International Journal of Social Science And Human Research

ISSN(print): 2644-0679, ISSN(online): 2644-0695

Volume 04 Issue 07 July 2021

DOI: 10.47191/ijsshr/v4-i7-30, Impact factor-5.586

Page No: 1785-1789

The Effectiveness of Problem Based Learning (PBL) Based E-Module on the Classic Genetic Materials to Improve the Student's Critical Thinking Skills

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ABSTRACT: This study aims to determine the effectiveness of *Problem Based Learning* (PBL)-based e-module. The method used was a quasi-experimental with a *Posttest Only Control Design*. The pilot sample in this study were the students of the Biology Study Program, Universitas NegeriPadang (UNP) in 2019 academic year chosen by using a purposive sampling technique. The instruments used in this study were the lecturer interview questionnaires, student needs analysis questionnaires, validity and practicality questionnaires and evaluation questions based on critical thinking indicators. The results of the analysis of evaluation questions showed that the mean scores of critical thinking skills of the experimental class students were higher than the control class. The mean score of the experimental class was 76.89 while the control class was 65.11. The result of critical thinking t test shows that t count (0.000) < from (0.05). Thus, it indicates that the e-module on PBL-based classical genetic material is effective for improving the students' critical thinking skills.

KEYWORDS: E-module, PBL, Critical Thinking

I. INTRODUCTION

The 21st century learning has challenges, opportunities, and problems that are very different from the past(Lubis, 2019).
Chu (2018) stated that in order for university graduates to be able to take on a role in the 21st century, it is necessary to master 21st century skills that can be achieved through the educational process. NEA (National Education Association) has identified 21st century skills as "The 4Cs" skills. "The 4Cs" include critical thinking, creativity, communication, and collaboration. Critical thinking is a skill that is essential for life and functions effectively in all aspects of life.

In addition, Wahyuni (2015) states that critical thinking is a form of thinking that seeks to understand problems in depth, has an open mind to the decisions and opinions of others, tries to understand and evaluate correctly the information received before making a decision and is able to connect between cause and effect in finding solutions to problems faced both in the process of learning activities and in the environment of everyday life. The learning process in higher education is expected to be able to train students to think critically.

Based on the results of the critical thinking test to the students of Biology Study Program at UniversitasNegeri Padang (UNP) on October 13rd, by giving the essay questions by the researcher to the students, it shows that the students' critical thinking skills in the Genetics subject were 54.71. According to Manahal (2017) it shows that the students' critical thinking skills are categorized as less critical.

Genetics is a compulsory subject for the students of the UNP Biology Education Study Program. Genetics subject are closely related to real life so that problems can arise in everyday life. One of the suitable learning models to stimulate students' critical thinking skills is the *Problem Based Learning* (PBL) model. The application of the PBL model is expected to overcome the student difficulties in solving problems related to the genetic material so that the students can use it when facing real problems.

Based on the researcher's interview with one of the lecturers in the Genetics subject at the Biology Department, UNP, Mrs. Dr. Dwi Hilda Putri, S.Si, M.Biomed on August 26th, 2020 revealed that the student learning outcomes in genetics courses were low. If looking at the test scores, approximately 60% of the students have good scores. Based on the questionnaire analysis of the student needs, so far in genetics learning 95% of the students used teaching materials in the form of textbooks. The textbooks used have not been compiled using a learning model that directs the students to think critically about a developing phenomenon. In addition, the students want teaching materials in the form of electronic modules to be more practical and easily accessible anywhere and anytime.

Therefore, one way to improve the student learning outcomes is by providing teaching materials that allow students to study independently online with good quality and in accordance with the expected learning outcomes, so the development of teaching materials is prioritized for electronic modules (*e-module*). PBL-based electronic module can stimulate the students to think critically to understand the genetic material to solve the problems contained in it so that learning can be student-centered. This is in line with Rahmatika (2020) that PBL-based electronic module can improve students' critical thinking skills and their cognitive learning outcomes. Furthermore, Suarsana and Mahayukti (2013) stated that problem-solving-oriented electronic module can improve students' critical thinking skills and their responses in lectures are very positive. The problem in this research is whether the e-module developed is effective to improve students' critical thinking skills. The purpose of this study was to test the effectiveness of the e-module developed to improve the students' critical thinking skills.

II. RESEARCH METHOD

This research was a quasi-experimental (quasi-experimental). This study aims to test the effectiveness of the e-module developed to improve the students' critical thinking skills. This research design used *Posttest Only Control Design*. The *Posttest Only Control Design* is shown in Table I.

Table I: *Posttest Only Control Design* Research Design.

Class	**Treatment**	***Posttest***
Experimental	X	T
Control	-	T

Source: (Lufri, 2015) Information:

X : Learning using PBL-based e-module.
- : Learning using teaching materials commonly used in class
T : The final test is given to the sample class at the end of the lesson

The population of this study was the students of Biology Study Program, UniversitasNegeriPadang (UNP) in 2019 academic year. The sample of this study was the students from Class A as the experimental class and Class B as the control class chosen by using the purposive sampling technique. The independent variable in this study was the use of PBL-based*e-module*on the classical genetic material. The dependent variable in this study was critical thinking skills. This type of research was a primary research because the data was obtained directly based on the student assessments regarding the response to the emodule and the value of the evaluation test in the form of an essay. The research instruments used were (1) lecturer interview questionnaires, (2) student needs analysis questionnaires, (3) validity and practicality questionnaires (4) evaluation questions based on critical thinking indicators. The data analysis technique was to see the effectiveness of the students on PBL-based emodule based on posttest scores.

In this study, the researcher chose critical thinking indicators according to Phillips, critical thinking indicators according to Phillips are as follows:

1. Analysis, a person's ability to understand and express the meaning of various kinds of data, experiences, and judgments.
2. Evaluation, the ability to assess information and the results of someone's reasoning
3. Inference, a person's ability to make a hypothesis in order to draw conclusions from the information obtained.
4. Deductive reasoning, the subject's ability to start with a premise or can also be interpreted as an activity to prove a formula.
5. Inductive reasoning, someone's reasoning ability starting from related knowledge and experience towards conclusions that may be true (Phillips, 2004).

The analysis of the effectiveness of the PBL-based *e-module* on the classical genetic material used essay test questions to see the critical thinking skills. Critical thinking skills are scored based on each assessment rubric, and the number of scores obtained is calculated. The rubric for scoring critical thinking according to Zubaidah (2015) is shown in Table II.

Table II. Critical Thinking Scoring Rubric

Score	**Description**
I	**II**
5	• All concepts are correct, clear and specific • All descriptions of answers are correct, clear, and specific, supported by strong reasons, true, clear arguments • The flow of thinking is good, all concepts are interrelated and integrated • Grammar is good and correct

	• All aspects are visible, the evidence is good and balanced
4	• Most of the concepts are correct, clear but not specific • Most of the descriptions of answers are correct, clear, but less specific • The flow of thinking is good, most of the concepts are interrelated and integrated • Grammar is good and correct, there are minor errors • All aspects are visible, but not yet balanced
3	• Some of the concepts are correct and clear • Some of the descriptions of the answers are correct and clear but the reasons and arguments are not clear • The flow of thinking is quite good, some are interrelated • Grammar is quite good, there are spelling errors • Most aspects that seem correct
2	• Unfocused or exaggerated or dubious concepts • The answer description does not support • The flow of thinking is not good, the concepts are not interrelated • Grammar is good, incomplete sentences • Few aspects seem right
1	• All concepts are incorrect or insufficient • Incorrect reasons • The flow of thinking is bad • Poor grammar • Overall aspects are not sufficient
0	No answer or the answers are incorrect

Source: (Zubaidah S. , 2015)

Posttest results were analyzed by using the Ermayanti (2016) formula:

$$\text{Result} = \frac{\text{Total Score}}{\text{Maximun Score}} \text{X100\%}$$

The results of the critical thinking analysis were confirmed by the criteria of critical thinking according to Maulana (2017), which can be seen in Table III.

Table III. Criteria for Critical Thinking

Interval	**Kriteria**
$0 \leq N \leq 39$	Not critical
$40 \leq N \leq 55$	Less critical
$56 \leq N \leq 65$	Enough critical
$80 \leq N \leq 100$	Critical
$66 \leq N \leq 79$	Very critical

Source: (Maulana, 2017)

Hypothesis testing criteria H0 is accepted (H1 is rejected) if the significance value is >0.05 H0 is rejected (H1 is accepted) if the significance value is <0.05. Before the t-test is carried out, the normality and homogeneity tests are first carried out. The data is normal if the significance is > 0.05 and the data is homogeneous if the significance is > 0.05.

III. RESULT AND DISCUSSION

Learning outcomes data were obtained through the learning outcomes tests conducted at the last meeting. The test was given in the form of essay questions. The data on the assessment of the students' critical thinking skills were presented in Table IV which was the final exam score.

Table IV. Critical Thinking Assessment Results

Kelas	N	Xmin	Xmax	Mean	Standar Deviasi
Control	27	46	78	65.11	8.671
Experimental	27	60	90	76.89	9.070

Based on Table IV, it can be seen that the mean of the students' critical thinking skills from the experimental class was higher than the control class. The experimental class is a class that is given treatment in the form of PBL-based *e-module* on the classical genetic material while the control class is a class without treatment. The mean result of the experimental class was 76.89 with a standard deviation 9,070. Then, the mean result of the control class was 65.11 with a standard deviation 8.671.

In testing the hypothesis, the normality test and homogeneity test were first carried out as a prerequisite for the data analysis. Based on the results of the analysis of the prerequisite test, it was found that the result of critical thinking skills was normally distributed and homogeneous. The results of normality and homogeneity tests can be seen in the table. Furthermore, the data on the critical thinking skills were tested for hypotheses using the Independent Samples T Test. The results of hypothesis testing of the critical thinking skills in the experimental and control classes can be seen in Table V.

Table VI. Calculation of t-test of Critical Thinking Skills

Kelas	Signifikansi	Kesimpulan
Control	0.000	H_0 ditolak
Experimental		

Based on Table VI, it is known that the significance value of students' critical thinking skills is 0.000. This indicates that the value of sig. <0.05 which means that H0 is rejected and H1 is accepted. Thus, it is known that the use of PBL-based *emodule* on the classical genetics has an effect on the students' critical thinking skills.

The effectiveness of the *e-module* can be seen from the students' critical thinking skills obtained after the students use the e-module in the learning process. The students' critical thinking skills were assessed through a final exam held after learning. The instrument used was in the form of essay questions consisting of 10 items. Testing the effectiveness of the emodule was carried out by using the t-test because the data were normally distributed and homogeneous. Based on the t-test, the result was that the hypothesis was accepted. Therefore, it can be concluded that the use of e-module PBL-based on the classical genetic material is effective for learning.

Based on the results of the study, there were differences between the students' critical thinking skills from the control class and the experimental class. The treatment in the experimental class used the PBL-basede-module on the classical genetic material while the control class used the common e-module. The PBL-based e-module developed can improve the students' critical thinking skills. This is in accordance with the opinion of Hosnan (2014) which states that the main goal of PBL is to develop students' critical thinking skills, problem solving abilities, and build their own knowledge. The PBL model can generate critical thinking skills and new knowledge that is useful for the long term (Sungur and Caren, 2006).

PBL begins with presenting the problem. The problem is based on a real-life problem that has been selected to meet the criteria (Graff and Kolmos, 2003). At the stage of problem orientation, the students could analyze the information presented. The problems presented in the e-module in the form of discourse were sourced from news, articles and journals related to classical genetic material closely related to the phenomena of everyday life.

The problems given in the e-module aimed to build students' curiosity by connecting theory with everyday life. The students were required to determine problem identification and formulate problems at the problem orientation stage. The next stage was to develop and implement a plan. This stage aims for students to conduct reference studies to answer the formulation of the problem that has been made. They discuss in their groups to relate problems to the e-module by conducting reference studies so that problems can be solved optimally. According to Yuan, et al (2011) through PBL with heterogeneous group members it allows students to exchange ideas, work together to solve problems which in turn can improve critical thinking skills. In addition, Wynn (2010) said that in the PBL model the lecturer acts as a facilitator so that students are active in the learning process.

Furthermore, in the stage of providing solutions, the students were expected to be able to present the work of the group and answer all questions from other groups. Orozco and Yangco (2016) stated that problems in the PBL approach become a stimulus for students in learning activities. Obviously, learning aims to find alternative solutions to problems according to the context of existing knowledge.

The last stage was evaluation. The students assessed the strengths and weaknesses of other groups and then made conclusions. The presenter group looked for answers from the responses that have been given by other groups. Then, the researcher evaluated the results of the discussion and together concluded the learning materials contained in the e-module.

IV. CONCLUSION

Learning using PBL-based *e-module*on the classical genetic material was effectively used in learning to improve the students' critical thinking skills. The mean of the students' critical thinking skills from the experimental class was higher than the control class. The mean score of the experimental class was 76.89 while the control class was 65.11. The results of the ttest were 0.000<0.05. Thus, it can be interpreted that PBL-based *e-module* on the classical genetic material is effective for improving students' critical thinking skills

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