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DEVELOPING SCIENCE MODULE OF PROBLEM-BASED LEARNING TO IMPROVE CRITICAL THINKING SKILL

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Abstrak:

Penelitian ini bertujuan untuk menghasilkan modul IPA model Problem Based Learning (PBL) yang layak untuk meningkatkan kemampuan berpikir kritis siswa dan menganalisis keefektifan pembelajaran IPA dengan modul IPA PBL dalam meningkatkan kemampuan berpikir kritis siswa di SMP Negeri 2 Wates. Metode yang digunakan adalah Research and Development (R&D) yang mengacu pada model pengembangan Four-D (4D) dengan desain studi kasus one-shot pre-experimental. Penelitian menggunakan purposive sampling diperoleh subyek penelitian adalah 31 siswa kelas VII D. Instrumen yang digunakan adalah lembar validasi, angket respon siswa, lembar observasi pelaksanaan pembelajaran, dan tes berpikir kritis. Teknik analisis kelayakan modul IPA adalah konversi nilai kuantitatif menjadi kualitatif, empat kategori. Sedangkan teknik analisis keefektifan modul adalah uji-t sampel berpasangan dan skor N-gain. Hasil penelitian menunjukkan bahwa modul IPA PBL untuk meningkatkan kemampuan berpikir kritis layak dalam kategori sangat baik dan keefektifan pembelajaran IPA dengan modul IPA PBL efektif dalam meningkatkan kemampuan berpikir kritis siswa, dengan nilai signifikansi Sig(2- tailed) menunjukkan (p= 0,000 < 0,05) dan nilai N-gain sebesar 0,37 dalam kategori sedang.

Kata kunci: *Modul, Problem Based Learning, Berpikir Kritis*

Abstract:

This study aims to produce a feasible science module of Problem Based Learning (PBL) to improve students' critical thinking skills and analyze the effectiveness of science learning with science module of PBL in improving students' critical thinking skills at 2 Wates JHS. The method used is Research and Development (R&D) referring to the Four-D (4D) development model with a pre-experimental one-shot case study design. The research using purposive sampling obtained subjects were 31 students of class VII D. The instruments used were validation sheets, student response questionnaires, learning implementation observation sheets, and critical thinking test. The technique of analyzing the feasibility for the science module is the conversion of quantitative scores into qualitative, four categories. While analysis technique for the effectiveness of the module is paired sample t-test and N-gain score. The results showed that the science module of PBL to improve critical thinking skills was feasible in very good category and the effectiveness of science learning using science module of PBL was effective in improving students' critical thinking skills, with a significance value of Sig(2-tailed) showing (p= 0.000 <0.05) and the N-gain value is 0.37 in medium category.

Keywords: *Module, Problem Based Learning, Critical Thinking*

Introduction

Education is a very important need for a human civilization this is related to the role of education in educating humans and developing knowledge, science, and technology to support the development of the times, so as to be able to meet human needs. The functions and objectives of national education as stated in Law no. 20 of 2003 is to develop capabilities and shape the character and civilization of a dignified nation in order to educate the nation's life and build better life skills.

The implementation of the 2013 Curriculum is a form of effort so that students have 21st century skills, namely, critical thinking, collaboration, communication, and creativity in knowledge and sensitivity to the environment. Critical thinking skills are fundamental skills in the 21st century including the ability to access, analyze, synthesize information, which can be learned, trained, and mastered.

In the Science Performance assessment shown in the results of the 2018 PISA publication where Indonesia received a score of 396 from the highest score obtained by China 590 and placed Indonesia at level 2 of the highest level 6 (OECD, 2019). In addition, the results of observations and interviews conducted before and during the educational program at 2 Wates JHS, it is known that the science learning carried out refers to the main teaching materials in the form of material resumes and practice questions obtained by students through school. Resume material and questions given by the school only hone the ability to remember, understand, and apply the criteria for questions C1-C3 so that students are less honed in critiquing a situation with the knowledge they have.

In learning with problem based learning models, analysis is an important key in the learning process. The ability to interpret, infer, analyze, evaluate, and explain is part of the indicators of critical thinking ability. This ability is supported by direct experience of problems obtained by students through PBL learning and processed with the science process which will form critical, creative, and analytical thinking skills. And the characteristics of the interaction of living things with the environment are suitable if developed in a science module based on problem based learning to improve students' critical thinking skills.

Based on what has been described from the results of the 2018 PISA publications, observations, and interviews, the effort that can be made to fulfill the needs analysis above is to develop a problem-based learning science module in learning material on the interaction of living things with the environment for teaching and learning activities in the classroom.

Modules are teaching materials containing subject matter that are arranged and presented in writing in such a way that the readers are expected to be able to absorb the material themselves (Wasisto, 2016). Meanwhile, according to the Directorate of Education Personnel (2008) writing the module has the aim of clarifying and facilitating the presentation of messages so that they are not too verbal, overcome the limitations of time and space, can be used appropriately and varied, and allow students to measure or evaluate their own learning outcomes.

Problem-based learning (PBL) is based on the theory of cognitive psychology, especially based on the theory of Piaget and Vigotsky (constructivism). According to constructivism theory, students learn to construct their knowledge through interaction with their environment. PBL problem-based learning can make students learn through efforts to solve real world problems in a structured way to construct students' knowledge. This learning requires students to actively conduct investigations in solving problems and the teacher acts as a facilitator or mentor. Learning will be able to form higher order thinking skills and increase students' ability to think critically (Abdullah, 2017).

The problem-based learning module in it must show steps or syntax that in accordance with the problem-based learning model. Problem based learning science modules can improve critical thinking skills with the characteristics of formulating problems, formulating hypotheses, collecting data, testing hypotheses and students can determine alternative solutions (Rokhim, 2018).

Critical thinking ability is one of the higher-order thinking skills that requires students to be active learners because students are required to analyze, evaluate, and create (Conklin, 2012).

The previous opinion is in line with Johnson (2010) that critical thinking is a directed and clear process that is used in activities such as solving problems, making decisions, persuading, analyzing assumptions, and conducting scientific research. So that in the process of analytical/critical thinking is the ability to assess one's ideas, look at the strengths (strengths), and weaknesses (weaknesses), and provide suggestions for improvement (improvements) (Abdullah, 2017).

Method

This study uses a qualitative Research and Development (R&D) approach referring to the Four-D (4D) development model including Define, Design, Develop, and Disseminate which is carried out using a pre-experimental one-shot case study design. This research was conducted on 15 February – 5 March 2021 for the even semester (II) academic year located at 2 Wates JHS, Wates, Kulonprogo, Special Region of Yogyakarta. The subject of this research is the students of 2 Wates Junior High School, class VII D with 31 students. The research subjects were obtained using a purposive sampling technique, that the selection of samples as desired (Sugiyono, 2009. Purposeful sampling is a sampling technique used if it has certain considerations in taking the sample. The sample was selected using considerations that is having their own cellphone and having an active email.

The research was conducted using a pre-experimental one-shot case study design, the design can be seen as follows:

Treatment	Observasi
X	O

Figure 1. One-Shot Case Study Design
Source: Sugiyono, 2009.

Notes :

X = Giving treatment

O = Observation after treatment (posttest)

Based on Figure 1. The design of a one-shot case study which is a Quasy Experimental study with a single treatment (one-shot case study) on a group of subjects who were treated (X), then observed (O). In addition, the researcher only conducted one treatment which was thought to have had an effect, then a posttest was held (Sugiyono, 2009). Data collection techniques used in this study were questionnaire techniques, observation techniques, and test techniques. The instruments used are validation sheets, student response questionnaires, learning implementation observation sheets, and critical thinking skills questions in the form of pretest-posttest questions.

Science Module Feasibility Validation Analysis

Calculate the average score of each component of the assessment aspect using the formula (Sugiyono, 2009):

$$\overline{X} = \frac{\sum X}{N}$$

Converts the average score to a grade by category. The reference for changing the score to a scale of four can be seen in Table 1 below:

Table 1. Conversion of Scores into Four Scale Values

Score Range	Interval	Category
$X \geq \overline{X} + 1.\ SBx$	$X \geq 3$	Very Good
$\overline{X} + 1.SBx > X \geq \overline{X}$	$3 > X \geq 2{,}5$	Good
$\overline{X} > X \geq \overline{X} - 1.SBx$	$2{,}5 > X \geq 2$	Enough
$X < \overline{X} - 1SBx$	$X < 2$	Less

(Mardapi, 2008)

Based on Borich in Trianto (2010) the reliability of the validation of expert lecturers and science teachers can be determined using the Borich formula, namely Percentage of Agreement, with the following equation:

$$PA = 100\% \{1 - (\frac{A-B}{A+B})\}$$

Provided that the results of the validation of the science module are reliable if they have a reliability value or Percentage of Agreement above 75%.

Analysis of Student Response Questionnaires

Analysis was carried out by changing the qualitative value in the student response questionnaire into a quantitative value then make changes for changing the score to a scale of four in Table 1.

Analysis of Learning Implementation Observations

Analysis techniques for observing the implementation of problem based learning learning activities through observation sheets were obtained with the following formula:

$$\%\text{Implementation} = \frac{\sum \text{Implemented}}{\sum \text{Learning steps}} \text{ X } 100$$

The percentage of implementation is then converted into qualitative data using the Category as shown in Table 2 below:

Table 2. Percentage of Learning Implementation

No.	Percentage (%)	Category
1.	X > 80	Very Good
2.	60< X≤ 80	Good
3.	40 < X ≤ 60	Enough
4.	20 < X ≤ 40	Less
5.	X≤20	Very Less

(Widoyoko, 2009)

Effectiveness Analysis of the Science Module

Prerequisite test was analyzed using normality test and homogeneity test. The results obtained determine the test to be carried out, parametric with the provisions of normal data distribution or nonparametric with conditions if the parametric test is not met. The prerequisite test is carried out by several assumption tests as follows.

1) Normality Test

The normality test was carried out using the SPSS (One Sample Kolmogorov-Smirnov Test) application program. If *Asymp.Sig* (2-tailed) ≥ ½ α , then H0 is accepted. If *Asymp.Sig* (2-tailed) < ½ α, then H0 is rejected.

2) Homogeneity Test

The homogeneity test was analyzed using the SPSS application program. Provisions in making decisions are if the value of *Sig* ≥ α, then H0 is accepted. If the value of *Sig* < *α*, then H0 is rejected.

3) Paired t-Test

The test is carried out by using a paired t-test using the SPSS program application with the condition that if the value of *Sig.(2-tailed)* < 0,05, then H1 is rejected and H0 is accepted.

Analysis of Critical Thinking Ability

Data analysis techniques of students' critical thinking skills through pretest and posttest can be known by Normalized gain with the following formula:

$$g = \frac{\overline{X} \text{ score posttest} - \overline{X} \text{ score pretest}}{\overline{X} \text{ score maksimal} - \overline{X} \text{ score pretest}}$$

The results obtained are then converted using the Category in Table 3 below:

Table 3. Conversion of Normalized gain

Interval	Category
g> 0,70	High
0,3 ≤ g ≤ 0,70	Medium
g < 0,30	Low

(Hake, 1999)

Result

This study aims to determine the feasibility of the module and the effectiveness of science learning with a problem-based learning science module developed to improve critical thinking skills. The data taken in this study were in the form of validation sheets, learning implementation sheets, student response questionnaires, and pretest-posttest questions.

The feasibility assessment on the validation sheet is carried out by three validators. The validators are two Science Education Lecturers, FMIPA UNY as expert lecturers on materials and media and one science teacher at 2 Wates JHS. Based on the assessments carried out by expert lecturers and science subject teachers, the average value of problem based learning science modules in all aspects was 3.71 with a very good category. The validation results obtained based on the analysis that have been carried out are summarized in Table 4.

Table 4. Results of Validation Analysis

No	Rated Aspect	Average			Category
		Expert 1	Expert 2	Teacher	
1	*Self-Instructional*	3,5	3,67	4	Very good
2	*Self-Contained*	3,5	4	4	Very good
3	*Stand Alone*	4	3	4	Very good
4	*Adaptive*	3	4	3	Very good
5	*User Friendly*	3,67	4	4	Very good
6	*Critical Thinking Skill*	3,67	3,67	4	Very good
7	*Problem Based Learning*	3,5	3,75	4	Very good
Average		3,55	3,72	3,86	Very good

Based on the validation results, the Percentage of Agreement (PA) value is 95%. This shows that the problem-based learning science module used in this study is feasible and reliable to be used for research. The summary of the calculation of the Percentage of Agreement (PA) from the validator is written in Table 5.

Table 5. Results Science Module of Problem Based Learning Reliability Analysis

No	Rated Aspect	Average Validator Score		PA (%)
		Expert	Teacher	
1	*Self-Instructional*	3.59	4	95
2	*Self-Contained*	3.75	4	97
3	*Stand Alone*	3.5	4	93
4	*Adaptive*	3.5	3	92
5	*User Friendly*	3.89	4	99
6	*Critical Thinking Skill*	3.67	4	96
7	*Problem Based Learning*	3.63	4	95
Average				95

After conducting a feasibility assessment by expert validators and science teachers, a pretest was carried out. Pretest is an activity carried out before students are given treatment. The results of the pretest stated that most of the students before being given science learning with problem-based learning science modules had critical thinking skills in the poor category, as many as 15 students (48.4%). The results of the pretest obtained based on the analysis that has been carried out are summarized in Table 6.

Table 6. Analysis of Students' Critical Thinking Ability Levels in the Pretest Group

Category	Frequency	Percentage (%)
Very Good	1	3,2
Good	2	6,5
Enough	13	41,9
Less	15	48,4
Total	31	100,0

The results above show that students have not been able to build their own knowledge, develop questioning and thinking skills to a higher level (Qomaryah, 2019).

After the pretest was carried out, the class was treated by carrying out the learning process using a problem-based learning science module. During the learning process to monitor the implementation of problem based learning learning, observations of the implementation of learning are carried out. Observations were carried out by one observer, namely the seventh grade science teacher at 2 Wates JHS. The results show the percentage of implementation is 98% with a very good category. A summary of the results of the implementation of learning can be seen in Table 7.

Table 7. Results of the Learning Implementation Observation Sheet Analysis

No.	Meeting	Implementation (%)	Category
1.	1	93%	Very good
2.	2	100%	Very good
3.	3	100%	Very good
Average		98%	Very good

Classes that have been treated with a learning process using a problem-based learning science module, at the final stage of learning the material on the interaction of living things with the environment are asked to work on posttest questions. The posttest results stated that most of the students after being given science learning with problem-based learning science modules had critical thinking skills in the good category, namely as many as 14 students (45.2%). The posttest results obtained based on the analysis that has been carried out are summarized in Table 8.

Table 8. Analysis of Students' Critical Thinking Ability Levels in the Posttest Group

Category	Frequency	Percentage (%)
Very Good	10	32,3
Good	14	45,2
Enough	6	19,4
Less	1	3,2
Total	31	100,0

The results above indicate that there is an effect between the pretest and posttest. Rokhim (2018) explains that a problem-based learning science module can improve critical thinking skills because it has the characteristics of formulating problems, formulating hypotheses, collecting data, testing hypotheses and students can determine alternative solutions.

Students are also asked to fill out a student response questionnaire related to the problem-based learning science module used during the learning process of the interaction of living things with the environment. The results obtained from the responses of students obtained a value of 2.99 with a good category. A summary of the results of the student response analysis can be seen in Table 9.

Table 9. Results of Questionnaire Analysis of Student Responses to the Science Module

No	Aspect	Average	Category
1	Attitude	2,84	Good
2	Interest	3,06	Very good
3	Learning Outcomes	3,09	Very good
	Average	2,99	Good

The level of students' critical thinking skills after learning with the problem-based learning science module was analyzed by first conducting prerequisite tests, namely normality tests and homogeneity tests. Normality analysis using the Kolmogorv Smirnov test, stated that the pretest and posttest variables had a significance value of more than 0.05. This shows that the data is normally distributed. The results of the normality test obtained based on the analysis that has been carried out are summarized in Table 10.

Table 10. Normality Test

Variable	Sig.	Critical Value	Explanation
Pretest	0,423	>0,05	Normal
Posttest	0,384	>0,05	Normal

Furthermore, homogeneity analysis using Levene's test, stated that the pretest and posttest variables had a significance value of more than 0.05. This shows that the data is homogeneous, the results of the homogeneity test obtained based on the analysis that has been carried out are summarized in Table 11.

Table 11. Homogeneity Test

Variable	Sig.	Critical Value	Explanation
Pretest Posttest	0,	>0,05	Homogen

Based on the results of the prerequisite test above, it is possible to perform a parametric test using the paired t-test. The significance test states t arithmetic (-10.800) which is an absolute value so that t is obtained 10.800 with a significance value of Sig (2-tailed) showing ($p = 0.000 < 0.05$) which states that there is an increase after using the problem-based learning science module, compared to before using. So that the problem-based learning science module is effective to be used in science learning material on the interaction of living things with the environment at 2 Wates JHS. The results of the paired t-test obtained based on the analysis that has been carried out are summarized in Table 12.

Table 12. Paired Samples Test

	Paired Differences				Sig. (2-tailed)
	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
			Lower	Upper	
Pretest-Posttest	12.4422	2.2347	-28.699	-19.571	.000

The improvement of students' critical thinking skills was analyzed based on the Normalized gain (N-gain) score. The improvement analysis was taken from the students' pretest-posttest scores. Analysis of increasing critical thinking skills using Normalized gain, can be seen as follows:

Table 13. Normalized Gain Analysis for Increasing Students' Critical Thinking Ability

Quantity	Mean Score		Normalized gain	Category
	Pretest	Posttest		
31	34,5	58,6	0,37	Medium

Table 13 above states that there is an effect of learning science with problem-based learning-based science modules on improving critical thinking skills of students in class VII D 2 Wates JHS, the Normalized gain value based on the Pretest-Posttest shows a score of 0.37 in the medium category.

Sianturi (2018) suggests that the critical thinking ability of students who take part in problem-based learning (PBL) is higher than that of students who take conventional learning. This can happen

because in learning with the PBL model, students are actively involved in group discussion activities to build and construct new knowledge.

Conclusion

Based on the results of the data analysis and discussion that has been stated, it can be concluded that the science module for the interaction of living things and environment based on problem based learning to improve critical thinking skills is feasible and effective to use in the science learning process. Based on the results of data analysis and discussions that have been put forward, there are several suggestions that the science module for the interaction of living things and environment based on problem-based learning becomes teaching material that is considered in the learning process and can be developed further for other subjects.

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