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Module Development through Project-Based Learning to Enhance Students' Creative Thinking

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Abstract *– In implementing the project-based learning model, students are expected to improve their creative thinking. This research aims to develop a module through project-based learning to improve the creative thinking skills of vocational students. Employing a research and development design, the research involves a 4-D model with four stages, namely defining, designing, developing, and disseminating. Respondents in this study were teachers and students at SMKN 1 Grati, Pasuruan Regency, totaling 13 people. The research was carried out during the period August 1 – September 15, 2021. The results showed that the average value of the validation results for PjBL-based modules was 88.3% (very valid), and lesson plans were 80.3 (valid). Then, the average percentage of teachers' responses to the modules that have been developed was 85% (very practical,) and of students' responses was 78% (practical). Therefore, it can be concluded that the PjBL-based learning module developed in the research can be categorized as valid and practical.*

Keywords: *creative thinking; module; project-based learning; vocational students*

I. INTRODUCTION

Physics is one of the subjects incorporated in science, which is considered by students as a subject that is too abstract to understand (Ekici, 2016). The chapter on energy and its changes is a complex matter in physics and is also very applicable. In the process of learning energy material and its changes, teachers often use the lecture method, while students only act passively in class listening to the teacher's explanation (Napsawati & Kadir, 2022). If students' mastery of concepts is low, students will have difficulty understanding higher-level material. This is due to students' habits of solving problems systematically without understanding the actual concept and students' low mastery of concepts related to the material (Suendarti & Liberna, 2021). Low mastery of concepts can cause students to experience difficulties in solving physics problems. The

impact of low understanding and mastery of concepts can result in the inability of students to achieve a good level of creative thinking (Khaeruddin & Bancong, 2022).

The concept of physics can be built based on students' learning experiences in everyday life (Annisa & Asrizal, 2022; Setiyoaji et al., 2021), but the concepts that are built are sometimes not aligned with the science concept (Silung et al., 2016). This is what causes misconceptions in students (Madu & Orji, 2015). Based on previous studies, it was found that students had difficulty understanding the concept of energy and its changes (Didiş et al., 2014). In addition, students also experience difficulties in understanding the concept of energy properly (Lindsey, 2014). The difficulties faced by students include calculating the amount of work in a system and associating work with changes in energy in a system (Lindsey, 2014). In addition, the abstract concept of energy also provides obstacles in understanding it (Linuwih & Sukwati, 2014).

Based on the researchers' observations, the characteristic of SMKN 1 Grati students is observing steps according to the Standard Operating Procedures (SOP) in productive subjects aimed at preparing students to enter the world of work, therefore, the ability to be literate and think creatively is low because SMKN 1 Grati students rely on SOP. Whereas in learning physics, aspects of creative thinking skills are the main goal of the educational process (Armandita et al., 2017). According to Nur (2016), one of the learning objectives is to be able to make students have good creative thinking skills in solving various problems that exist in the surrounding environment. The ability to think creatively relates to creating new ideas to solve a problem. According to Mursidik et al. (2015), considering the intense competition in the global era and the complexity of problems that exist in all aspects of life emphasizes the importance of the ability to think creatively in the younger generation. In addition, student learning outcomes will be more meaningful if students have the ability to apply their knowledge to solve problems encountered in everyday life. Therefore, it is very important for an educator to develop students' creative thinking skills (Armandita, 2017).

Efforts to improve the ability to think creatively can be done through the implementation of a learning model. Based on research conducted by Handayani and Koeswanti (2021), the problem-based learning model can improve students' creative thinking skills with the lowest score of 2.65%, the highest of 19.90%, and an average increase of 11.28%. In line with the statement of Aziz and Prasetia (2021) that the application of the creative problem-solving learning model can improve the creative thinking skills of SMP Al-Hidayah Medan students and can increase students' activeness in expressing creative ideas when solving problems. Based on the research conducted by Aflah et al. (2023), it can be seen that by using the Project Based

Learning (PjBL) model it can be seen that the value of the creative thinking ability of class V students at SD TI 030 Batu Belah, Kampar District. Ardiansyah and Sunaringtyas (2016) use a creative process developed by Wallas, which state that the creative process includes four stages, namely the preparation stage, the incubation stage, the illumination stage, and the verification stage. Research conducted by Maryani et al. (2019) revealed that the improvement of creative thinking skills could be improved with certain approaches by increasing indicators of (1) fluency, (2) flexibility, (3) originality, and (4) elaboration.

Saputra et al. (2013) define PjBL as a teaching approach that is built on real learning activities and tasks that provide challenges to students related to everyday life to be solved in groups. Students in the PjBL model not only understand the content but also cultivate skills in taking a role in society. In addition, the PjBL model to improve students' creative thinking skills also requires a framework. The required framework is Technology Pedagogical and Content Knowledge (TPACK). According to Putri et al. (2022), TPACK is very important for technology-enhanced education and has improved over the last few years. Durdu and Dag (2017) argued that TPACK is a new type of knowledge that teachers must master to be able to integrate technology well into learning. Apart from being a new type of knowledge, TPACK has become a framework that can be used to analyze teacher knowledge regarding the integration of technology in learning (Tawil et al., 2022).

Based on this description, this study aims to develop a physics learning module with the TPACK framework. The learning model used is the PjBL model. The development of the energy module and its changes using the PjBL model is expected to improve the creative thinking skills of students at SMKN 1 Grati.

II. METHODS

This research is a development research or Research and Development (R&D). Sugiyono (2009) suggests that R&D is a research method used in producing a certain product and testing its practicality and effectiveness. The development model used is the four-D development model. The stages of this four-D model are define, design, develop, and disseminate (Thiagarajan et al., 1974). The define stage consists of two steps, namely, material analysis and student analysis. The design stage of the teaching module begins with writing, reviewing, and editing the teaching module that has been compiled. Furthermore, the develop stage aims to produce a module on energy and its changes using the TPACK framework which has been revised based on input and discussion results from experts, so that valid and practical teaching modules can be obtained. Finally, the disseminate stage is carried out in the same class as the trial class. Then, the teaching module is used by researchers to teach in the

class. The procedure to collect the data in this study is shown in Figure 1.

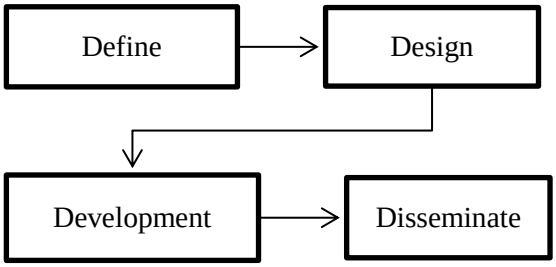


Figure 1. The Four-D model used in the module development

In this study, the subject of the research is the PjBL-based teaching module, while the respondents in this study were teachers and students of SMKN 1 Grati, totaling 13 people. To collect the data, the respondents filled out the practicality questionnaire in order to find out the practicality of the teaching module developed.

The instrument is a tool used to obtain data or information to test the validity and practicality of the teaching module (Toni et al., 2022). To test the validity and practicality of the teaching module that was prepared, the instruments used are:

a. Teacher's response questionnaire to the teaching module

The response questionnaire was used to obtain the teacher's responses to the teaching module developed, including whether it is practical or not. This questionnaire was filled in by the teacher after reviewing and using the teaching module in learning.

b. Teacher's response questionnaire on learning implementation

This questionnaire is used to find out whether the learning prepared is well implemented during learning and also to find out whether the learning used is practical or not in its application in the classroom.

c. Student response questionnaire to the teaching module

The student response questionnaire is filled in by the students themselves to get student responses or responses from the teaching modules used during learning. This student response data will determine the practicality of the teaching modules that have been developed and used.

Data analysis of the research results was carried out to determine the practicality of teaching modules that have been made and developed. The research data were analyzed using descriptive statistical methods to get the average value and percentage. Calculation of the final score data from the practicality analyzed using the formula (Sudjana, 2016):

$$P = \frac{X}{Y}\ x\ 100\ \% \qquad 1)$$

Description:
P: Practicality score
X: Score acquisition
Y: Maximum score

The practicality category of teaching materials based on the final score obtained can be seen in Table 1.

Table 1. Product practicality categories and intervals

Intervals	Category
0 – 20	Very impractical
21 – 40	Not practical
41 – 60	Less practical
61 – 80	Practical
81 – 100	Very practical

(Azmi & Festiyed, 2023)

III. RESULTS AND DISCUSSION

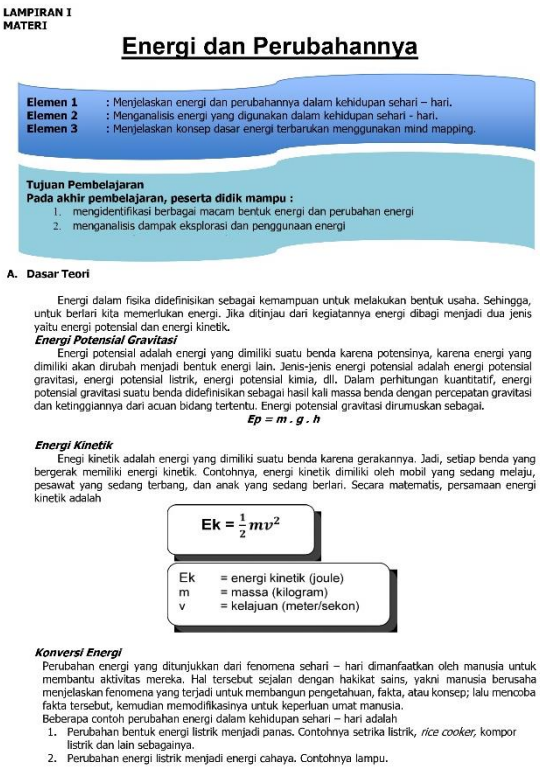
This stage presents the results of the development of PjBL-based teaching modules at SMKN 1 Grati. The material used in the development of this teaching module is energy and its changes. This development step started from analyzing the material to the practicality of the teaching module. After collecting research data, the data were described. The description of the research data is explained as follows:

Define stage

The define stage was the result of an analysis of the material and students. The results of the material analysis carried out were used as a basis for determining the concept of energy and its changes. The concept of energy and its changes was applied in accordance with the PjBL model. This model was used to increase student activity and competency, while student analysis was carried out to determine student characteristics including interests, attitudes, and learning styles. These characteristics were used as a reference for developing teaching modules. The results of the analysis show that students were less active in learning or discussion forums in the classroom, and students' ability to integrate energy material was still less developed. In addition, students still had difficulty in solving problems related to changes in energy because the material described was too complicated. The students also rarely repeated the material at home.

Design stage

Based on the disadvantages and advantages of the material and students, teaching materials can be designed to support the implementation of learning at school. Teaching materials designed in the form of teaching modules based on PjBL. The teaching module consists of a cover that contains the identity of the module, including the title of the material, target users, and module authors. The picture on the cover is in accordance with the material in the module. Furthermore, the content page contains material, exercises, experiments, and projects. An example of the appearance of a module that has been developed using the PjBL model can be seen in Figure 2



LAMPIRAN I
MATERI

Energi dan Perubahannya

Elemen 1 : Menjelaskan energi dan perubahannya dalam kehidupan sehari – hari.
Elemen 2 : Menganalisis energi yang digunakan dalam kehidupan sehari - hari.
Elemen 3 : Menjelaskan konsep dasar energi terbarukan menggunakan mind mapping.

Tujuan Pembelajaran
Pada akhir pembelajaran, peserta didik mampu :
1. mengidentifikasi berbagai macam bentuk energi dan perubahan energi
2. menganalisis dampak eksplorasi dan penggunaan energi

A. Dasar Teori

Energi dalam fisika didefinisikan sebagai kemampuan untuk melakukan bentuk usaha. Sehingga, untuk berlari kita memerlukan energi. Jika ditinjau dari kegiatannya energi dibagi menjadi dua jenis yaitu energi potensial dan energi kinetik.

Energi Potensial Gravitasi

Energi potensial adalah energi yang dimiliki suatu benda karena potensinya, karena energi yang dimiliki akan dirubah menjadi bentuk energi lain. Jenis-jenis energi potensial adalah energi potensial gravitasi, energi potensial listrik, energi potensial kimia, dll. Dalam perhitungan kuantitatif, energi potensial gravitasi suatu benda didefinisikan sebagai hasil kali massa benda dengan percepatan gravitasi dan ketinggiannya dari acuan bidang tertentu. Energi potensial gravitasi dirumuskan sebagai.

$$Ep = m \cdot g \cdot h$$

Energi Kinetik

Enegi kinetik adalah energi yang dimiliki suatu benda karena gerakannya. Jadi, setiap benda yang bergerak memiliki energi kinetik. Contohnya, energi kinetik dimiliki oleh mobil yang sedang melaju, pesawat yang sedang terbang, dan anak yang sedang berlari. Secara matematis, persamaan energi kinetik adalah

$$Ek = \frac{1}{2}mv^2$$

Ek = energi kinetik (joule)
m = massa (kilogram)
v = kelajuan (meter/sekon)

Konversi Energi

Perubahan energi yang ditunjukkan dari fenomena sehari – hari dimanfaatkan oleh manusia untuk membantu aktivitas mereka. Hal tersebut sejalan dengan hakikat sains, yakni manusia berusaha menjelaskan fenomena yang terjadi untuk membangun pengetahuan, fakta, atau konsep; lalu mencoba fakta tersebut, kemudian memodifikasinya untuk keperluan umat manusia.

Beberapa contoh perubahan energi dalam kehidupan sehari – hari adalah

1. Perubahan bentuk energi listrik menjadi panas. Contohnya setrika listrik, *rice cooker,* kompor listrik dan lain sebagainya.
2. Perubahan energi listrik menjadi energi cahaya. Contohnya lampu.

Figure 2. Module appearance

Development stage

The development stage is a stage to produce valid and practical PjBL-based teaching modules so that they are good for use in learning. The assessment results from validators and data from teacher and student response questionnaires were used as a reference for validation and practicality assessments. The validation results given by validators for PjBL-based teaching modules can be seen in Table 2.

Table 2. Teaching module validation analysis results

Indicators	Validator assessment (%)	
	Lesson plans	Teaching module
Content	81	91.6
Construction	75	87.5
Language component	85	85.7
Category (%)	80.3	88.3
Category	Valid	Very valid

From Table 2, it can be seen that the results of the validator's assessment for the teaching module show that the designed product was categorized as very valid. The validation results printed at a percentage of 88.3% for teaching modules and 80.3% for lesson plans. The results of this analysis concluded that the PjBL-based teaching module designed was very valid.

The practical value of the teaching module is seen in the teacher response questionnaire assessment and student response questionnaire. From the teacher's response questionnaire, the average percentage was 85%, or in the very practical category, while the student response questionnaire obtained an average percentage of 78%, being in the practical category. Based on the responses from the questionnaire given to teachers and students, it was found that the PjBL-based teaching module developed was practical in its use so that learning with this PjBL-based teaching module could increase the students' potential. The results of this response questionnaire can be seen in Table 3.

Table 3. Analysis of response questionnaire to module

Statements	Response questionnaire	
	Teacher	Student
Total score	51	282
Maximum score	60	364
Average percentage	85%	78%
Category	Very practical	Practical

The development of PjBL-based teaching modules for students started with the define stage. This define stage is the stage of material analysis and student analysis. From this analysis, it was obtained that students of SMKN 1 Grati were less active during learning. Students are also not active in creating a product related to material energy and its changes. Even during the discussion activities, there were still students who were not active or rarely involved in asking and answering questions or presenting discussion results.

The next stage was the teaching module design stage. The design stage was carried out after obtaining data from the defining stage. At this design stage, the steps that must be taken

were to validate the teaching module to experts. The results of validation at the design stage were used as a reference in the preparation of teaching modules that are valid and can be used in the learning process. The validation results from the validator showed that the developed PjBL-based teaching module was very valid and suitable for use. The next step was the development stage which included the practicality test of the teaching module.

The practicality of the teaching module relates to the ease of use of teaching materials by teachers and students in the learning process. Based on the results of data analysis from teachers' and students' response questionnaires, the PjBL-based teaching module developed is classified into a very practical category. According to Amini et al. (2019), PjBL is based on constructivism theory and is student-centered. The learning process through PjBL allows educators to provide students with direct experiential learning. This is in accordance with Permendikbud No. 103 of 2014 concerning lesson plans and teaching materials used in the learning process. This practicality is seen from the ease of use, the time required, and the attractiveness of the teaching module because it is able to invite students to be active (Tasci, 2015). This PjBL-based teaching module was developed to make it easier for students to understand the material of energy and its changes. This PjBL-based teaching module is also equipped with student activities in doing experiments and doing projects. Sari et al. (2020) revealed that PjBL-based modules are effective in improving learning outcomes with a percentage of 86.7%.

The activities in the teaching module will increase students' activeness and creativity in learning. In line with the research that has been done (Saputra et al., 2013; Sari et al., 2020; Aflah et al., 2023), this teaching module is expected to develop students' ability to complete projects and produce a product related to physics. Students' ability to create this product will be useful when prospective physics teachers go directly to the field or teach in schools. The application of this PjBL-based teaching module can help students understand the materials so that the learning can be more meaningful.

IV. CONCLUSION AND SUGGESTION

Based on the development research and trials that have been carried out, it can be concluded that the teaching modules developed through PjBL can be categorized as valid and practical in improving students' creative thinking skills at SMK 1 Grati, Pasuruan Regency. The average value of the validation results for PjBL-based modules is 88.3% (very valid), and the average scores of teacher and student responses to the modules that have been developed are 85% (very practical) and 78% (practical), respectively

Based on the development research that has been carried out, the author suggests that other researchers develop this PjBL-based teaching module in other subjects. Further-

more, this study has limitations because it only uses one class. Therefore, it is suggested that further researchers use a larger and more varied sample class.

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