SPEKTRA: Jurnal Kajian Pendidikan Sains
Vol. 10, No. 1, 2024, pp. 117-127
ISSN: 2548-642X, DOI: 10.32699/spektra.v10i1.431

DEVELOPMENT OF E-MODULE SCIENCE LEARNING BASED ON PROJECT BASED LEARNING TO IMPROVE CRITICAL THINKING SKILLS

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Artikel Info

Article History:

Received 26/07/2023
Revised 26/04/2024
Accepted 30/05/2024

Keywords:

E-module
IPA
Project based learning
Critical Thinking

ABSTRACT

Critical thinking is one of the skills that must be possessed by students in the 2013 curriculum, especially in 21st-century learning. Indonesia's low ranking in PISA results in the critical thinking category, ranked 64 out of 65 countries is important from this study. The low thinking skills of students are caused by students' critical thinking skills in science learning are still not optimal. Based on observations made by researchers in the learning process, teaching materials use more books so that learning does not run interactively. This leads to students' critical thinking skills being poorly trained. This research aims to develop teaching materials in the form of project-based learning e-modules that improve the critical thinking skills of grade 5 elementary school students effectively. The development method in this study uses a 4-D model from Thiagarajan (1974), namely Define, Design, Development, and Dessimination. The instruments used in this study were interviews, questionnaires, and observations. The results of this study showed that *the project-based learning* e-module was valid with material validation results of 75.6%, media validation results of 84.5%, and language validation results of 81.25%. In addition, student responses from individual trials were 97%, in small group trials by 90%, and in large group trials by 87%. Quantitative analysis with *independent sample t-test* using SPSS 26 *for Windows* showed that there was an average difference in final observation results between the experimental class and the control class of 2.625 with *a sig (2-tailed) p-value* of 0.000. These results were obtained from the responses of experimental and control class students. Thus it can be concluded that the use of e-modules in learning has improved students' critical thinking.

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1. INTRODUCTION

Currently, Indonesia is still implementing the Curriculum 2013 that adapts to 21st learning. The 2013 curriculum program emphasizes character building, attitudes and knowledge, as well as critical thinking. The 2013 curriculum covers many subjects so that science subjects are aimed at shaping students' scientific competencies related to life, environmental understanding, science and problem solving. Thus, science subjects can represent the implementation of 21st century learning

so that students are required to be able to think critically (Sari et al., 2022:2) in integrating all content contained in science learning.

Based on the results of the researchers' interviews on the implementation of science learning in general, there are still many obstacles such as students tend to be passive, look bored, students have not been able to answer questions from an explanation given.

The ability to think critically involves various decisions and considerations that are not only technical, because the thinking process is complex. Therefore, critical thinking must be trained and become one of the concerns in the implementation of learning to form students who are able to develop the ability to think in all things (Aprilianto & Sutarni, 2023: 808) Critical thinking is an intellectual disciplinary process. Actively and actively take in conceptualizing, applying, analyzing and evaluating information collected by observation, experience, reflection, and communication as a guide for belief and action (Rudi, 2019: 24). Meanwhile, according to Situmorang (2023: 89), critical thinking is a natural logical thinking process that already exists in a person when facing changes in any area of life

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In the 2013 curriculum students are encouraged to participate more actively in the classroom, and teachers are no longer the center of learning, teachers become facilitators, mediators, and motivators of students. 21st century learning is called 4C Skills, namely *critical thinking* , *creative*, *communication* and *collaboration*, But also must be able to master compassion and computation. For this reason, the ability required is no longer 4C but becomes 6C (Kemendikbud, 2020). Therefore, critical thinking is an important skill that learners must have in the learning process. Learners who can think well will succeed in life. 21st century learning requires people with the ability to make decisions and filter information. With good critical thinking, students can filter information and not quickly believe in incorrect sources (Inggriyani &; Fazriyah, 2017: 31)

The critical thinking skills possessed by students in science learning are still not optimal, this is based on the results of observations and interviews of researchers with teachers and grade 5 students of SD Insan Kamil Bogor. In the science learning process that is carried out still using book teaching materials only so that learning does not run interactively, this is what causes students' critical thinking skills to be less trained. The critical thinking ability of students in Indonesia is still relatively low (Berjamai &; Davidi, 2020: 45)

Hasil Studi PISA yang dirilis oleh OECD menunjukkan bahwa kemampuan siswa di Indonesia dalam membaca meraih skor rata-rata mencapai 371, dengan rata-rata OECD 487, untuk skor rata-rata matematika mencapai 379 dengan skor rata-rata OECD 487, kemudian untuk sains skor rata-rata mencapai 389 dengan skor rata-rata OECD 489. Berdasarkan data PISA tersebut menunjukkan bahwa Indonesia berada pada kuadran low performance dengan high equity. Oleh sebab itu Indonesia masih bisa untuk meningkatkan kemampuan berpikir kritis karena Indonesia memiliki kapasitas dan potensi yang belum dikembangkan (Lidiawati & Aurelia, 2023:2)

Efforts to improve critical thinking skills require teaching materials and learning methods based on technological developments. Modules can be one form of teaching materials developed

because modules have 5 main characteristics that become advantages, namely *self-intrudtional* (facilitates independent learning*), self-contained* (contains all material), *stand-alone (*does not depend on other teaching materials), and *use friendly* (easy to use) (Suwartaya et al., 2020: 4). Efforts that can be made to adjust the development of the module era are made in electronic form or often called e-modules so that they can be more practical and efficient. The form of learning must produce products and one of them is learning media that is used as a source of learning (Dwiningsih et al., 2018: 156-176). The Ministry of Education and Culture (2017: 3) explained that e-modules are a form of presenting teaching materials independently that are arranged systematically in certain learning, which are presented in electronic format, where each learning activity in it is connected *with a link* as a guide that makes students more interactive, equipped with the presentation of video tutorials, animations and audio to enrich the learning experience.

In addition to learning media, learning methods and techniques also have an equally important role in students' critical thinking skills. Innovative media will provide maximum results if there are approaches and learning methods that support students' critical thinking skills. One method that can support critical thinking skills is the *Project-based learning* (PjBL) method. This PjBL method can have a significant influence on the skills of the science learning process in elementary schools. With this method learners learn with situations and settings on real problems. Therefore, everything can be carried out by means of group work dynamics, independent investigation, achieving a high level of understanding, developing individual skills and social skills (Murniarti, 2017: 373)

Science learning e-modules that are in accordance with the demands of 21st century learning can also be a medium that supports the achievement of learning objectives, science learning e-modules can be more optimal by combining PjBL methods that develop students' critical thinking skills. Thus, students are trained how to think critically, trained to solve problems and acquire knowledge related to the problem at hand where students explore information in e-modules that have interesting material.

Based on the description above, the purpose of this study is to describe the validity and effectiveness of PjBL-based science learning e-module teaching materials to improve critical thinking skills of grade 5 elementary school / MI students. Validity is based on feasibility research from validators. While effectiveness can be seen from the comparison of values between the experimental class and the control class. The material studied in this PjBL-based science learning e-module consists of, core competencies, basic competencies, learning objectives, materials, PjBL stages*, pre-test, post-test,* and reflection. Which is expected to improve the critical thinking skills of grade 5 elementary school / MI students.

2. RESEARCH METHODS

This research uses Research and Development (R&D) research. According to Borg and Gall (1998) states that "Research and development is a process used to develop and validate education product, by "product" we mean not only such things as textbooks, instructional films, and computer software, but also methods, such as a methods of teaching, and program, such as a drug education program or a staff development program" (Sugiyono, 2022:28). The development was carried out using a 4-D model developed by Thiagarajan (1974). This 4-D model has a flow, namely, define, design, development and disseminate (Thiagarajan, Semmel & Semmel, 1974).

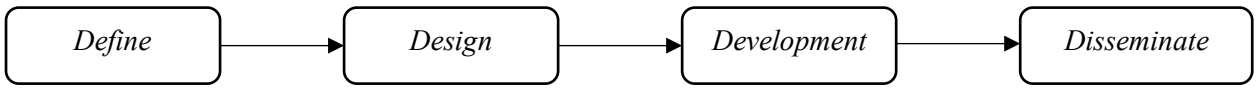

Figure 1. 4-D Model Flowchart

The development of project-based learning e-modules for science learning to improve students' critical thinking skills was carried out in grade 5 of SD Insan Kamil Bogor. In testing feasibility, it requires the assessment of media experts, material experts, and linguists from lecturers who are experts in their fields as well as trials involving grade 5 students of SD Insan Kamil who conduct individual trials, small group trials and large group trials. To determine whether or not there is an improvement in critical thinking skills of grade 5 elementary school students, it is carried out by analyzing the initial observation data and final observation quantitatively by conducting an *independent sample t-test* using SPSS 26 *for windows*.

3. RESULTS AND DISCUSSION

The development of PjBL-based science learning e-modules is carried out using a 4-D model. The flow of 4-D model development is the *define,* design, *development*, and *disseminate* stages . The following is an explanation of the stages of developing PjBL-based science learning e-modules to improve critical thinking skills of grade 5 elementary / MI students:

3.1. *Define*

The defining stage is the stage that aims to analyze and identify problems related to product development. Analysis was conducted through interviews and observations. The results of direct observation in grade 5 of Sd Insan Kamil showed several problems in the learning process. These problems include still using textbooks as learning resources, learning focus is still focused on teachers and lack of students' critical thinking skills in the learning process. In addition, the commonly used learning model is still conventional, so students' critical thinking skills are not optimal. E-module learning was developed which refers to core competencies and basic competencies in theme 9 "Things around us", sub theme 1 single and mixed substances based on PjBL. So the researcher made an e-module as a learning resource for students modified with the PjBL learning model.

3.2. *Design*

The Planning Stage aims to prepare the basic framework for the preparation of e-modules as a whole. There are 3 stages, namely: *media selection.* In this development research, learning media will be made in the form of e-modules that will be made with *Canva media*. *The selection format*, in the PjBL-based science learning e-module to improve the critical thinking skills of grade 5 elementary school / MI students was designed using the *Canva* application with an A4 *layout* size, with titles using *adigiana toybox* font and content text using *medium atma font,* with attractive color displays, images and animations also accompanied by learning videos and *links* interactive quizzes. The scope of the content of the presentation of the material contains a summary of material about single and mixed substances so that students are able to understand the material

correctly. Then each chapter contains PjBL stages which contain 6 chapters to make beverage products that contain vitamin C in addition to citrus fruits.

3.3. *Develop*

After preparing the PjBL-based science learning e-module, the next stage is validation by three experts, namely material experts, media experts and linguists. The purpose of this validation is to assess the feasibility of PjBL-based science learning e-modules in improving students' critical thinking skills. The criteria used by researchers in determining the validity of learning modules are:

Table 1. Validity Assessment Criteria

Presentation (%)	Validity Level	Eligibility Criteria
81-100	Highly Valid	No Revision
61-80	Valid	No Revision
41-60	Quite Valid	Needs Revision
21-40	Less Valid	Revision
0-20	Invalid	Total Revision

(Sugiyono, 2022)

The assessment results from media experts obtained a percentage of eligibility rate of 84.5% with a very valid category. Then media experts provide input and suggestions for the development of PjBL-based science learning e-modules:

Change the theme image according to the title and content of the material.

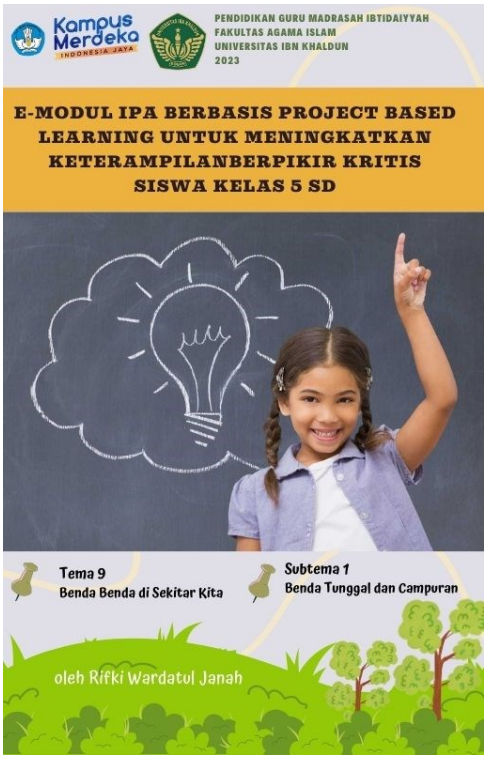

Figure 1 Cover and Theme Before Revision

Figure 2 Cover and Theme After Revision

The assessment results from linguists obtained a validity percentage of 81.25% with a very valid category. Then linguists provide input for the development of PjBL-based science learning e-modules, to improve the content section of the material and examples more regularly.

Figure 3 Material and Examples Before Revision

Figure 4 Material and Examples After Revision

The assessment results from material experts obtained a percentage of validity rate of 75.6% with a valid category. Then material experts provide input for the development of PjBL-based science learning e-modules, enriching resources so that more examples are contained in the e-modules.

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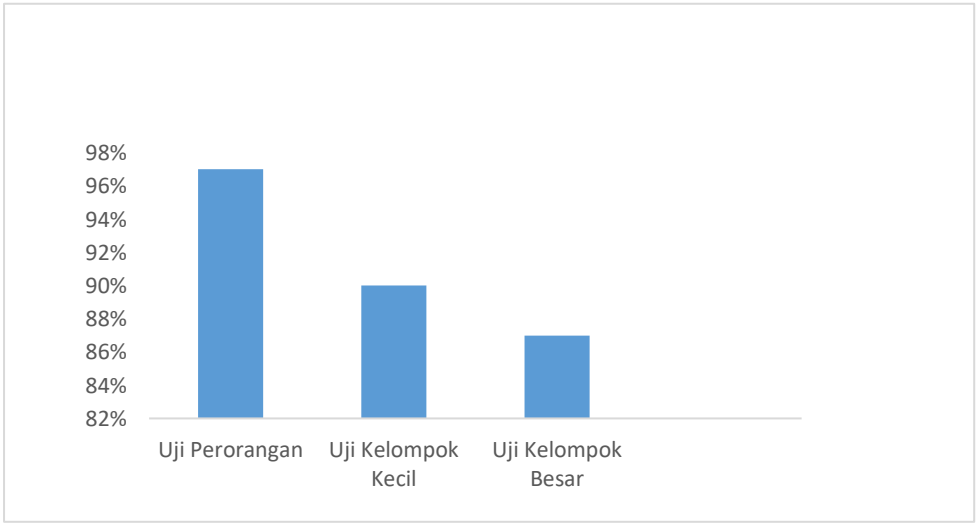

Figure 5 Graph of Trial Results

To determine the effectiveness of PjBL-based science learning e-modules, individual trials, small group trials and large group trials were conducted. At this stage, direct observation of students is carried out in the learning process in the experimental class by researchers with two conditions, namely initial observation and final observation. Initial observations were made before using the PjBL-based science learning e-module and final observations were made after using the PjBL-based science learning e-module. The individual test involved 5 grade 5 elementary school students as respondents, for the small group test involving 10 students and for the large group test involving 24 students.

After making initial observations and final observations in individual tests, small group tests and large group tests, it was found that there was an improvement after and before using the PjBL-based science learning e-module during learning. There was an increase in the average score of the initial and final observations in the individual test of 13.2, an increase in the average score of the initial and final observations in the small group test of 12.4, and an increase in the average score of the initial and final observations in the large group test of 16.41. From these data, it can be concluded that the PjBL-based science learning e-module is effective for developing critical thinking skills for grade 5 elementary school students.

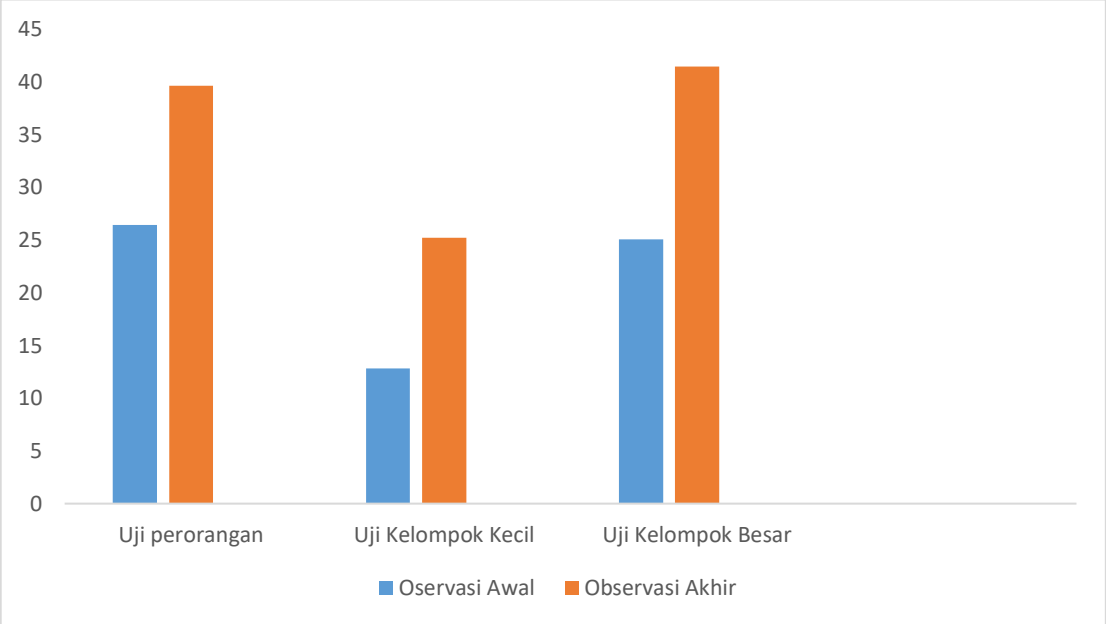

Figure 6 Graph of Individual, Small Group and Large Group Test Score Differences

Then an independent sample t-test *was carried out using SPSS 26* for Windows *to determine whether or not there was an improvement in students' critical thinking skills after using the PjBL-based science learning e-module. To carry* out the independent sample t-test*, the data requirements tested must be normally distributed and homogeneous, then normality and homogeneity tests are carried out.*

Normality and homogeneity tests were carried out to determine whether the data used was normal or not with a α level of 0.05. When testing normality and homogeneity assisted with the SPSS 26 *for Windows application*, the normality test was carried out using the formula *One Kolmogrov Smirnov.*

H0= Normal distributed sample

Ha= Sample is not normally distributed

This conclusion is based on the significant level obtained greater than 0.05 then H0 is accepted and if the significant level is less than 0.05 then Ha is accepted and H0 is rejected. The results of the normality test are obtained from the results of the experimental class and the control class.

Table 2 . One Sample Kolmogrov-Smirnov Test Normality Test Results

Tests of Normality							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Class	Statistic	df	Sig.	Statistic	Df	Sig.
Critical Thinking Skills	Initial observation of the experiment(e-module)	.177	24	.051	.943	24	.187
	Final Observation of the Experiment(e-module)	.159	24	.118	.917	24	.051
	Initial observation of control (conventional)	.170	24	.071	.944	24	.202
	Final observation of control (conventional)	.207	24	.009	.923	24	.070
a. Lilliefors Significance Correction							

Based on the results of Table 2 regarding the normality test at the initial observation of the experimental class obtained sig 0.187, the final observation of the experimental class obtained sig 0.051, the observation of the control class obtained sig 0.202, and *the final observation of the control class obtained* sig 0.070 , the result is greater than *0.05* then H0 is accepted and Ha is rejected. It can be concluded that the result data is normally distributed.

Table 3 . Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Critical Thinking Skills	Based on Mean	.762	1	46	.387
	Based on Median	.707	1	46	.405
	Based on Median and with adjusted df	.707	1	44.188	.405
	Based on trimmed mean	.949	1	46	.335

Based on the results of the homogeneity test in table 3, *a sig* result of 0.378 was obtained. This shows that the *sig* is greater than 0.05 and it can be concluded that the data is homogeneous.

The calculation results in table 4 of the *independent sample t-test data* obtained an average difference between the experimental class and the control class as a whole of 2.625. The results

were obtained from experimental class respondents and control classes, with *a sig (2-tailed) p-value* of 0.000. So Ha was accepted and there was a significant difference between the control class and the experimental class. This means that there is an increase in critical thinking skills. This effectiveness test uses a comparison between the control class and the experimental class, where the experimental class gets treatment while the control class does not get treatment. Based on the overall data, it can be concluded that the use of PjBL-based science learning e-modules can improve students' critical thinking skills.

Table 4. Hasil Uji *Indeoendent Sample T-Test*

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
critical thinking skills	Equal variances assumed	.762	.387	4.949	46	.000	2.625	.530	1.557	3.693
	Equal variances not assumed			4.949	44.488	.000	2.625	.530	1.556	3.694

3.4. *Disseminate*

At the development stage, the distribution of learning media produced is e-module learning. The e-module was then given to the 5th grade homeroom teacher of SD Insan Kamil Bogor to be shared in the Whatsapp group of each grade 5 in the form of an e-module link. The response given was very good. Grade 5 students of Insan Kamil Bogor seem very interested in learning using e-modules.

4. CONCLUSION

The results of development research show that e-module science learning based *on project based learning* is the right and effective method to improve students' critical thinking skills. Validation carried out by experts in the e-module assessment also showed valid results with material aspects reaching 75.6% in the valid category, media aspects reaching 84.5% with very valid categories, and language aspects 81.25% with very valid categories.

The effectiveness of the project-based learning e-model of science learning in improving students' critical thinking skills can be observed through initial observation and final observation

of students' critical thinking achievements. The results showed significant changes, with individual test scores increasing from an average of 26.4 at baseline observations to 39.6 at final observations. Small group test scores also increased at the average initial observation by 12.8 to 25.2 at the final observation. The large group test score also increased to mean at the initial observation of 25.04 and increased to 41.45 at the final observation. This shows that the average final observation results are higher than the initial observations in achieving students' critical thinking skills.

PjBL-based science learning e-modules are also able to improve students' critical thinking skills when compared to control classes. There was a difference in mean value between the control class and the experimental class of 2.625 with a significance (2-tailed) of 0.000. Therefore, it can be concluded that the PjBL-based science learning e-module is effective and feasible to be used to improve students' critical thinking skills in grade 5 elementary school.

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