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Analysis of Needs for e-Modules Based Problem-Based Learning on Renewable Energy Materials to Improve Creative Thinking Skills of Senior High School Students

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Abstract

This aims to explore the needs and interests of students in learning Physics through the use of electronic modules at SMA Negeri 1 Namang with a descriptive research approach. The research involved 99 students from three classes. The results of the preliminary study show that only 25.3% of students have knowledge of electronic modules, while their use in schools is still rare. However, all students showed a high interest in learning using electronic modules that contain images, text, and videos. Electronic modules are considered learning resources that facilitate understanding of the material and improve the overall learning process. Students expect electronic modules that are concrete, easy to understand, and able to improve creative thinking skills. They also want material that is explained in-depth and relevant to everyday life and is supplemented with relevant examples of questions. The appearance of an attractive electronic module is also considered important by students. In the context of an independent curriculum, students experience difficulties in learning renewable energy material, with several factors causing difficulties such as material that is difficult to understand, too many formulas, limited learning resources, and lack of application of examples and various learning orientations. This research shows the need to develop electronic modules that are complete, interactive, and in accordance with the needs of students to increase their understanding and interest in learning Physics.

***Keywords**: e-module; problem-based learning models; creative thinking skills*

Introduction

The presence of the industrial revolution 4.0 has had a very big influence on human life. Almost all aspects of human life today are inseparable from the role of technology. The industrial revolution 4.0 also had an impact on the world of education in Indonesia, starting with the digitization of the education system which requires every element in the education sector to be able to adapt to the changes that are taking place (Dito & Pujiastuti, 2021). In Indonesia, it is necessary to create quality human resources to be able to compete with society. On this basis, 21st-century education should be able to develop superior knowledge, skills, attitudes, and values (Prayogi, 2020).

21st-century skills can be trained through education so that educators and students expand their capabilities with technology in order to improve the quality of their future careers and social life (Farisi, 2016).

In the 21st century era, there are three main competencies that are the main focus in the learning context, namely the competence to think, act, and live in the world (Rosdiana et al., 2020). Thinking competence includes critical thinking skills, creative thinking, and problem-solving skills. Acting competencies include skills in communication, collaboration, digital literacy, and technology literacy. Meanwhile, competence in living in the world includes the ability to take initiative, self-direction, global understanding, and social responsibility.

In the context of 21st-century learning, the application of these competencies is crucial, given the demands for innovation, creativity, and adaptability which are the keys to facing the challenges of the times. Thus, curriculum development that supports the integration of these

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competencies in learning is very important and relevant to preparing future generations who are ready to face global complexities (Abdillah & Hamami, 2021). Physics learning facilitates students to develop 4C'S, namely *critical, creative, collaboration, and communication skills* (Waluyo & Wahyuni, 2021).

In facing the intense competition for human resources globally in the 21st century which is marked by a dynamic and competitive global environment, the independent curriculum is present as a solution to meet these challenges. Indarta et al., (2022) state that the importance of the Free Learning Curriculum as a response to the demands of the times, by providing freedom and flexibility to students to optimally develop their potential and interests, becomes increasingly evident in order to ensure the success of a nation in facing global challenges by produce graduates who are competent, innovative, and ready to face rapid changes.

This curriculum was developed with the hope of creating a millennial generation that is able to understand the material or knowledge taught by the teacher quickly, not just being good at remembering the teaching material provided by the teacher. To achieve quality human resources, good student learning outcomes are needed, which can be realized by increasing learning motivation through the use of information and communication technology in the learning process (Pratama et al., 2023). Students are also expected to be able to utilize technology in their learning process. Previously, education in Indonesia relied heavily on textual books, but now digital products have begun to be replaced (Samala et al., 2021). This is what marks the rapid development of technology, especially digital in the 21st century.

Teachers in the 21st-century education era need to adapt strategies, models, and teaching methods to the characteristics of the latest generation of students (Sobarningsih & Muhtar, 2022). This is supported by Mulyono (2022) who states that conventional learning approaches are no longer effective enough. They must be innovative and update their knowledge and skills in order to create interesting and interactive learning experiences by utilizing technology.

The 21st-century learning model, as suggested by Indarta et al. (2021), emphasizes the use of technology, especially the internet, as a supporting tool. Students are required to be active and independent in developing 4C skills (critical thinking, communication, collaboration, and creativity). Physics learning facilitates students to develop 4C'S (Waluyo & Wahyuni, 2021). Therefore, teachers need to support students by utilizing relevant technology so that they can face real-world challenges and are ready to contribute to an increasingly digital and global society.

The 21st-century learning model also emphasizes how students can think critically, are good at communicating, are able to collaborate, and have high creativity (Ramadhani et al., 2019). One learning model that supports the achievement of these goals is the Problem-Based Learning model (Awaludin et al., 2020).

The implementation of the Problem-Based Learning model is an important focus in improving students' creative thinking skills (Elizabeth & Sigahitong, 2018). Renewable energy is becoming an increasingly relevant and urgent topic in efforts to maintain environmental sustainability and reduce the negative impacts of climate change (Desnita, 2015). In this context, this research aims to identify the need for PBL implementation to improve creative thinking skills on renewable energy materials. This research will also present solutions that are planned and supported by the latest references to overcome the existing challenges. Through the right learning approach and the development of relevant skills, students will be better prepared to face the challenges of renewable energy in the future and play an active role in maintaining environmental sustainability (Zain & Gunawan, 2019).

The development of teaching materials adapted to the conditions of Indonesian students has interesting interests in research and development. Several studies have developed and tested the effectiveness of modules or modules to improve critical thinking and creative thinking skills. Asnawati et al. (2022) research results show that the Google Meet and Google Classroom applications are effectively used in implementing PBL to develop the skills of 4C students. (Khamzawi et al., 2015) developed interactive multimedia based on the Problem-Based Learning model in the physics subject of fluid dynamics for class XI high school. The results of Khamzawi et al. (2015) show that interactive multimedia based on the Problem-Based Learning learning model in the physics subject of fluid dynamics for class XI high school is very feasible to use. So then the question arises of how much is needed to develop electronic

modules based on the Problem-Based Learning model on renewable energy material in physics learning at the high school level.

Based on this explanation, the purpose of this study is to provide an overview regarding the need for the development of electronic modules based on the Problem-Based Learning model in physics learning at SMA Negeri 1 Namang.

Research Methods

This research uses a descriptive research approach to explore the need for developing electronic modules based on Problem-Based Learning on renewable energy material with the aim of improving students' creative thinking skills. Data collection techniques used in this study were questionnaires and interviews.

The research subjects consisted of class X students at SMA Negeri 1 Namang in the 2022/2023 Academic Year. The questionnaire was carried out for class X students using the Google form.

Data collection was carried out to obtain information about how important it is to develop electronic modules based on Problem-Based Learning on renewable energy materials in the context of improving learning. Data from the questionnaire were then analyzed descriptively, including data reduction and conclusion. To calculate the percentage use the formula 1.

$$\text{Interpretation of scores} = \frac{\text{Total Skor}}{\text{Skor Maksimum}} \text{ x } 100 \qquad (1)$$

Interpretation results of scores are categorized based on the following Table 1 (Sugiyono, 2010).

Table 1. Interpretation of student response scores

Percentage (%)	Category
0 % - 25 %	Strongly Disagree
26 % - 50 %	Disagree
51 % - 75 %	Agree
76 % - 100 %	Strongly Agree

By using descriptive research methods and data collection techniques that include questionnaires, this research is expected to provide a clear picture of the need and importance of developing problem-based learning electronic modules on renewable energy material in improving students' creative thinking skills at SMA Negeri 1 Namang.

The data analysis carried out will provide useful information in making decisions related to the development of electronic modules and improving physics learning in the school.

Results and Discussion

This research involved 99 respondents from three classes at SMA Negeri 1 Namang. In Figure 1, data is presented regarding the class identity of the respondents in this study. The data provides information about the number of students involved in the research and the respondents to the questions asked. These data provide a solid basis for the analysis and conclusions drawn in this research because they reflect the perceptions and responses of a group of students who are representative of the population studied. The results of the analysis of student responses are shown in Table 2.

Table 2. Data from the analysis of the needs of students

No	Aspect	Percentage (%)
1	Student knowledge of e-modules	(25.3) yes (44.4) never heard of (30.3) do not know
2	Application of e-modules to student learning	(30.3) never (35.4) rare (34.3) ever heard of
3	Material that is easy for students to understand in e-modules	(26.2) a lot of text (35.5) lots of pictures (10.9) lots of audio (20.8) lots of videos
4	Opinions of students regarding the benefits of e-modules	(57.6) simplify the learning process (42.4) makes it easier to understand the material
5	Student opinions about e-modules that can facilitate learning	(41.4) has an attractive appearance and is not boring (31.3) has complete material and sample questions (24.2) has contained information for everyday applications

No	Aspect	Percentage (%)
6	Class X physics material that is difficult for students to understand.	(40.6) renewable energy
7	Constraints experienced by students during the learning process	(14.6) less learning resources (28.5) the material is difficult to understand (12.6) learning tends to assignment (12.6) the explanation is not accompanied by examples of daily application (26.5) too many formulas mathematically
8	The importance of using e-modules as a solution to the problems experienced	(78.8) agreed
9	Students' expectations of the developed e-module	(83.8) can be used for the public (14.1) according to needs and improve creative thinking skills

Analysis of the need for *e-modules* in learning

Based on the results of the analysis of student responses shown in Table 1, it can be seen that the introduction shows that only 25.3% of students have knowledge about the module, and most of the students still have a minimal level of understanding regarding the potential and benefits of using electronic modules as learning aids.

In addition, the study findings also indicate that the use of electronic modules in the school environment is still not common and is still limited. The results of the preliminary study revealed that as many as 30.3% of students said they had never and 35.4% said they rarely used *e-modules* as a learning resource.

This situation indicates that more intensive efforts are needed to introduce and integrate electronic modules in the context of learning in schools so that students can take advantage of the potential of available technology to improve the quality of learning and expand access to more diverse and interactive learning resources.

The data shown in Table 1, it shows that students have an interest in learning using electronic modules that display lots of pictures (65.7%), text (48.5%), and videos (38.4%). However, the results of the preliminary study also revealed that even though the level of knowledge about electronic modules was still low, all students showed a high interest in learning using electronic modules that displayed lots of pictures at 65.7%. They are attracted to powerful visualizations in the form of images that can help clarify concepts and enrich their understanding. In addition, as many as 48.5% of students also showed an interest in using electronic modules that contain text. This shows that they recognize the importance of getting written information in addition to understanding the concepts being taught. In addition to images and text, around 38.4% of students showed an interest in electronic modules that present material in video form.

Based on the opinions of students, the electronic module is very helpful in understanding the material as much as 57.6% of students. They felt the electronic modules made it easier to access and explained concepts better. In addition, 42.4% of students feel that the electronic module improves the learning process as a whole. Electronic modules help them learn in an interesting way and provide flexibility in accessing the material.

Students also have certain expectations of electronic modules. They expect the electronic module is able to change abstract content into more concrete (53.3%), making it easier to understand and connect complex concepts to become more real and feel relevant. Furthermore, they hope that the e-module can improve creative thinking skills (44.4%), by presenting challenging tasks and promoting innovative problem-solving. In addition, students also wanted material that was explained in depth and able to add to their insights (80.8%), so that they could broaden their knowledge and understanding of the topic being studied.

With high interest, practical benefits, and related expectations, students believe that the use of electronic modules as a learning resource will have a positive impact on their learning process. They hope that the e-module can provide an interactive, interesting, and effective learning experience in facilitating better understanding and the development of creative thinking skills.

Based on the research results, it can be seen that as many as 24.2% of students have a similar

view of the ideal electronic module. According to them, the expected electronic module is one that is able to present material in a complete manner, with information that is relevant and useful in everyday life. As many as 31.3% of students also wanted examples of relevant questions so they could apply the knowledge learned in a more real context.

In addition, students also pay attention to the appearance of electronic modules that are interesting and not boring. This is shown by 41.4% of students expecting attractive visual elements in the module, such as the use of graphics, images, and animations that can enrich the learning experience. This is because students believe that a visually attractive display can increase their interest and involvement in the learning process.

By taking into account the expectations of these students, the development of electronic modules can be more directed to meet their needs. Modules that present material in a comprehensive, relevant, and related to everyday life, as well as a visually attractive display, can motivate and increase students' interest in learning (Awwaliyah et al., 2021). In addition, the use of electronic modules that combine useful content with an attractive appearance can also improve students' creative thinking skills to achieve a better understanding (Istikomah et al., 2020; Zulkarnaen et al., 2022).

Analysis of the importance of PBL-based *e-modules* on renewable energy materials

In the context of the currently implemented independent curriculum, students have been focused on materials that are considered essential. Nonetheless, the results of the questionnaire conducted showed that most students (58.6%) had difficulty learning renewable energy materials.

The difficulties experienced by students in learning renewable energy materials can be caused by several factors that become obstacles during the learning process. One of the factors is the complexity of the material which is difficult to understand, where as many as 43.4% of students stated that they had difficulty understanding concepts related to renewable energy. In addition, another factor that plays a role is the number of formulas that need to be mastered, which was expressed by 40.4% of students as one of the causes of their difficulties. These formulas require a deep understanding and the ability to apply them appropriately.

Furthermore, the limitations of learning resources are also a factor affecting students' difficulties in learning renewable energy material. As many as 22.2% of students said that limited access to quality and relevant learning resources was an obstacle to gaining a good understanding of the material. Lastly, the lack of examples and learning orientations that provide better understanding are also considered contributing factors to students' difficulties. They want learning that is more focused on understanding concepts rather than just assignments.

By understanding these factors, it is important for *e-module development* to pay attention to the complexity of the material, present formulas in a clear and structured way, provide adequate learning resources, and provide relevant examples and a comprehensive learning orientation. This will help overcome the difficulties students face in learning renewable energy materials and improve their understanding effectively.

Almost all students stated the importance of using *e-modules* on renewable energy materials as a solution to the problems they were experiencing. Furthermore, it can be seen that students have high expectations for the development of *e-modules*, where as many as 83.3% of them express a desire to have *e-modules* that suit their needs. They hope that this *e-module* can improve their creative thinking skills so that they can develop the ability to think innovatively and produce creative solutions in solving problems. In addition, as many as 14.1% of students also expect that the material presented in *the e-module* can be understood properly so that they can better master the concepts being taught and gain a deep understanding.

This is in accordance with the definition of an *e-module* according to Deviana (2018) that an *e-module* includes interesting teaching materials by containing complex concepts and teaching and using easy-to-understand languages so that students can study it independently.

In developing *e-modules*, it is important to pay attention to the expectations of these students. *E-modules* need to be designed creatively and relevant to the needs of students in order to meet their expectations. The content presented in *the e-module* must be clear and easy to understand, with in-depth and precise explanations according to the

level of understanding of students (Saprudin & Hamid., 2021). In addition, the use of learning methods and strategies that can encourage creative thinking skills also needs to be considered in the development of this *e-module*. By fulfilling students' expectations, *e-modules* can be an effective tool in increasing their understanding and creative thinking skills.

This research shows that the use of electronic modules in energy learning has great potential to improve understanding of the material and the learning process as a whole. Students show a high interest in using electronic modules that are equipped with various features, such as images, text, and videos. This is in accordance with research (Sriyanti et al., 2020). that students are interested in using e-modules as learning tools so as to help students in teaching and learning activities.

Some students experience difficulties in learning renewable energy material. Factors that cause these difficulties include the difficulty level of material that is difficult to understand, the large number of formulas, limited learning resources, and the lack of examples and adequate learning orientation. This shows the need for a learning approach that is more effective and provides more complete learning resources. In line with the results of research (Mahrus et al., 2021) which says that the use of appropriate and effective learning resources can help reduce students' learning difficulties when understanding the material.

Students also expressed their hopes for the electronic module in energy learning. They want an electronic module that is able to change abstract content into more concrete so that the material can be understood more easily. In addition, students also expect that electronic modules can improve creative thinking skills and provide in-depth understanding and increased insight.

In addition, previous research by Yerimadesi et al. (2022) showed that the use of electronic modules can help improve students' creative thinking skills. This finding is very relevant to the results of this study which shows that students have expectations for *e-modules* that are able to improve their creative thinking skills. In the context of learning Physics, electronic physics modules that are designed interactively and challengingly can encourage students to think actively, ask questions, and seek creative solutions to problems related to renewable energy materials, as stated by Mubarok et al. (2022).

In interactive electronic modules, students have the opportunity to interact directly with learning materials through features such as animations, simulations, and interactive assignments. This provides a more interesting learning experience and invites students to be actively involved in the learning process. Students can explore their understanding through independent exploration and find creative solutions to the problems given. Thus, *e-modules* can function as an effective tool in enhancing students' creative thinking skills in learning Physics concepts, especially in the context of renewable energy.

In addition, the use of *e-modules* also provides flexibility to students in accessing learning materials. With *e-modules* that can be accessed anytime and anywhere via smartphone devices, students have control over their time and place of study. This allows students to learn independently and take advantage of the technology they have. In the era of an independent curriculum that emphasizes empowering students in the learning process, *e-modules* can be an effective alternative in providing accessibility and independence for students in studying Physics material.

Therefore, this study shows that there is a strong need and high interest from students in using *e-modules* as a means of learning Physics at SMA Negeri 1 Namang. *E-modules* equipped with image, text, and video features, as well as interactive and challenging designs, can facilitate understanding of the material and improve students' creative thinking skills. Thus, the development of *e-modules* that are complete, interactive, and in accordance with the needs of students is a recommendation given to improve the quality of learning Physics. Implementation of *e-modules* through a descriptive research approach can empower students' use of technology and have a positive impact.

Conclusion

Based on the results of the study, it can be concluded that the use of *e-modules* is still rarely used by teachers, so students need *e-modules* that can assist in facilitating the learning process and understanding renewable energy material well and making conceptual descriptions that are in

accordance with real conditions and designed according to the needs of students. So what is suitable for use in *problem-based learning-based e-modules* that can improve students' creative thinking skills that are interesting by containing images, text, sound, audio, and video. Some suggestions for further research, namely that the animation media developed should be made creative, practical, and effective. And the results of this study can be used as study material for further research on *e-modules* in learning.

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