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The Effectivity Study: Implementation of the Physics e-Module with PjBL-STEM Model to Describe Students' Creative Thinking Skills and Learning Motivation Profile

N. R. Millen[1*], Supahar[2]
[1,2]*Natural Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta*
[*]*Corresponding Author. Email: naritarelly.2019@student.uny.ac.id , supahar@uny.ac.id*

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Abstract
This research focused on developing and implementing the Physics e-Module PjBL-STEM Model to improve creative thinking skills and learning motivation of grade-X students in straight-motion topics discussion. The purpose of this development research was to 1) produce a feasible Physics e-Module PjBL-STEM Model, 2) know the effectiveness of the implementation of the Physics e-Module PjBL-STEM Model to improve students' creative thinking skills and learning motivation, and 3) describe the students' creative thinking skills and learning motivation profile. The e-module development procedure adopted the Research and Development (R&D) method using the ADDIE model developed by Dick and Carry. The subjects were first-grade high school students who used the 2013 curriculum at a school in Yogyakarta city. The study showed that The Physics e-Module PjBL-STEM Model was feasible to use in physics learning based on the assessment of experts and practitioners. Second, the implementation of the Physics E-Module PjBL-STEM Model was effective in increasing students' creative thinking skills by 85% and students' learning motivation by 68% in the good category. And, the students' creative thinking ability profile was 54.16%, while the students' learning motivation was 60.41%. Both have average and above-average values. Students with the ability to think creatively and have the motivation to learn above the average are most students who use the Physics e-Module PjBL-STEM Model in physics learning.

INTRODUCTION

The 21st-century learning paradigm requires students to have various abilities to equip them to survive in the global era (Afandi et al., 2019; Reddy et al., 2020). Students are expected to have good communication skills, collaborate and innovate, and think analytically, critically, and creatively in solving problems as formulated by The Partnership of 21st Century Skills (P21), which is referred to as the "4C" ability.

One of the 21st-century abilities or 4C abilities that has a complex substance is the ability to think creatively. The PISA 2021 framework regarding the ability to think creatively, explains why the ability to think creatively is one of the abilities that is quite crucial. It is crucial because creative thinking is a real competency that has a knowledge and practical base that can support an individual to achieve better results in solving a complex problem (OECD, 2019).

Various kinds of learning systems that aim to provide a lot of knowledge to students have been implemented in Indonesia. Students in Indonesia study linguistics, social, and natural sciences, including physics. Physics, according to Wospakrik in Mundilarto (2012: 3), is a branch of natural science that aims to study and provide an understanding of the concepts behind the occurrence of phenomena encountered in everyday life, both qualitatively and quantitatively.

Physics learning is one of the lessons that can lead students to practice creative thinking skills. This statement is supported by the theory presented by Chiappetta (1988:104-115) regarding how to study physics. It was explained that to study physics, methods, approaches, and strategies are needed that are different from other fields of study. Similar research by Bao (2019: 8-10) also describes something similar, that physics or learning glasses

can lead students to have top-level abilities and skills. Various abilities such as observation, collecting information and data, making hypotheses, conducting experiments, and making conclusions are carried out in learning physics. These skills can lead students to have the qualifications needed in the future.

Equipping students to have the ability to think creatively is not enough to only review one factor. Apart from learning physics, students' intrinsic factors are also needed to maximize learning. Motivation is the essence of every motive and activity undertaken by every human being to fulfill life needs (Valarmathi, 2011:1). In subjects that have a high level of difficulty, such as physics subjects, high learning motivation is needed, aiming students do not face difficulties to hinder the learning process. Therefore, it is necessary to increase student learning motivation.

Another factor needed to build students' creative thinking skills and learning motivation is the implementation of interactive physics learning and the active involvement of students. Learning may run optimally if it is supported by the right learning models and media (Yuliansih, 2021: 411). One learning model that can involve students actively in learning is the PjBL model. According to previous research, the application of this PjBL model also has a positive influence on students' creative thinking abilities, problem-solving, and collaboration (Harahap et al., 2020; Putri et al., 2020).

The project-based learning model can be maximized with a harmonized learning approach. One suitable approach is the STEM approach. The disciplines of Science, Technology, Engineering, and Mathematics (STEM) are combined to solve problems encountered in everyday life based on physics and can be used as a solution to answer the challenges of 21st-century learning. The application of PjBL-STEM learning has a positive effect on students' abilities. Problem-solving, mathematical creativity, and learning motivation (Afriana et al., 2016; Baran et al., 2021; Purwaningsih et al., 2020) because students learn to deepen understanding, develop products, and systems that are useful for improving abilities- these abilities (Jauhariyyah et al., 2017; Triana et al., 2020).

In addition to learning models, choosing the appropriate learning media can also support learning optimally. As an effort to improve students' creative thinking skills and learning motivation, learning media are expected to be multifunctional so that students can be more flexible in exploring physics. One of the multi-functional media is an e-module. Adjusting to technological and internet developments, e-modules are more flexible and suitable to be implemented as learning media because they can be accessed anytime and anywhere (Astalini et al., 2019).

Reviewing previous research, e-modules can improve students' creative thinking abilities, results, and learning motivation (Prasetyo et al., 2021; Syahiddah et al., 2021). Therefore, this study aims to develop e-modules that are structured according to the PjBL-STEM learning model on straight-motion material to hone creative thinking skills and increase class-student learning motivation. The developed e-module with the PjBL-STEM model will be implemented for students to find out the effectiveness of the e-module. The implementation of e-modules in physics learning can also provide information related to the profile of student's creative thinking skills and motivation.

In connection with the implementation of the e-module, it is necessary to investigate the effect of the treatment given to students through assessment. Assessments aimed to obtain, synthesize, and interpret all information from students to make decisions about student profiles (Bashooir, 2018: 221). Implementation of e-modules supported by appropriate measurement procedures can be a combination of achieving the objectives of the research.

RESEARCH METHOD

The study used the Research and Development (R&D) method with the ADDIE model as a reference in developing and producing products. The developed product was an e-module that is suitable for learning physics in straight-motion material. The research was conducted in an odd semester before students started studying the topic of rectilinear motion. The subjects were class X students of SMAN 2 Yogyakarta. The subjects were selected based on the cluster sampling technique, which is a technique that randomly selects the class of the study. Students who participated in the study were divided into experimental groups, control 1 and control 2 to give a treatment (see Figure 1).

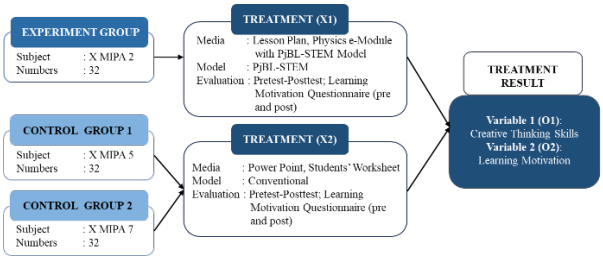

Figure 1. Experiment Design

The research instruments consisted of learning instruments and data collection. Learning instruments consisted of learning implementation plans and e-Modules. The data collection instruments consisted of a learning motivation

questionnaire, a creative thinking ability test questionnaire, a student response questionnaire, and an observation sheet on the learning implementation plan. The instrument was developed through the design stage. In the previous article, it was explained that the developed research instrument had been assessed for its validity and feasibility (Pebriana, 2021).

The instruments of this study were considered very feasible and valid by expert and practitioner validators. The research instrument has also been tested on a limited basis to determine the validity of the instrument empirically. Furthermore, a broad research instrument test will be carried out to determine the effectiveness and profile of students' creative thinking abilities and learning motivation.

Data collection used test techniques to measure students' creative thinking abilities. The tests given to students are in the form of essay questions, performed before (pretest) and after (posttest) learning physics. The learning motivation of students is measured using non-test techniques by giving questionnaires of before and final learning motivation. The data of the study were qualitative and quantitative data. The data obtained were then analyzed with a statistical approach.

Data from limited test results were analyzed using the QUEST program to determine compatibility with the Rasch model and the reliability of the instrument items. Data from the area test results were statistically analyzed using the SPSS program. Before testing the hypothesis, it is necessary to test the normality and homogeneity of the data. Hypothesis testing was performed to determine the effectiveness of the e-module on increasing variables.

The first hypothesis is related to whether there is a significant effect on the treatment given to the increase in the variables tested with GLM Manova. The second hypothesis related to the presence or absence of interaction (pretest-posttest) in each group, was tested using GLM Mixed Anava. The effect size test was conducted to determine the influence exerted on each group. And, the post hoc test was conducted to determine which group experienced the best improvement.

The ability profile of students is analyzed using the T score by reviewing the Z score obtained by changing the pure value using the following equation:

$$Z = \frac{X - \bar{X}}{STD}$$

Information

Z : *Z score*
$\bar{X}$: mean
X : students score
STD : standard deviation

Changing the Z score to a T score is done by using the following equation:

$$T = 10(Z) + 50$$

The values are categorized according to Sharon (2006), reviewing the T score with three categories. If students get a T score ≥ 60, then students fall into the above-average criteria. Students who get a 40 ≤ T score ≤ 50, are categorized as having average abilities, and those who have, have abilities below average.

RESULT AND DISCUSSION

Empirical trials were carried out at SMAN 9 Yogyakarta to test the empirical validity and reliability of the research instruments. The instruments tested were test questions and learning motivation questionnaires. The sample of empirical trials was 120 samples for testing creative thinking skills and 90 samples for learning motivation questionnaire items. The results of the empirical validity of the creative thinking ability test questions are presented in Table 1.

Table 1. Results of Item Fit Analysis

Item Accuracy (INFIT)			Difficulty		Quality
MNSQ	t	Cat*	b	Cat*	
0,99	-0,1	Fit	-0,83	Medium	Good
1,07	0,5	Fit	0,01	Medium	Good
1,18	0,1	Fit	0,44	Medium	Good
1,00	0,6	Fit	1,10	Hard	Good
0,86	-1,0	Fit	-1,42	Easy	Good
1,11	0,9	Fit	-0,49	Medium	Good
0,96	-0,4	Fit	-0,96	Medium	Good
1,04	0,3	Fit	1,42	Hard	Good
0,92	-0,6	Fit	-0,64	Medium	Good
0,81	-1,6	Fit	-0,20	Medium	Good
1,02	0,2	Fit	0,46	Medium	Good
1,15	0,5	Fit	1,10	Hard	Good

Data in Table 1 summarizes the results of empirical validity, reliability, and the difficulty level of the items showing values in the high category. Based on the results of the difficulty level of the test items, it was observed that numbers 4, 8, and 12 fall into the difficult category. In this item, the assessed aspect is the originality aspect of the answers given by students to determine their creative thinking skills. Meanwhile, 66% of the items have a level of difficulty in the medium category. Based on the item quality category based on the item response theory approach, it concluded that each test item has good quality for measuring students' creative thinking abilities. Furthermore, the results of the empirical validity of the learning

motivation test questionnaire are presented in Table 1.

Based on Figure 2, each item contained in the learning motivation questionnaire fits the PCM model seen from the INFIT MNSQ score (Adams & Khoo, 1996). In every aspect of learning motivation has matched with PCM models. Based on these results, the developed questionnaire is considered capable of measuring students' learning motivation by reviewing each indicator.

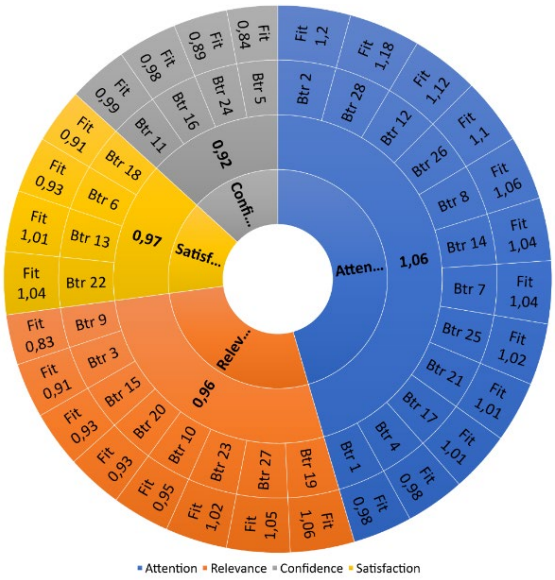

Figure 2. Questionnaire Item Fit Analysis

Table 2 presents the reliability values of the test items in terms of the item values and case estimates. The data was obtained with the help of the QUEST program, where the output of the items-estimates shows the item separation index. Table 2 shows the results of the item's reliability to measure the ability to think creatively in the high category of 0.77. The reliability of the questionnaire items used to measure students' learning motivation also showed very high results. Questionnaire items have a reliability of 0.82, which means they are very reliable to be tested on students. This leads to the conclusion that the test items and questionnaires designed to measure students' creative thinking skills and learning motivation are reliable to use.

Table 2. The Reliability of Instruments

No.	Variable	Reliability of Estimates	Score	Category
1.	Creative Thinking Skills	Summary of Items Estimates	0,77	High
2.	Learning Motivation	Summary of Items Estimates	0,82	Very High

After knowing that the instrument is empirically valid and reliable, the research continues with a broad test. Data obtained from the broad test were analyzed for normality and homogeneity using the Kolmogorov-Smirnov and Shapiro-Wilk tests and Lavene's Test. The analysis was performed using a statistical program and obtained results of significance > 0.05 on the data pretest, posttest, and early and late learning motivation in each research group. Therefore, it concluded that the sample data is normally distributed and homogeneous.

The requirements of the parametric test to test the effect and the increase in variables have been fulfilled. So, the analysis can be continued at the test stage of the General Linear Model Manova and Mixed Anava. The results of the Manova GLM test are presented in Table 3.

Table 3. GLM Manova Test Results

Effect	Output Wilks' Lambda		
	F	Sig.	Partial Eta Square
Media	21, 674	0,00	0,423

Based on Table 3, the significance value of learning media is <0.05. So, H0 is rejected. This means that the learning media (E-Module Physics Model PjBL-STEM, LKS, PPT) given to students have a significant influence on increasing students' creative thinking abilities and learning motivation.

The influence of the learning media on the ability to think creatively and the student's learning motivation is in the medium category of 42.3% in terms of partial eta square. Although it is known that there is a significant effect, the GLM Manova test has not informed which learning media is the most significant for increasing research variables.

Therefore, a more specific analysis needs to be continued using the GLM Mixed Anava.

GLM test Mixed Anava was conducted to find out the difference between the scores pretest-posttest within one group and between research groups. Table 4 contains the results Univariate Test of Within-Subjects Effects indicating interaction *pretest-posttest* in one research group on the variables measured. Based on the significance score Greenhouse-Geisser in section time **Media_Pembelajaran*, obtained a value of <0.05 on the measurement of the variable ability to think creatively and motivation to learn.

Table 4. Univariate Test

Source	Output Greenhouse-Geisser		
	Variable	F	Sig.
time* Media	Creative Thinking	31,4	0,00
	Learning Motivation	21,7	0,00

Table 4 provides information that H0 rejected. It means that there is an interaction indicating that the value changes pretest going to the posttest in the three groups (experimental group, control 1, and control 2) differed significantly.

Table 5. The Mean Difference Within the Group

No.	Group	Creative Thinking		Learning Motivation	
		Sig.	Mean Diff	Sig.	Mean Diff
1.	Experiment	0,00	11,875	0,00	19,279
2.	Control 1	0,00	7,781	0,00	10,873
3.	Control 2	0,00	6,281	0,00	6,564

To find out the results more clearly related to which learning media has the most significant effect, further analysis is carried out on the output pairwise comparison spaces. The data from Mean Difference shows that the group that experienced the most significant change was the experimental group. The experimental group had the most change because learning used learning media in the form of the PjBL-STEM Model Physics E-Module which was supported by the prepared lesson plans to improve students' creative thinking abilities and students' learning motivation.

The average difference of 11.87 in the ability to think creatively can be seen through the improvement in every aspect of the ability to think creatively contained in Figure 3.

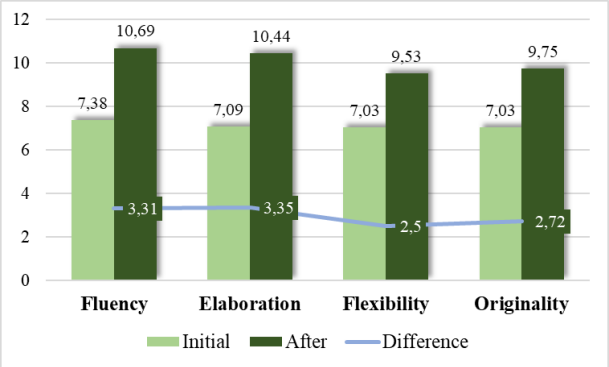

Figure 3. The Improvement of Students' Creative Thinking Skills Reviewing every Aspect

The difference in the statistical test results given by the Mean Difference is consistent with the results of the analysis of the average aspects of the pretest and posttest conducted by students. In addition, the increase in each aspect of learning motivation can also be seen in Figure 4.

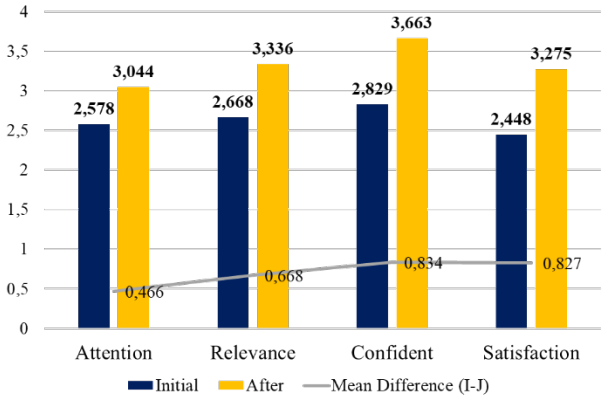

Figure 4. The Improvement of Students' Learning Motivation on every Aspect

This increase is represented through the way students solve the problems given in the test. On the aspect of elaboration, students can properly convey their ideas logically to the problems given. On the aspect of flexibility, students can provide solutions but still have difficulty connecting and solving several problems in mathematical-physical form and flexibility in presenting results.

In addition, an increase in students' learning motivation can also be observed during communication activities. Students have better self-confidence. Students can communicate the results of their project development well in front of the class. Thus, it concluded that the learning motivation of students to learn the physics concept of straight motion has increased significantly.

Progress in solving these problems occurred after students learned the concept of rectilinear motion using the PjBL-STEM Model Physics e-Module. The e-module has a construction that is designed for the students can learn things from real problems and then bring them into a physics

approach. Reviewing this, further analysis can be carried out on the effectiveness of the PjBL-STEM Model Physics e-Module.

The effectiveness of the PjBL-STEM Model Physics e-Module can be known through the value of *partial eta square* from the analysis of *effect size.* The score of *partial eta square* viewed from the output *Multivariate Tests Wilks' Lambda* obtained through the GLM mixed Anava test. Figure 5 shows the effectiveness of learning media on increasing students' creative thinking skills in each research group. The PjBL-STEM Model Physics E-Module is effective for increasing students' creative thinking skills in the high category of 85%.

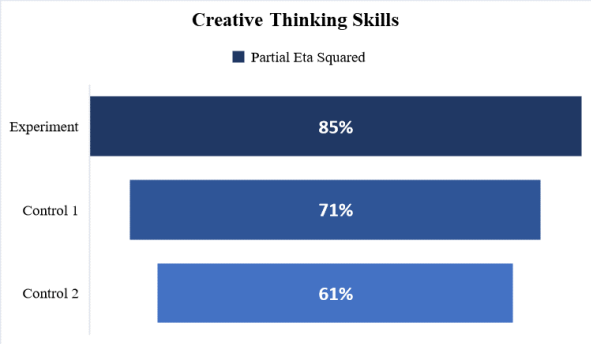

Figure 5. The Effectiveness of Learning Media on Each Group (Partial Eta Square)

Figure 6 shows the effectiveness of the PjBL-STEM Model Physics e-Module in increasing student learning motivation, included in the high category of 68%. This increase was higher than in other research groups. The results of the test effect size are consistent with the previous analysis. It concluded that the PjBL-STEM Model Physics e-Module is effective for increasing creative thinking skills and learning motivation in high categories.

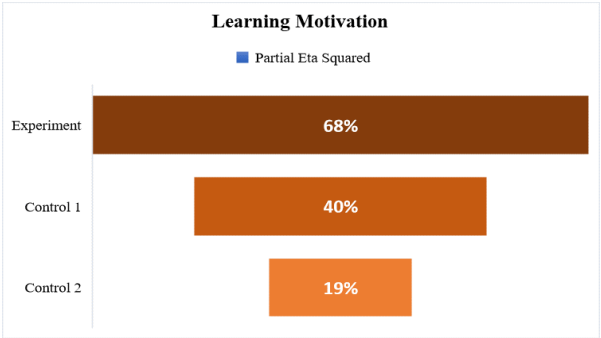

Figure 6. The Effectiveness of Learning Media used by Each Research Group on Learning Motivation

Analysis of students' profiles on their creative thinking skills and learning motivation was carried out to conclude the characteristics of the research sample. The analysis was performed based on the T score students obtained by reviewing the average value and standard deviation in the output estimates on the GLM test performed. The results of the analysis of the profile of creative thinking abilities and learning motivation of students are presented in Figure 7.

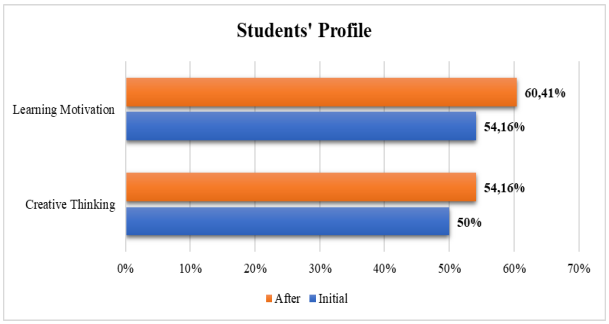

Figure 7. Students' Creative Thinking Skills and Learning Motivation Profile.

The percentage of students who have the ability to think creatively and learn motivation is in the average and above average categories. Students fall into the above-average category if they get a T-score above average (> 60%). Figure 7 is the profile of all students who participated as a sample in the research. According to the Figure 7, 60.41% of students from all samples have learning motivation in the average and above-average categories. This amount has increased by 6.25% from the initial motivation.

An increase also occurred in students' creative thinking abilities. The ability of students increased by 4.16% from the initial ability. Students who have the ability to think creatively on average and above average increase after the implementation of learning media and learning processes in research. The profile of students in each group is also presented in Figure 8.

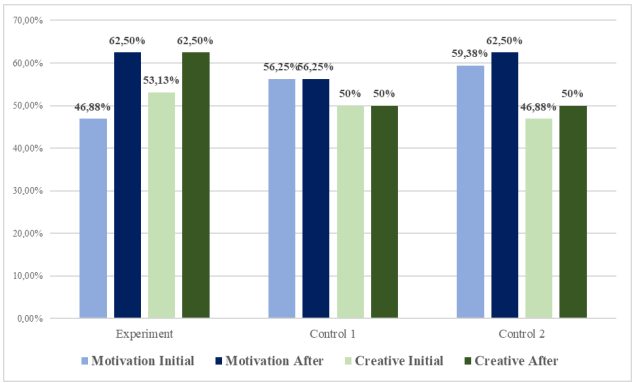

Figure 8. Students' Creative Thinking Skills and Learning Motivation Profile in Each Group

Based on Figure 8, the student's creative thinking skills and learning motivation that increased the most were in the experimental group. So, it concluded that the ability to think creatively and the student's learning motivation in the experimental group were better than in the other groups. This is influenced by the implementation of

the PjBL-STEM Model Physics e-Module which is supported by the appropriate lesson plan during the lesson.

CONCLUSION

Based on the discussion of the results of development, implementation to research evaluation, it concluded that developed learning media in the form of the PjBL-STEM Model Physics e-Module is good and feasible to use in learning. The feasibility of the product is concluded based on the assessment of experts, practitioners, and empirical assessment by students through limited tests and field tests. In addition, the PjBL-STEM Model Physics e-Module is effective for increasing students' creative thinking skills and learning motivation.

The PjBL-STEM Model Physics E-Module obtained a score of 85% for increasing creative thinking skills and 68% for increasing the learning motivation of students who fall into the high category. In connection with this, it is also known that the creative thinking ability profile of all students is 54.16% which is represented by the sample in the good and very good categories. The highest increase in the students' ability was obtained by students in the experimental group. The learning motivation profile of all students is 60.41% which is represented by the sample in the good and very good categories. The highest increase in the ability of students was obtained by students in the experimental group. The study can be used as reference material for further research. It is necessary to measure other aspects of creative thinking abilities as well as learning motivation and other abilities using the developed PjBL-STEM Model Physics E-Module.

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