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Building Systematic Think Ability

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***Abstract*—One of the indicators of mathematical reasoning is proof. The purpose of this study to analyze the difficulties of students in proving and influence proves the ability of systematic thinking process. The research method used is Quasi Experiment with Design Study of Nonequivalent Control Group Design. While the subject of this study is a student of mathematics education UIN Sunan Gunung Djati Bandung five semesters who are in charge of real analysis courses. The results showed that students' proof ability is still low, students difficulty proving due to several factors: lack of understanding of theorems or propositions, start confusion and lack of practice to prove. Through proving the ability of students systematic thinking process increases. The ability to think systematically can form a pattern of thinking that is orderly, thorough and logical.**

Keywords—reasoning; mathematical proof and systematic thinking

I. INTRODUCTION

Thinking structured, systematic and procedural is a competence built on mathematics. What and how to build these capabilities needs to be well structured from the curriculum structure, core competencies to the right indicators and steps in building that capability. The process needs to arrive at the appropriate evaluation instrument in building the structure of mathematical thinking skills, in this case, systematic thinking. Is it enough for students or students to do math problems systematic thinking ability automatically built or simply by hearing the explanation of the lecturer only. Of course, it needs to be studied nobler in depth from appropriate planning, strategy, technique, and method so that it impacts on a good result, for example in the college atmosphere that encourages students to actively build cognitive structure and systematic thinking for example through study community [1]. However, the achievement of mathematics learning outcomes in the case of critical thinking processes in universities in general still has not shown satisfactory results, this can be seen from the competence of students [2,3].

Ideally, course materials can be delivered well to students. Students understand and understand the steps of the lecture materials, especially the steps to solve the problem or solve the problem of proof. The level of difficulty of students studying real analysis is not fully author but some students are confused to initiate the process of proof, the evidentiary algorithm has not been understood and well understood, the condition is not different from the students at other universities students are confused to start from where when asked to prove, aware of the consequences of a theorem, his other findings and so on [4]. Other conditions, often passive students to express opinions do not want to ask even if there is material that is less understood. The implication of the value obtained by students is less satisfactory and has apathy towards the subject [5]. Based on the results of the research 92.5% of students stated that the real analysis, feel confused and difficulty in solving the problem of proof, student attitudes toward the real analysis course viewed from the substance or course material and students' earnestness studying the material obtained by 70% of students not studying this course previously the level of students' critical thinking skills both overall and by the level of mathematical ability (high, medium, low), already has the ability to generalize, but not yet have the ability to identify and justify concepts and not yet have the ability to analyze or evaluate an algorithm [5,6].

Each subject has a goal of learning achievement, such as improving communication skills, problem-solving, reasoning, critical thinking, creative thinking or vertical and horizontal thinking, critical thinking skills, and in the process of analysis, evaluation and synthesis in solving a mathematical problem [7]. Similarly, the real analytical course further encourages the reasoning and proofing capabilities. In the aspect of proof of ability that is expected one of them is the ability to think systematically, in addition, there are other capabilities achieved when the students prove. Systematic thinking is a thinking that involves step by step in the proof and the stages are interconnected and structured. There are stages of integral workmanship. Almost all types of integral problems require functional alignment, specifying the derivative and integral patterns of a function, and see if there are certain conditions before working on them. Systematic here is the order and sequence in the process.

Building the ability to think systematically requires the appropriate treatment or tools, whether through problem-solving or prove the ability to think systematically it woke up this must be examined more deeply or it could be concluded that the method of proof does not have any relation at all in building students' systematic thinking skills. The indicator of systematic thinking ability based on solving Polya problem that understands the problem, devise a plan, carry out the plan, and look back [8]. Other abilities built-in math as well as logical, meticulous, creative and critical should get attention on how to build it whether it is planning, process and building systematic ability and student difficulty factor in proving based on the test of proof ability. According to the theory of transformed

knowledge constructivism is not something independent but created and recreated [9].

II. RESEARCH METHODS

This study included quasi experimental research (experiment). The subject of this research is the students of mathematics education program of State Islamic University Sunan Gunung Djati in the fifth semester. The data collected in this study is data that fit with the focus of research is the ability to think systematically on the proof of real analytics courses. The data in the form of tests relating to the proof of material real data analysis of its non-test results questionnaire. Random sampling technique by group (cluster sampling). The sample of this study selected class A as an experimental class with the method of proofing of 38 students who follow the course of real and class B analysis as a control class with problem-solving method amounted to 37. Thus the design of this study are as follows:

O X_1 O

O X_2 O

With O = Pretest / posttest think systematically
X1 = The method of proof learning / Class A
X2 = The Method of Problem Solving/ Class B

III. RESULTS AND DISCUSSION

Stages of this study consist of pre-test, lectures through the method of proof or problem-solving method and then posts. In Class A for three meetings through the method of proof while class B through problem-solving method. At meeting 1 focus on direct proof; meeting 2 through the provision of mathematical induction and encounter 3 indirect proof. After the three meetings are done next posttest. The pretest results are presented in table 1 below.

TABLE I. PRETEST SYSTEMATIC THINKING ABILITY RESULTS

Class	Pretest	
	Average	*Standard deviation*
A	39	9,52
B	40	11,16

Maximum 100

Based on the results of table 1, pretest results in the two classes did not show this difference can be seen from the average value of pretest in class A 39 and in class B 40 with standard deviation class A 9.52 and class B of 11.16. this indicates that both classes have an equal initial ability. If the terms of the ability to prove the students at low levels for an average class A and class B 39 average of 40 is far from the ideal maximum value of 100. This is supported also by the objective conditions on the second day of the class. After three meetings are held next posttest. The pretest results are presented in table 2 below:

TABLE II. POSTES SYSTEMATIC THINKING ABILITY RESULTS

Class	Posttest	
	Average	*Standard deviation*
A	56	10,62
B	63	8,66

Nilai maksimum 100

Based on the results of table 2, the pretest results in the two classes show the difference but the difference is not too extreme this can be seen from the average value of posttest in the experimental class 56 and the control class 63 with standard deviation class A 10.62 and class B of 8, 66. In both classes, there is an increase in systematic thinking ability with sufficient level. The average systematic thinking ability of class A is smaller than class B this shows that the method of proof is more difficult than the method of problem solving but both methods have the ability to build the systematic ability of students because both the method of proof and problem solving have the same stage of completion problem, but on the verification stage more stringent. As in the matter of pretest and posttest about number 1. By definition prove that

$$a_n := \left\{\frac{2n^2+2}{2n^2+4}\right\}_{n=1}^{\infty} \text{ convergent t to 1}$$

Problem number 1 is a matter of direct proof. To answer the problem of this number 1, need the stages of proof as follows:

1) Understand the problem: the student must understand and know what is known and what is being asked.

2) Devise a plan: plot the answer by conducting a preliminary analysis through the definition of convergent t rows to obtain Hε∈N.

3) Carry out the plan: do the proof with the definition of convergent t lines.

4) Look back: check back and give conclusions from the results of the proof. When it is linked to systematic capability, it is clear that the problem of proof must be settled on a step-by-step basis since the first stage is a prerequisite for the next stage. Unlike the number 2 pretes and postes with the following problem. Let's say x_n convergent t sequence y_n convergent t sequence.

- Give each one an example(x_n) dan (y_n)!
- Determine the result of $(x_n) + (y_n)$, $(x_n) \times (y_n)$!, and explain whether the results are divergent or convergent?

To answer problem 2 required stages in solving the problem but the problem can be solved immediately without any preliminary analysis first. To obtain additional information about systematic thinking skills, students fill out a questionnaire with the following questionnaire results:

TABLE III. RESULT OF QUESTIONNAIRE OF SYSTEMATIC THINKING ABILITY

No	Statement	Yes	No
1.	The method of proof can improve my systematic thinking skills	58,57	41,43
2.	Studying real analysis is able to improve the evidentiary ability	44,28	55,72
3.	I have difficulty in solving the problem of proof	62,85	37,15
4.	The ability to think systematically helps solve everyday problems	57,14	42,86
5.	Thinking systematically can be built through problem solving in addition to proof	52,85	47,15
6.	Thinking systematically helps solve other mathematical problems	61,42	38,58
7.	the problem of proof is more difficult than about other problem solving	67,14	32,86

Based on the result of the questionnaire, it can be concluded that the method of proof and problem solving can build students' systematic ability. Students difficulty in solving the problem of proof.

IV. CONCLUSION

The students' proving ability at this low level indicates that the students have difficulty in proving the cause factors because of the initial confusion of the steps proving and lacking understanding the theorems and axioms well. Students have poor appraisal to the real course of analysis because it is too abstract and confused how to solve it. The ability to think systematically increases because the method of proof and problem solving has stages in solving the problem. Given the stages of solving the problem indirectly affect the ability to think systematically.

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