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# Validity of the Physics E-Module on Alternative Energy and Global Warming for Class X Based on an Integrated Problem Based Learning Model integrated 21st Century Learning

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**Abstract:** This research aims to reveal the level of validity of class prepared based on the syntax of the problem based learning model and integrated with the four 21st century skills, namely, collaboration skills, critical thinking skills, creative thinking skills and communication skills. This research is research and development using the Plomp model. The instrument used was a questionnaire and the data was analyzed descriptively based on the validation score sheet. Products are validated by experts. The observation results were analyzed using the Aiken V formula. The results of the analysis showed the average value of Aiken's V was 0.97. The validity results show that the physics e-module meets the valid criteria. These findings indicate that the physics e-module on alternative energy and global warming material, based on problem based learning integrated with 21st century learning, is suitable for use.

**Keywords:** E-module; PBL; 21st century learning

## Introduction

In the 21st century, science and technology are developing very rapidly. We as humans live in this century so that we can participate and follow progress. New innovations have been introduced across a number of disciplines to better prepare humanity for the challenges that lie ahead. The same applies to education, where teachers must prepare students for life in the 21st century (Nilyani et al., 2023; Zan et al., 2023). Increasingly advanced technological developments have begun to be applied in learning to increase efficiency. Learning in the 21st century emphasizes several skills such as creativity, critical thinking, cooperation, problem solving skills, communication skills, social skills, and character skills. Therefore, in facing this era, learning must be able to produce students who have various skills to achieve success in life (Yulkifli et al., 2019), students must master 21st century skills in order to play a role in the world of education and be able to work and survive in the future by using the skills they have (Hidayat et al., 2020).

One of the skills that must be mastered by students in education is Learning and Innovation Skills (learning and innovation skills), also known as the Four C, namely critical thinking, communication, collaboration, and creativity (Hasanah & Malik, 2019). 21st century skills have a very important role in the process of learning physics, this is because learning physics does not only focus on mastering facts, concepts, principles, and laws, but also involves other skills, such as the ability to find information, use technology, apply the scientific method, and critical thinking skills (Hudha et al., 2017). Physics is part of the natural sciences which strengthens the ability to think analytically in overcoming various problems related to events around us (Ningrum et al., 2015). Learning Physics is expected to be able to instill and cultivate the habit of thinking and behaving scientifically critically and creatively, so that students can apply this scientific mindset in various situations in their lives (Kallesta, 2017). Thus, they will be better

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prepared to face complex challenges and problems in an analytical and innovative way.

Based on the explanation above, it can be seen that the importance of 21st century skills for students in learning physics. However, the facts found in the 21st century skills field are still relatively low. Based on this problem, we need a solution to overcome it. The solution chosen in this study is to develop teaching materials in the form of physics E-modules based on problem based learning models integrated with 21st century learning with global warming material. In current technological developments, most students are more interested in teaching materials that utilize other media such as personal computers/laptops, even smartphones compared to teaching materials in the form of printed worksheets (Haryanto et al., 2020). E-Module can be a means to assist and facilitate teaching and learning activities so that effective interactions will be formed between students and teachers so that they can increase student activities in increasing learning outcomes. The created e-module integrates the problem-based learning model. The problem based learning model is a learning model that is able to improve students' 21st century abilities.

Problem based learning is a student-centered learning model, with learning methods that encourage students in investigations to solve real life problem cases (Tarmizi et al., 2017; Ulfah, 2017; Fidan & Tuncel, 2019; Gusti & Ratnawulan, 2021). Problem-based learning is considered capable of fostering a creative, collaborative spirit, developing higher-order thinking skills, increasing understanding, increasing independence, facilitating problem solving, and building teamwork (Salamiyah & Kholiq, 2020). The problem based learning model trains higher-order thinking skills, helps students to process existing information and gathers students' knowledge about the social world and its surroundings (Yustina et al., 2022). So that this model is very effective when applied in physics learning to improve the quality of learning and support the improvement of 21st century skills.

Several previous studies have also shown the effectiveness of using teaching materials and integrating problem based learning models in improving students' 21st century skills, this is evidenced by the results of research conducted by Susilo (2012), Rahmawati et al. (2017), Prana et al. (2018), Nugraha (2018), Astuti et al. (2018), Istriani & Suparman (2018), Nurhasanah et al. (2023), and Ulina (2022) shows that the use of problem-based learning-based teaching materials can improve critical thinking skills. Meanwhile according to Firdayanti et al. (2020), the results of the study show that problem-based learning-based teaching materials on global warming material meet valid qualifications and are suitable for use as learning resources.

However, there are several limitations to previous research. First, researchers only developed an E-module based on a problem based learning model to only look at one 21st century skill. Second, there has been no development of teaching materials in the form of E-modules based on problem based learning models that are integrated with 21st century learning. Third, there has been no development of teaching materials in the form of E-modules based on problem based learning models integrated with 21st century learning on global warming. Therefore, this research created a class X physics e-module on alternative energy and global warming based on problem based learning integrated with valid 21st century learning.

## Method

The research carried out was design research using the Plomp model development study type. The development study is at the prototype stage, namely product validation. Problem based learning e-module validity components include material substance, learning design, appearance and use of software. The assessment of the validity of the e-module is carried out by experts who are experienced in the field. Before evaluating the validity of the e-module, the validity of the instrument used was tested first. The questionnaire was completed by expert review and analyzed to determine the validity of the instrument. Valid instruments are used to assess the validity of e-modules. Furthermore, the questionnaire filled out by the expert is then analyzed to determine the validity of the e-module being developed. Validity analysis uses a Likert scale with steps (a) Giving a score to each answer; with strongly agree (5), agree (4), doubtful (3), disagree (2) and disagree (1), (b) Add up the total score of each expert review for all indicators, (c) Give a validity value by using Aiken's V Formula (Aiken, 1985).

$$V = \frac{\sum S}{[n(c-1)]} \quad (1)$$

with: s = r - lo, lo = the lowest validity score (in this case = 1), c = the highest validity score (in this case = 5), r = the number given by the expert review. Validity categories can be seen in Table 1.

**Table 1.** Validity Category (Novitra et al., 2020)

| Value | Category |
|---|---|
| ≥ 0.6 | Valid |
| < 0.6 | Invalid |

Based on Table 1, it can be seen the criteria for the validity agreement values obtained. This validity is

carried out using the Aiken's V formula and is categorized into two values, namely valid and invalid. The e-module instrument developed can be said to be valid if the value obtained exceeds or is equal to 0.6.

## Result and Discussion

Plomp development model, at the analysis stage a preliminary analysis is carried out to find problems that exist in the field. Then at this design stage, the researcher creates the design and its components developed e-module. Then at the development stage, we start creating and arranging teaching material developed into a good and validated e-module. The following is an overview of the e-module that has been developed which can be seen in the image below.


**Figure 1.** Cover of e-module

The cover on the e-module is designed with an attractive color combination. On this cover, there is the title, agency logo and independent curriculum logo, an image according to the contents of the e-module, and the author's identity. A good cover can make people interested in seeing and reading the contents of the final cover. A good cover of teaching materials must also be able to represent what is contained in it.

The e-module consists of several learning activities. In learning activities there are learning outcomes and learning objectives, material descriptions, practice questions, summaries, self-assessments, evaluations, answer keys, and bibliography. The development carried out in this e-module is to include problem based learning model syntax and 4C indicators, namely 21st century skills, in learning activities. Problem based learning syntax is included at the beginning, namely student orientation to encourage students to solve problems given in the form of cases that are appropriate to students' real lives, then other syntax is included in the student worksheet section which is also integrated with indicators of 21st century skills. Exercises, summaries and the evaluation contained in the e-module aims to strengthen new concepts discovered by students. The next section, namely the answer key and bibliography, is created so that students can study independently.

**Figure 2.** Parts of learning activities

*Results of Instrument Validity*

The instrument to validate the PBL-based physics e-module prototype integrated with 21st century learning was assessed first by 2 experts using the instrument validity assessment sheet. The components of the instrument validity assessment include the suitability of statements with the instrument grid, the instrument can reveal the quality of content, language, and construction of PBL-based physics e-modules integrated with 21st century learning, and the instrument is clear and easy to understand to use. The results obtained from this assessment were that the validity of the instrument was 0.96. The average validity value (Aiken's Values) of the PBL based physics e-module integrated with 21st century learning instruments from experts is greater than 0.6 in category validity. Thus, the validity instrument of the PBL-based physics e-module integrated with 21st century learning can validate the PBL-based physics e-module integrated with 21st century learning.

*Validity Result of Physics E-module Based on the PBL Model Integrated 21st Century Learning*

This e-module was validated by three validators, consisting of two lecturers from Padang State University and one physics teacher from SMAN 3 Sungai Penuh.

The research results indicate that the physics e-module for this class X valid can be found in Table 2.

**Table 2.** Validity of the Physics E-Module

| Aspect | Average | Criteria |
|---|---|---|
| Material Substance | 0.99 | Valid |
| Learning Design | 0.97 | Valid |
| Appearance | 0.97 | Valid |
| Utilization of Software | 0.94 | Valid |
| Average | 0.97 | Valid |

The results above provided by each validator show that the physics e-module is valid with an average value of validity (Aiken Value) of 0.97 and can be used physics learning with minor revision. The revision is relating to suggestions provided by the experts, as can be seen in Table 3.

Based on the suggestions given by the validator, the physics e-module prototype based on the PBL model integrated with 21st century learning was revised and a final prototype was obtained which was suitable for physics learning in Senior High School to develop 21st century competence. Good teaching materials can facilitate students to get to know the natural surroundings better (Cebesoy & Öztekin, 2017; Fischer et al., 2018; Brunner & Abd-El-Khalick, 2020; Chen & Xiao, 2021). Therefore, the presentation of material is said to be good if the teaching materials used are valid and suitable for use. This is in accordance with research (Ninawati et al., 2021) which developed an e-module based on I spring 9 software with very good feasibility criteria in the material aspect. Thus, it is hoped that the e-module in this research can be used to optimize learning activities that support 21st century skills.

**Table 3.** Validator Suggestions

| Validator | Suggestions | After Revision |
|---|---|---|
| EM | It would be better if the learning objectives section also describes the indicators for 21st century learning | Learning objectives have been adjusted to 21st century learning indicators |
| | The graphic on page 10 is not clear, corrected. | The graphic on page 10 has been corrected so that it appears clear and easy to read |
| FN | Self-assessment should also describe indicators of 21st century learning | Self-assessment has been improved by adapting to 21st century indicators |
| | Self-assessment has been improved by adapting to 21st century indicators | The syntax layout of the PBL model has been improved as per suggestions |
| UN | No Comment | - |

## Conclusion

Based on the research process and results, it was concluded that the design of the physics e-module to improve students' 21st century competence in physics learning in high school is valid in terms of material substance, learning design, appearance and use of software with an average value of validity (Aiken Value) of 0.97. This means that e-modules can be applied to physics learning in high school and in theory can improve students' 21st century competencies.

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**Author Contributions**
The author's contributions include Korry Nilyani: collecting data, analyzing data, writing original drafts, and so on; Ratnawulan: Person in charge of research.

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**Conflicts of Interest**
The authors declare no conflict of interest.

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