the PBL model can help students to develop their skills in finding the right solution to a problem (Wulandari, 2021).

Based on preliminary studies conducted at the school, several problems were found, namely the learning module used previously did not contain important components that should be contained in the module and the module used by students was also not integrated with the PBL model. Therefore, this research aims to develop Physics learning modules integrated with PBL models that are valid and can be used by students in learning. The developed module refers to the module components according to the Ministry of Education (2008) which consists of seven important components. These components are title, learning instructions (student/teacher instructions), competencies to be achieved, supporting information, exercises, work instructions (worksheets), and evaluation/assessment. Meanwhile, the integration of the PBL model is done by arranging learning activities based on the steps of the PBL model.

After the product was designed, the next step taken in this study was to assess the validity of the module. Module validation was conducted by three experts from the Physics department of FMIPA UNP. In the module validity assessment, there are six components assessed by the validator. These components are module components, content feasibility, language, presentation, graphics, and integration of PBL models. After the analysis, the V value for each component was obtained as follows: 1) the module component is 0.91; 2) the content feasibility component is 0.93; 3) the language component is 0.91; 4) the presentation component is 0.9; 5) the graphical component is 0.92; 6) the PBL model integration component is 0.97. From the data on the V value of the six components, the module validity value based on the average V value of all components is 0.92 with a very valid category. Based on the validity value, it can be concluded that the developed module has successfully achieved the development objective, which is to produce a valid learning module. This module can be an alternative teaching material that can be used by teachers and students to improve the quality of learning.

CONCLUSION

Based on the results of research and analysis conducted, it is known that the physics learning module integrated with the problem-based learning model on renewable energy material that has been developed belongs to the very valid category with a validity value of 0.92. All components in the module validity assessment have a high validity value with a very valid category. The validity component that has the highest validity value is obtained by the PBL model integration component, with a V value of 0.97. The validity component that has the lowest validity value is obtained by the presentation component, with a V value of 0.9. Although the presentation component has the lowest validity value, the value obtained is still in the very valid category. Thus, it can be concluded that the developed module is valid and can be used in learning activities.

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