

# The Implementation of Inquiry Based Learning toward Students' Learning Outcomes and Critical Thinking Skills

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**Abstract**—This research aimed to (1) test the effect of inquiry based learning toward learning outcome of cognitive product and cognitive process, (2) test the effect of inquiry-based learning toward critical thinking skills. Implementation this model using the quasi-experimental. The independent variable was inquiry-based learning while the dependent variables were learning outcome of cognitive product, cognitive process, and critical thinking skills. This research population was grade 11th students from SMA Negeri 1 Sungai Tabuk i.e. XI IPA-1, XI IPA-2, and XI IPA-3. This research samples for implementation of inquiry-based learning toward learning outcomes for the first treatment classes were XI IPA-2 and XI IPA-3, while the control class was XI IPA-1. The second treatment classes were XI IPA-1 and XI IPA-2, while the control class was XI IPA-3. The treatment classes were determined by using purposive sampling technique. This research samples for implementation of inquiry based learning toward critical thinking skills were XI IPA-2 and XI IPA-3, while the control class was XI IPA-1. This research was held for 3 months. The instrument to measure the cognitive product and cognitive process consisted of multiple-choice test and the critical thinking skills consisted of essay test. The data were analyzed by using anacova SAS release 9.1.3. The results are (1) inquiry base learning has effect to learning outcome of cognitive product and cognitive process, (2) inquiry base learning has no effect to the ability to apply, but has effect to the ability to analyze and the ability to evaluate.

**Keywords**—*Critical Thinking Skills, Inquiry Model, Learning Outcome*

## I. INTRODUCTION

One of the problems in facing educational world in Indonesia is that there is weakness of learning process. In the learning process, students are less encouraged to develop the ability to think. Learning in the classroom is only directed to memorize information without being required to understand what they have memorized [1][2]. The survey results of Trends in International Mathematics and Science Study (TIMSS) in 2011 reported that the percentage of Indonesian students ranked in 40th out of 42 countries. Indonesian students placed in 31st rank of the mid-level reasoning, in 41st rank of low-level reasoning and in 38th rank of the mid-level

of ability to know [3]. These results are consistent to the report of Program for International Student Assessment (PISA) in 2012 in which the ranking of students' critical thinking skills is 64th from 65 countries [4].

Ref [5] released a report of PISA from 2000-2009 and showed that overall Indonesian students' science literacy is in the range of 30-40%. Based on the results of this study, the learning process and assessment need to be designed to stimulate the increase of scientific literacy. Designing inquiry-based learning and innovation is an alternative to deal with this issue.

Inquiry-based learning has been often implemented. The use of this model has improved students' learning outcomes [6][7][8][9][10][11][12][13][14]. The use of this model has also increased the ability to think [9]. It is effective in demanding students to develop and evaluate their own hypotheses and obtain their own conclusions [15]. Critical thinking skills are obtained through inquiry and observation.

Learning is a relatively permanent change in behavior through experience and training [16]. Learning is successful if there are distinct behavior changes in students. The science learning through inquiry involves science process and skills used by scientists to study and assist students in applying the skills [17].

The learning outcomes are widely interpreted in a model to include not only the cognitive and grade point, but also a wide range of behaviors and attitudes [18]. The learning process inside and outside school produces three capabilities known as a bloom taxonomy consisting of cognitive abilities, affective and psychomotor [19].

Critical thinking is represented by the skills of critical thinking: (1) inference, (2) the introduction of assumptions, (3) deduction skills to determine conclusions, (4) interpretation, and (5) evaluation [20]. Interpretation is the ability to understand and express the meaning of the various experiences, circumstances, data, events, consideration, conventions, beliefs, rules, procedures or criteria [21]. Inference is like concluding an image of some of the presented

supporting data. Explaining/describing is the ability to express and justify the reasoning in relation to the conceptual, methodological, criteria and considerations based on the underlying context.

The increase of critical thinking skills through; (1) reading, (2) listening, (3) observing, and (4) analyzing [22]. Based on the aforementioned proposals, the research question was formulated as follow: Does the inquiry-based learning in biology learning affect the learning outcomes and high school students' critical thinking skills?.

**II. METHOD**

The design of this study was distinguished into two types. Types 1 was the implementation of inquiry-based learning model on learning outcomes using a quasi-experimental with counter balance design, as shown in Figure 1.

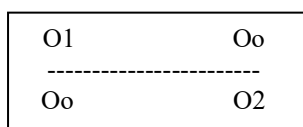


Fig 1. The Model Design of Counter Balance Study

Where are O1: Treatment Class I (The Concept of Circulatory System); Oo: Class Control; and O2: Treatment Class II (The Concept of Motion Systems)

Types 2 was the implementation of inquiry-based learning model in the ability to think also uses quasi-experimental with the design of the nonequivalent control group design, as shown in Figure 2.

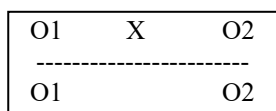


Fig 2. The Model Design of the Nonequivalent Control Group Design

Where are O1: Pretest; O2: Posttest; and X: Treatment

The independent variable was inquiry-based learning. The dependent variable was the learning outcomes of cognitive product, the learning outcomes of cognitive process, and critical thinking skills. Control variable was the number of lesson hours, syllabus, educational background of teachers and teaching materials.

The research population of XI class students of SMAN 1 Sungai Tabuk Banjar consisted of three classes, namely XI-1 XI-2 and XI-3 class. The following is the division of the research sample: (1). To examine the significance of the implementation of inquiry-based learning model on learning outcomes, the treatment classes I were XI-2 and XI-3 classes, while the control class was XI-1 class. The treatment classes II were XI-1 and XI-2 classes, while the control class was XI

IPA-3 class. The treatment classes were determined by using purposive sampling technique; (2) To examine the significance of the implementation of inquiry-based learning model on critical thinking skills, the treatment classes were XI-2 and XI-3 classes, while the control class was XI-1 class.

The research was conducted in three months (October-December 2016) in SMA Negeri 1 Sungai Tabuk Jl. Gerilya Sungai Tabuk Kramat, District Banjar.

The research instruments used in this research were (1) an instrument to measure cognitive product which consisted of a multiple choice test; (2) an instrument to measure cognitive process which consisted of a multiple choice test, and; (3) an instrument to measure critical thinking skills which consisted of an essay test.

A multiple-choice test and an essay test were validated using Rasch models [23]. The data collection and analysis techniques were distinguished into: (1) the learning outcomes of cognitive product were obtained through a multiple choice test, which was given a score of 1 if it is correct and 0 if it is wrong; (2) The learning outcomes of cognitive process is obtained through a multiple-choice test, given a score of 1 if it is correct and 0 if it is wrong; (3) the results of learning critical thinking skills is obtained through an essay test, scored using a rubric essay test. Each data group was compared with the control group, using the anacova program of SAS 9.1.3. version.

**III. RESULTS**

*A. Learning Outcomes*

The results of the cognitive learning products and cognitive processes processed using anacova are presented in Table 1. Table I shows the average difference of the learning outcomes of cognitive product between treatment class and control.

TABLE I. SUMMARY OF THE LEARNING OUTCOMES OF COGNITIVE PRODUCTS AND COGNITIVE PROCESSES

Biology Concept	Learning Outcomes	Control Class		Treatment Class	
		Pretest	Posttest	Pretest	Posttest
Circulatory System	Cognitive Product	41.94	60.54	50.61	70.18
	Cognitive Process	40.54	56.88	49.09	63.15
Movement System	Cognitive Product	35.00	60.00	36.00	65.00
	Cognitive Process	41.00	44.00	42.00	73.00

Table II. shows the average difference of the learning outcomes of cognitive product between treatment class and control class. The same thing applies to the learning outcomes of cognitive process. The significance test of the average difference using anacova is summarized in Table 2.

**TABLE II. SUMMARY OF COVARIANCE ANALYSIS OF STUDENT OUTCOMES**

Biology Concept	Learning Outcomes	N	F-ratio	Pr > F	R <sup>2</sup>	c.v.	Description
Circulatory System	Cognitive Product	85	42.95	<0.001	0.50	9.64	Significant
	Cognitive Process	85	94.84	<0.001	0.69	7.83	Significant
Movement System	Cognitive Product	85	37.84	<0.001	0.47	3.29	Significant
	Cognitive Process	85	54.56	<0.001	0.56	8.92	Significant

Table 2. shows that there is an effect of inquiry-based learning in biology learning to the cognitive products learning outcomes (F-ratio = 42.95;  $P = 0.001$  and F-ratio is 37.84,  $P = 0.001$ ). There is an effect of inquiry-based learning in biology learning to the cognitive processes learning outcomes (F-ratio = 94.84;  $P = 0.001$  and F-ratio is 54.56,  $P = 0.001$ ).

### B. Critical Thinking Skill

Learning outcomes of the effect of inquiry-based biology learning to high school students' critical thinking skills is summarized in Table III.

**TABLE III. SUMMARY OF COVARIANCE ANALYSIS ON VARIOUS PARAMETER OF STUDENTS' CRITICAL THINKING SKILLS**

Indicator	Parameter	N	F-ratio	Pr > F	R <sup>2</sup>	c.v.	Description
Application	Determine	60	1.03	0.360	0.03	5.29	No Significant
Analysis	Giving Attribute	62	39.75	0.001	0.57	35.13	Significant
Analysis	Integration	61	2.83	0.050	0.08	29.24	Significant
Analysis	Analysis	61	11.89	0.001	0.29	13.10	Significant
Evaluation	Improving	61	2.70	0.050	0.08	46.00	Significant

Table 3 shows that there is no significant effect of inquiry-based learning biology to the ability to apply (F-ratio = 1.03;  $P = 0.36$ ). There are significant differences in ability to analyze (F-ratio = 39.75;  $P = 0.001$ ; F-ratio 2,83,56;  $P = 0.05$ ; F-ratio is 11.89,  $P = 0.001$ ). There are significant differences in the ability to evaluate (F-ratio = 2.70;  $P = 0.05$ ).

## IV. DISCUSSION

### A. The Effect of Inquiry Based Learning on the Learning Outcomes of Cognitive Products

Inquiry-based learning can improve the learning outcomes of cognitive product and has significant effect. This finding is consistent with the research that has been reported previously by [24] although a lot of research explains that inquiry-based learning affects the learning outcomes [7][8][11][12][13][14]. The researchers above did not distinguish between the

learning outcomes of cognitive product and cognitive process, as set out in the Ministerial Regulation number 41 of 2007 [25].

Separating the learning outcomes between cognitive product and cognitive process is not without reason because learning is a process. It is an activity and not a result or goal [26]. Learning is a process of change in behavior, from not knowing into knowing [27].

Ironically, the learning outcomes are not measurable because the words used to formulate the learning outcome are not operational, as reported in other studies [28], [9]. They use the term "understanding" as the embodiment of learning outcomes.

### B. The Effect of Inquiry Based Learning on the Learning Outcomes of Cognitive Process

Inquiry-based learning can improve learning outcomes of cognitive processes and has significant effect. These findings are supported by previous studies [24], [29]. Other studies have generally explained that the inquiry-based learning affects the learning outcomes. For example it only affects the learning outcomes [12], or using the word construct such as the "understanding" of learning outcomes [7], [8], [9], [11], [14], [28].

The use of construct word in formulating research objectives has obscured the research objectives to be achieved. In fact, it should to be measured because it reflects the process of change in behavior [27]. In general, the results of the research do not distinguish between cognitive products and cognitive process [6], [8], [9].

Inquiry-based learning is significant to the learning outcomes of cognitive process because there are tasks to be accomplished together, so there should be a division of work. The effective communication will facilitate cooperation within the group. Thus, the opportunity to understand the learning material will be better. More importantly, the education is directed to the process of finding a concept, not just memorizing concept.

### C. The Effect of Inquiry-Based Learning on the Critical Thinking Skills

Inquiry-based learning does not affect the ability to apply, but it affects to the ability to analyze and evaluate. This research divides the indicator of the ability to think critically, in contrast to some studies that have been reported previously, without outlining the indicator of critical thinking skills [9], [11][30].

One of the studies has found the indicator of critical thinking skills which is the ability to explain [14]. Nevertheless, the ability to explain according to Bloom's Taxonomy does not include the critical thinking skills [31].

Many studies have only measured the critical thinking skills [24][29][32][33][34] although there are undifferentiated indicators to be achieved [24][34]. However, the research which carried out in groups does not reflect individual skills.

Inquiry-based learning in biology learning does not affect the ability to apply. This can be understood because the ability to apply (C3) does not require a high ability to achieve it. As a comparison of skills to formulate the problem and formulate hypotheses through descriptive research can be equated with the ability to apply which is also obtained by a good category [35]. Therefore, it uses the benchmark for critical thinking skills which is a prerequisite to acquire critical thinking skills.

Inquiry based-learning has effect toward the ability to analyze and ability to evaluate. This is contrasted with the previous research by [35] in which the ability to analyze and ability to make conclusions show any improvements. Otherwise, Ref [24] found that ability to formulate the problems, formulate hypotheses, collect and analyze the data, and make conclusions are classified as good.

## V. CONCLUSION

Based on the research and discussion, it is concluded that inquiry-based learning on biology learning has effect to learning outcome of cognitive product. Inquiry-based learning on biology learning has effect to learning outcome of cognitive. Moreover, inquiry-based learning on biology learning has no effect to the ability to apply, but has effect to the ability to analyze and the ability to evaluate.

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