EFFECT OF PROBLEM BASED LEARNING (PBL) MODELS OF CRITICAL THINKING ABILITY STUDENTS ON THE EARLY MATHEMATICS ABILITY

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Abstract

The purpose of this study is (1) to determine the mathematical critical thinking skills of students using of Problem Based learning models and conventional learning models on Class X Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi, and (2) determine the best among its learning models Problem Based learning and conventional learning to enhance students' mathematical critical thinking skills Class X Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi.

This research was conducted in Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi Academic Year 2015 / 2016. Subjects of this study consisted of students of class X_9 there are 34 people as an experimental class, and students in class X_{10} there are 31 people as a control class.

The results of this study were (1) the ability to think critically class X_9 Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi by problem based learning model is a minimal medium, (2) the ability to think critically class X_{10} Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi by conventional learning model is maximum medium, (3) average N-Gain for each indicator of the ability to think critically mathematics in class X_9 by problem based learning higher compared with students in class X_{10} by conventional learning models in Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi, and (4) There are significant differences critical thinking skills mathematically among students class X_9 by problem based learning model and class X_{10} by conventional learning models for all Classification N-Gain (high, medium, and low) at Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi.

Keywords: Problem Based Learning (PBL), critical thinking, Early Mathematics Ability

A. INTRODUCTION

Education is one of the manifestations of human culture that is dynamic and developmental requirements. Therefore, changes or educational development is in line with the cultural change in life. Mathematics is a field of study that has an important role in education. Mastery of mathematics is a must for learning mathematics in school text books still tend to be oriented and less related to the daily life of students (Amri, 2013: 2). Learning concepts tend to the abstract if using speech or conventional learning methods, so that the mathematical concepts difficult to understand.

This looks at students of Class X Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi that critical thinking skills in particular subjects of mathematics for the last 2 years was less that the value of 36.61 and 37.21. Therefore, in particular the concept of learning math concepts necessary to find appropriate models of learning so that students easily learn math.

One model of learning that can be used is problem based learning (PBL). PBL model selection is also in accordance with the purpose of learning mathematics that focuses on ways of thinking or reasoning, developing creative activity, developing the ability to solve problems and communicate ideas. This is in line with the opinion of Cunningham et al (Karlimah, 2010: 63), that the problem-based learning as a learning strategy that simultaneously develop problem-solving strategies, disciplinary knowledge, and skills of putting students in activities to solve the problem by making the confrontation of the problem structure in the form of real problems in daily life -day. Through the model PBL students also learn to take responsibility for learning, not just receive information passively, but should actively seek the necessary information in accordance with existing capabilities. In PBL learning students are required to ask questions and express opinions, find the relevant information from sources that are hidden to find different ways (alternative) to get a solution, and finding the most effective way to solve the problem (Husnidar, 2014: 72).

According to Pierce and Jones (Fachrurazi, 2011: 80) in the implementation of PBL there is a process that must be raised, such as: involvement (engagement), inquiry and investigation, performance, frequently asked questions and discussion (debriefing).

Engagement aims to prepare students to act as problem solvers (self-directed problem solver) which can cooperate with other parties, exposes students to a situation that could encourage to being able to find the problem, investigate and resolve it. Inquiry and investigation activities include exploring ways of explaining and implications, as well as the activities of collecting and distributing information. Performance aims to present the findings obtained. Question & answer and discussion, ie testing the accuracy of the solution and to reflect on the problem solving is done.

The steps of learning in PBL by Arends (Apriono 2014: 15), is as follows:

1. Orienting the students on issues

At the beginning of learning by PBL models, teachers convey clear learning objectives, set a positive attitude towards learning, and explained to students how their implementation. Furthermore, teachers are doing orientation issues until problems arise or discovered by the students. Based on the problems students are actively involved in solving it, find the concept and principles.

2. Organising students to learn

Learning with PBL models require skills development collaboration among students and help them investigate the problem together, it is helping to plan the investigation and reporting of their duties. Besides the need for study groups. There are a few things to note, that learning is formed varies with the capability, race, ethnicity, and gender in accordance with the objectives to be achieved. If the difference in the group is required, then the teacher can create a group with students deal.

3. Help investigate independently or group

Investigations carried out independently, in groups or in a small group that is the core of the model PBL. Although each situation requires a slightly different problem investigation techniques, most include data gathering process and experimentation, hypotheses, explanations and settlement administration. At this stage the teacher encourages students to collect data and carry out the actual activities until they truly understand the dimension of the problem situation.

4. Develop and present work

The results that have been obtained must be presented in accordance with the students' understanding. Students independently or group to respond to the work of his friend. Discussion, dialogue, even debate to comment on solving the problems presented. In this case the teacher directs, member views on student responses but not acting as a resource as justification.

5. Analyze and evaluate the results of problem-solving

The final stage of learning by PBL models include assistance to students analyze and evaluate their own thought processes as the activities and intellectual skills they use in solving problems in achieving results. During this stage, the teacher assigns students recast of the ideas and their activities at every stage of learning.

Steps of learning in the PBL are summarized in Table 1 below.

Table 1
Sintaks problem based learning (PBL)

Fase	Indicator	Teacher Behavior
1	Orienting the students on issues	▪ Informing learning objective ▪ Creating a classroom environment that allows an exchange of ideas that is open. ▪ Directing a question or problem. ▪ Encouraging children to express ideas openly.

Fase	Indicator	Teacher Behavior
2	Organising students to learn	▪ Help students find the concept-based problem ▪ Encouraging openness of the democratic process of learning ▪ Test the students' understanding of the concept finds
3	Help investigate independently or group	▪ Provide ease of students in problem solving ▪ Encouraging cooperation and task completion. ▪ Encouraging dialogue, discussion with friends ▪ Helps define and organize tasks ▪ Helps formulate hypotheses ▪ Assist in providing solutions
4	Develop and present work	▪ Guiding students work on student activity sheet ▪ Guiding students present the results of work.
5	Analyze and evaluate the results of problem-solving	▪ To help students review the results of problem-solving ▪ To motivate students to engage in problem solving ▪ Evaluate the material

Based the steps on PBL learning mentioned above, it appears that this learning engages students in the learning process that is active, collaborative, student-centered, who develop the problem solving and self-learning ability. It is indicated that PBL could encourage students to think critically in solving mathematical problems. This is in line with the opinion of Pernama (2007: 118) that PBL is defined as an approach to learning that begins with the presentation of a problem that is designed in the context of relevant materials to be studied to encourage students to: acquire knowledge and understanding of concepts, achieving critical thinking, have the independence to learn , participating in group work skills, and problem solving skills.

The ability to think critically is part of the initial ability of students. This is in line with the opinion of Thoha (2006) that a characteristic of the initial capabilities are able to think critically, creatively, and innovative.

There are several definitions of critical thinking as suggested by Norris (1991: 1) that the critical thinking as rational decision making what is believed and done. Then, Ennis (1991: 26) also states that critical thinking is reflective thinking focused on deciding what to believe and do. The decision-making process should be done carefully and unhurried. This means that critical thinking requires the use of various strategies to be able to produce a decision as a basis for taking action or belief.

In the process of learning, critical thinking skills level consists of several indicators, namely: to understand, apply, analyze, synthesize, and evaluate the information collected (Richard W. Paul, 2005: 28). While Izmaimuza (2010: 64) provide an indicator of critical thinking skills: the ability to identify the mathematical concepts, connect between concepts, evaluate, troubleshoot, and analyze. The fifth aspect is described as follows:

(1) Identifying the concept is a skill outlines a structure into the components that determine the structure of the organization. Aspects identify concepts include: writing down what is known and asked of the matter. (2) Analyzing is to describe and understand the various facets gradually in order to come to a new formula. Aspects analyzed include: can define / concept / definition / theorem in solving the problems clearly and precisely. (3) Connecting one concept is incorporating parts into a formation or a new arrangement. Aspects related the concept include: can apply the concept / definition / theorem in solving problems. (4) Problem solving mathematical concept into an application problem resolution. Aspects solve the problem include: procedures and results showed the main problem solving / determination of the solution / answer. (5) Evaluating is provide an assessment of the value measured by using a certain standard. Evaluating aspects include: re-test solutions / answers and determine the conclusion of a problem.

Indicators of critical thinking skills listed above can be summarized in table 2 below:

Table 2
Indicators of critical thinking mathematically

No	Aspect Measured	Measured Indicators
1	Identify concepts	1.1 To write what you know
		1.2 Can explain what is asked of matter
2	Analyzing	2.1 Can define the concept / definition / theorem in solving the problems clearly
		2.2 Can define the concept / definition / theorem in resolving problems with precision
3	Linking between concepts	3.1 Be able to apply concepts to solve problems
4	Solve mathematical problems	4.1. to indicate the procedure in problem resolution/ determination of the solution / answer
		4.2 to show major results in problem solving / determination of the solution / answer
5	Evaluate	5.1 to reexamine the solution / answer
		5.2 to determine the conclusion of an answer

(Ismaimuza (2010: 64)

Based on the above, the problem in this study were (1) how critical thinking ability of students' mathematical either using based problem model and conventional learning model in class

X Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi, and (2) Is the problem based learning model better than the conventional learning model to improve students' critical thinking skills mathematical Class X Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi.

B. METHODS RESEARCH

This research was conducted in Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi Academic Year 2015 / 2016. Subjects of this study consisted of students of class X_9 there are 34 people as an experimental class, and students in class X_{10} there are 31 people as a control class. The study design was used *Randomized Control Group PreTest-PostTest*. This design can be described in the following table 3:

Table 3
The study design was *Randomized Control Group Pretest-Posttest*

Student groups	Measurement (pretest)	Treatment	Measurement (Posttest)
Group Experiment (E)	T_{01}	X	T_{11}
Group Control (K)	T_{02}	—	T_{12}

(Nazir, 1988: 289).

Explanation :

E = class experiment

K = control class

X = Treatment with the implementation of Problem Based Learning model in the experimental class

T_{01},T_{02} = pretest Mathematically critical thinking skills of students before treatment

T_{11}, T_{12} = posttest mathematical students' critical thinking skills after treatment

Analysis of the data in this study using descriptive and inferential analysis. The formula used in the data analysis are Normalized Gain, with equation:

$$Normalized\ Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Explanation : S_{post} = Posttest score,

S_{pre} = Pretest score, and

S_{max} = The maximum score.

Gain Normalized value criteria such as Table 4 below:

Table 4: Criteria Normalized Gain

Acquisition Normalized Gain	Criteria
Normalized Gain > 0,70	High
0,30 ≤ *Normalized Gain* ≤ 0,70	moderate
Normalized Gain < 0,30	Low

(Archambault in Duda, 2010:32).

Gain Normalized calculation is done with a view to eliminating the guess work of students and the highest rate effects, so avoid the conclusion that bias (Hake and Heckler in Lambertus, 2010: 95). Furthermore, Gain Normalized value is processed, and processing adapted to the problems and the proposed hypothesis.

C. RESEARCH RESULTS

1. Results Descriptive Analysis Mathematical Critical Thinking Ability in Experiment Class and Control Class

a. Distribution of the value pretest and posttest experimental class students

Distribution of the value pretest and posttest experimental class students with based problem learning model is processed into a normalized gain (N-Gain). Data classification N-Gain the experimental class are presented in Table 5 below:

Table 5
Data Classification N Gain Mathematical Critical Thinking Skills Student Experiment Class

N-Gain	Classification	F	Relative frequency (%)
G < 0,30	Low	0	0
0,30 ≤ G ≤ 0,70	moderate	27	79,41
G > 0,70	High	7	20,59
Sum		34	100

Based on data in Table 5 above, it appears that the critical thinking skills of students at low Gain N classification does not exist. It shows that the students' critical thinking skills based on problem-based learning model is a minimal medium.

b. Distribution of the value pretest and posttest control class students

Distribution of the value pretest and posttest control class with conventional learning models processed into gain normalized (N Gain). Data classification N Gain the control class are presented in Table 6 below:

Table 6
Data Classification N Gain Mathematical Critical Thinking Skills Student Control Class

N-Gain	Classification	F	Relative frequency (%)
G < 0,30	Low	6	19,35
0,30 ≤ G ≤ 0,70	moderate	25	80,65
G > 0,70	High	0	0
Sum		31	100

Based on data in Table 6 above, it appears that the critical thinking skills of students in higher Gain N classification does not exist. This shows that the critical thinking skills of students based on conventional learning models is the maximum medium.

c. The average N-Gain for each indicator Critical Thinking Mathematically Experiment Class and Class Controls

The average N-Gain for each indicator of the ability of critical thinking mathematically the experimental class and control are presented in Table 7 below:

Table 7

On average each Indicator N Gain Mathematical Critical Thinking Skills Experiment Class and Control Class

Indicator	Class	
	Experiment	Control
Identify	0,94	0,52
Analyzing	0,86	0,50
Connecting Concepts	0,62	0,29
Solve the problem	0,53	0,26

Based on the data in table 7 above, it appears that the average N Gain for each indicator critical thinking skills in students mathematics experimental class is higher in comparison with the control class. This shows that the critical thinking skills of mathematics students in the experimental class in a better overall compared to students in control class.

Data in Table 7 above can be presented in graph Normalized Gain as figure 1 below.

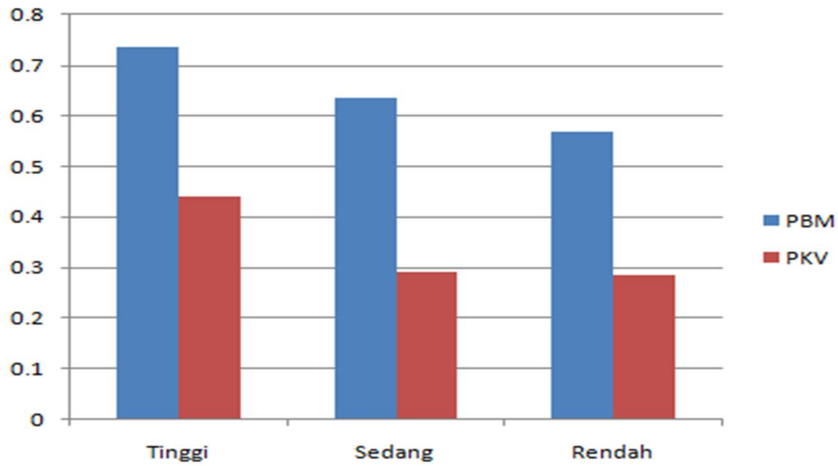

Figure 1. graph of Gain Normalized for each Indicator Mathematical Critical Thinking Skills Experiment Class and Control Class

2. Inferential Analysis Results

a. Normality test

Data normality test is intended to determine the average mathematical think critically ability on whether the population distribution is normal or not. This is done by using SPSS 16.0 and can be seen in Table 8 below.

Table 8
Normality Test Data N-gain based learning model PBL and VCM for all groups Classification N Gain the ability of critical thinking mathematically

N Gain Classification	Statistical	PBL Model	PKV Model
High	N	7	6
	Absolut	0,218	0,313
	KS-Z	0,578	0,766
	Sig	0,893	0,601
	Exp	H0 be accepted	H0 be accepted

Moderate	N	16	18
	Absolut	0,220	0,263
	KS-Z	0,881	1,117
	Sig	0,420	0,165
	Exp	H0 be accepted	H0 be accepted
Low	N	11	7
	Absolut	0,124	0,141
	KS-Z	0,411	0,373
	Sig	0,996	0,999
	Exp	H0 be accepted	H0 be accepted

Based on the data in table 8 above, it appears that the data is N-gain based learning model PBL and PKV for all groups Classification N Gain (high, moderate, and low) on the ability of critical thinking mathematically is normal.

b. Homogeneity of Variance Test

Homogeneity of variance test is used to determine whether the two sets of data variance critical thinking skills mathematically homogeneous or not. Based on the results SPSS 16.0 can be seen in Table 9 below:

Table 9

Variance Homogeneity Test Data N-gain class with PBL models and class with PKV models for all Classification N Gain mathematical critical thinking skills

N Gain Classification	Model	N	Varians (s)	(S^2)	F	Value F table	Exp
High	PBL	7	0,0005	0,00000025	16	4,950	H0 rejected
	PKV	6	0,002	0,000004			
Moderate	PBL	16	0,002	0,000004	36	4,950	H0 rejected
	PKV	18	0,012	0,000144			
Low	PBL	11	0,007	0,000049	13,795	4,950	H0 rejected
	PKV	8	0,026	0,000676			

Based on the data in table 9 above, it appears that the variance data is N-gain between the experimental class learning model PBL and group control class learning model PKV for all Classification N Gain (high, moderate, and low) on the ability of critical thinking mathematically homogeneous.

c. Hypothesis testing

Hypothesis testing is used to determine whether there is a significant difference between mathematical critical thinking skills experimental class with a problem based learning model and control class with conventional learning models. Based on the results SPSS 16.0 can be seen in Table 10 below:

Table 10

Hypothesis Testing Data N-gain to see the difference between PBL learning model and PKV model for all groups Classification N Gain mathematical critical thinking skills

N Gain Classification	Model	N	Varian (s)	Mean	t	Value t table	Exp
High	PBM	7	0,0005	0,739	354,38	2,508	H0 rejected
	PKV	6	0,002	0,442			
Moderate	PBM	16	0,002	0,638	120,11	2,508	H0 rejected
	PKV	18	0,012	0,293			
Low	PBM	11	0,007	0,572	28,354	2,508	H0 rejected
	PKV	7	0,026	0,287			

Based on data in Table 10 above, it appears that there is a significant difference between critical thinking skills mathematical experimental class with a problem based learning and classroom learning model konvensional.untuk control with all Classification N Gain (high, moderate, and low) on the ability to think critical mathematically.

D. DISCUSSION

This research was conducted in Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi academic year 2015/2016 consists of X_9 class students as an experimental class, and X_{10} class students as a control class. Each class was given a different treatment, the experimental class was treated with based problem learning model and control class with conventional learning models. Both of these classes (experimental class and control class) have the ability to start the same with the indicated value of the initial mathematical ability of students from the two classes was flat at an average value 36.7 for X_9 class students and 35.8 for X_{10} class students.

The learning process was conducted over eight meetings with problem based learning model for classroom experiments, and conventional learning models for the control class, with mathematics learning materials paada topic: dub, roots, and logarithms. Before the learning process carried out beforehand are given a pretest with the purpose of identifying the initial mathematical ability of students on topics dub, roots, and logarithms both experimental class and control class. Based on the results obtained pretest for the experimental class average value of 35.9, while the control class gained an average value of 33.3. After the learning process for eight sessions given each posttest for the experimental class and control class with a view to determine the critical thinking skills of mathematics students during the learning process. Based on the results obtained posttest for the experimental class average value of 76.2, while the control class gained an average value of 54.2. Because the value pretest and posttest of students for each class of experimental and control classes differ greatly then used the N-Gain values with the aim of keeping the refraction value of each class group.

Based on the results of data classification N-Gain both experimental class and control class descriptively have shown very different results, the ability to mathematics think critically student experiment class models with problem-based learning model is a minimal medium. While mathematical critical thinking skills control class with conventional learning model is the maximum medium. Similarly, when viewed from each of the indicators of the mathematics critical thinking skills are also significant differences between the experimental class and control class, namely indicators: (1) identify, N-gain value of experimental class 0,94, while the control class 0,52 , (2) analyzing, N-gain value of experimental class 0,86, while the control class 0,50, (3) linking the concept, N-gain value of experimental class 0,62, while the control class 0,29, and (4) to solve the problem, N-gain value of experimental class 0,53, while the control class 0,26.

Descriptive analysis above is also supported by the results of testing the hypothesis that there are significant differences critical thinking skills mathematically between the experimental class with a problem based learning model and control class with conventional learning models for all Classification N Gain (high, moderate, and low) to the ability of critical thinking mathematically. So it is concluded that there are significant differences between a mathematical critical thinking skills using problem-based learning model with conventional learning models. And a mathematical critical thinking skills using problem-based learning model is better with conventional learning model.

This is consistent with the theory study and the results of previous studies. Among these Kolmos (2003) states that the Problem Based Learning is a learning model that provides a challenge for students to learn how to learn is good, and work together in groups to find solutions to real-world problems. Then, Wahyuni (2010) stated that the problem-based learning can encourage students to solve authentic problems, spurring the group discussions and develop independent learning. Problem-based learning can also improve asiswa skills in solving problems and develop critical thinking skills. Students will gain a more comprehensive understanding of the subject matter and learn more.

E. CONCLUSIONS

Based on the results of research and discussion, we conclude as follows.

1) The ability to think critically class X_9 Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi by problem based learning model is a minimal medium,
2) The ability to think critically class X_{10} Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi by conventional learning model is maximum medium,
3) Average N-Gain for each indicator of the ability to think critically mathematics in class X_9 by problem based learning higher compared with students in class X_{10} by conventional learning models in Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi, and
4) There are significant differences critical thinking skills mathematically among students class X_9 by problem based learning model and class X_{10} by conventional learning models for all Classification N-Gain (high, medium, and low) at Senior High School 1 Wawotobi-Unaaha Southeast Sulawesi.

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