

## Analysis of Learning Obstacles Related to Mathematical Thinking Skills

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### ABSTRACT

Critical thinking skills are a person's ability to think systematically and directed in providing feedback on information, analyzing assumptions, and making decisions about what is believed and done. Ability is superior in this 21st-century learning, it is important to have especially by prospective mathematics teacher students, but there are still many students who experience obstacles in honing these abilities. This study aims to analyze the epistemological constraints faced by students in improving mathematical critical thinking skills in lectures on transformation geometry. This study is descriptive qualitative research; data were collected from the test, interview, and observation. Given five problems related to thinking critically mathematically ability with five indicators, against 6 respondents who have different belief of mathematical, namely high, medium, and low. The results showed that of the five indicators of mathematical critical thinking ability, the lowest was about advice clarification and inference that is giving a further explanation about the application of concepts and ways to deduce problems. Therefore, it is suggested that lectures on transformation geometry are more related to daily conditions and better train students in making appropriate

**Keywords:** 21st-century skill, critical thinking, mathematics.

### INTRODUCTION

Skills in 21st-century learning, known as Four C's of 21st Century Skills are the thinking abilities that students must have in learning in order to support and improve the work environment [1]. The Importance of Thinking Ability This becomes a challenge for prospective students to master it so that in the learning process in class, it must be able to hone these abilities. One thinking ability is needed. Mathematics is the ability to think critically [2].

With the times and the speed of science, students must be equipped with quality critical thinking skills. Therefore, learning is directed not only in terms of understanding but also in the analysis of concepts needed to solve problems more effectively [3]. The ability to think critically mathematically is the basis of the process of thinking to analyze arguments and bring ideas to meaning to develop logical thinking patterns [4]. Finally, mathematical critical thinking skills can be honed if prospective teacher students are accustomed to problems that contain logical thinking processes.

Critical thinking processes are reasoning activities that are based on studies, all in the analysis of causes and how to proceed. Prospective teacher students who are able to think critically if in their learning can express ideas, arguments based on previous concepts, so students are not only good listeners, but are also able to understand and analyze the information obtained. One of them is learning geometry transformation.

This branch plays an important role in life especially as an application in solving problems related to size and shape [5]. Like measuring tower height, area, volume, and so on. Because of its urgency, geometry is a subject that must be taught to prospective mathematics teacher students. Therefore, the learning process of geometry must be done innovatively [6].

For the development of active and innovative learning, there are at least three important elements namely time, teaching materials, and teaching methods. If all three are properly integrated, it will improve students' thinking abilities at a higher level [7], so that in learning geometry, learning resources are needed in the form of materials/textbooks which can not only improve students' cognitive abilities but

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also their effective abilities. Furthermore, it must be realized that in learning geometry, lecturers have a very important role to create effective and pleasant environmental conditions for prospective teacher students [8]. An effective and enjoyable environment is expected to maximize coaching and arouse the interest of prospective teachers in learning. Therefore we need a way of including (1) encouraging prospective teachers to find their own concepts or formulas, (2) actively involving prospective teacher students in finding concepts or formulas, (3) using a program/application suitable for learning

In addition to the learning process being a factor in mathematical critical thinking ability, there are also affecting factors that influence it, one of which is a belief about mathematics. Mathematical belief affects how students “welcome” mathematics lessons, [9] which is the result of experience. Mathematics Education Study Program students who later will be educated to become mathematics teachers, are known to still experience difficulties in dealing with mathematics. This can be seen, when studying mathematics, they are often not confident in explaining the mathematical material being studied. They look unsure in learning mathematics. Whereas with good mathematical beliefs, prospective teacher students are expected to be able to realize the potential situation to be able to think forward mathematically [10].

If students have good beliefs, then they will try even more in learning mathematics, because beliefs have a direct relationship with one's business so beliefs become the foundation of learning [11]. However, this does not appear to students when dealing with math problems, more quickly discouraged and unsure of their own.

From the description above, this study analyzed the epistemological learning obstacle of prospective teacher students related to the improvement of mathematical critical thinking skills, when viewed from beliefs in mathematics. Epistemological learning obstacle is a person's knowledge that is only limited to certain contexts, so when he is faced with different situations can result in the knowledge he has cannot be used or have difficulty in using it. There are 3 indicators of learning epistemological constraints are Conceptual, Procedural, and Technical Operational.

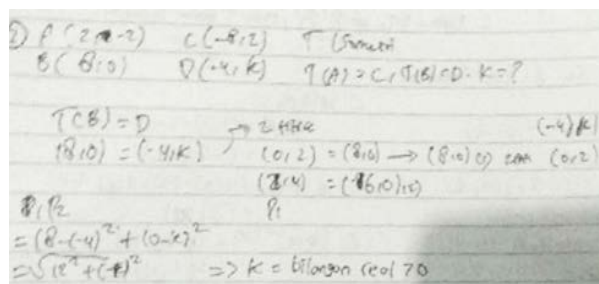
## RESEARCH METHOD

This research was conducted to analyze the challenges of pre-service teacher learning, especially to improve critical thinking skills in mathematics. This research method is descriptive qualitative research that aims to describe the barriers about epistemology students who learn mathematical-related thinking skills with 4 dimentions such as 1) advanced clarification, 2) basic support, 3) inference, and 4) strategies and tactics. The research subjects were six pre-service mathematics teachers who attended the transform geometry lecture consisting of 2 students with high mathematical belief (S1, S2), two students with moderate mathematical belief (S3, S4), and two students with low mathematical belief (S5, S6)). The questionnaire about mathematical belief was given to prospective teacher students to collect responses about the beliefs of mathematics while attending learning in lectures. Indicators of belief in mathematics were clarified into 5 (five) indicators, namely certainty of knowledge, the role of lecturers, systematic processes, innate ability and quick learning with five answer choices in the form of a rating scale. Which before has been done instrument validity and reliability.

## RESULTS AND DISCUSSION

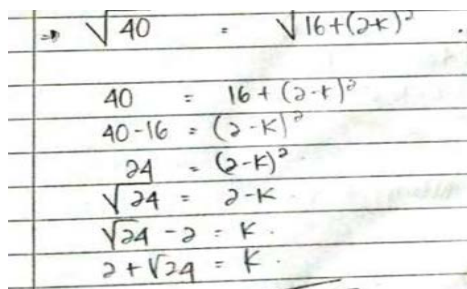
### 3.1 Mathematical Critical Thinking Skills of Students with Low Mathematical Belief

From 27 student teacher candidates randomly taken 2 students who have low mathematical beliefs namely S1 and S2.



$P(8,0)$      $Q(-4,k)$      $T(0,2)$   
 $T(0,2) = \frac{1}{2}(P+Q)$   
 $(0,2) = \frac{1}{2}((8,0) + (-4,k))$   
 $(0,2) = \frac{1}{2}(4,k)$   
 $(0,2) = (2, \frac{k}{2})$   
 $0 = 2$      $2 = \frac{k}{2}$   
 $k = 4$   
 $P(8,0)$      $Q(-4,4)$   
 $PQ = \sqrt{(8 - (-4))^2 + (0 - 4)^2}$   
 $= \sqrt{12^2 + (-4)^2}$   
 $= \sqrt{144 + 16}$   
 $= \sqrt{160}$   
 $= 4\sqrt{10}$

Figure 1. Result of S1



$$\begin{aligned} \Rightarrow \sqrt{40} &= \sqrt{16+(2-k)^2} \dots \\ 40 &= 16+(2-k)^2 \\ 40-16 &= (2-k)^2 \\ 24 &= (2-k)^2 \\ \sqrt{24} &= 2-k \\ \sqrt{24}-2 &= k \\ 2+\sqrt{24} &= k \end{aligned}$$

Figure 2. Result of S2

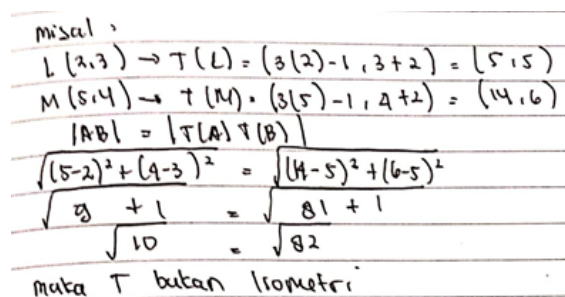
Table 1. Result about Critical thinking ability respondent S1 and S2

Type of obstacle	Identification of obstacles
Conceptual	S1 and S2 do not identify the results of deductions made but can determine some completion steps that are not yet perfect for the mention. On the ability to think critically S1 and S2 are less able to clarify the purpose of identifying or formulating questions accordingly
Procedural	S1 completion is not in accordance with Step should be, S2 is correct in the procedure
Technical Operational	S1 experienced an error in calculating the value of the calculated operation, whereas the S2 calculation was correct, but the information used was not written correctly

From the results of S1 and S2 students who are classified as having low mathematical beliefs, there are obstacles, especially in terms of procedural and operational techniques, although in identifying problems they have done but still not perfect, so in the process of completion (operational steps), there are still many mistakes. In this case, students who have low mathematical belief need practice and deepening of the material. Deepening of the material is needed so that students can make connections between the concepts that have been learned and those that will be studied [12].

### 3.2 Mathematical Critical Thinking Skills of Students with Medium Mathematical Belief

From 27 student teacher candidates randomly taken 2 students who have medium mathematical beliefs namely S3 and S4.

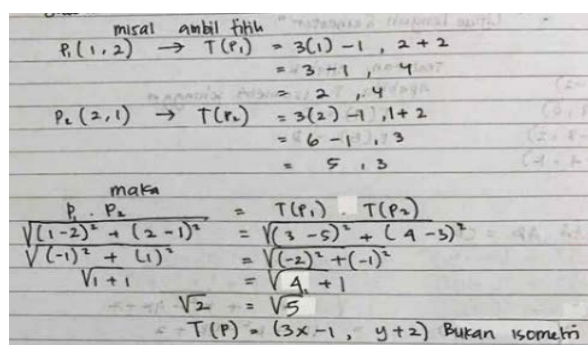


misal :

$$\begin{aligned} L(2,3) &\rightarrow T(L) = (3(2)-1, 3+2) = (5,5) \\ M(5,4) &\rightarrow T(M) = (3(5)-1, 4+2) = (14,6) \\ |AB| &= |T(A)T(B)| \\ \sqrt{(5-2)^2 + (4-3)^2} &= \sqrt{(4-5)^2 + (6-5)^2} \\ \sqrt{9+1} &= \sqrt{81+1} \\ \sqrt{10} &= \sqrt{82} \end{aligned}$$

maka T bukan isometri

Figure 3. Result of S3 and S4



misal ambil titik

$$\begin{aligned} P_1(1,2) &\rightarrow T(P_1) = 3(1)-1, 2+2 \\ &= 3-1, 4 \\ &= 2, 4 \\ P_2(2,1) &\rightarrow T(P_2) = 3(2)-1, 1+2 \\ &= 6-1, 3 \\ &= 5, 3 \end{aligned}$$

maka

$$\begin{aligned} P_1 \cdot P_2 &= T(P_1) \cdot T(P_2) \\ \sqrt{(1-2)^2 + (2-1)^2} &= \sqrt{(3-5)^2 + (4-3)^2} \\ \sqrt{(-1)^2 + (1)^2} &= \sqrt{(-2)^2 + (-1)^2} \\ \sqrt{1+1} &= \sqrt{4+1} \\ \sqrt{2} &= \sqrt{5} \\ \therefore T(P) &= (3x-1, y+2) \text{ Bukan isometri} \end{aligned}$$

Figure 4. Result of S3 and S4

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**Table 2.** Result about Critical thinking ability respondent S3 and S4

Type of obstacle	Identification of obstacles
Conceptual	S3 and S4 do not identify the questions given and provide reasons for their completion. S4 makes a mistake in writing the point, namely point T (P1)
Procedural	The solution to S3 and S4 in the end is not given an explanation that the distances AB and T(A)T(B) are not the same (not marked are not equal)
Technical Operational	technically, S3 and S4 have done the calculations correctly

From the test results, the obstacle for S3 and S4 in identifying the questions given was the incomplete writing of the isometric concept which resulted in the correct answer. The results of the interview with S3 why he only answered like that, he said that he knew that important concepts were not the same. S4 replied that what was important was not the same. However, if asked further about the concept of isometry, they still could not give the right answer.

### 3.3 Mathematical Critical Thinking Skills of Students with High Mathematical Belief

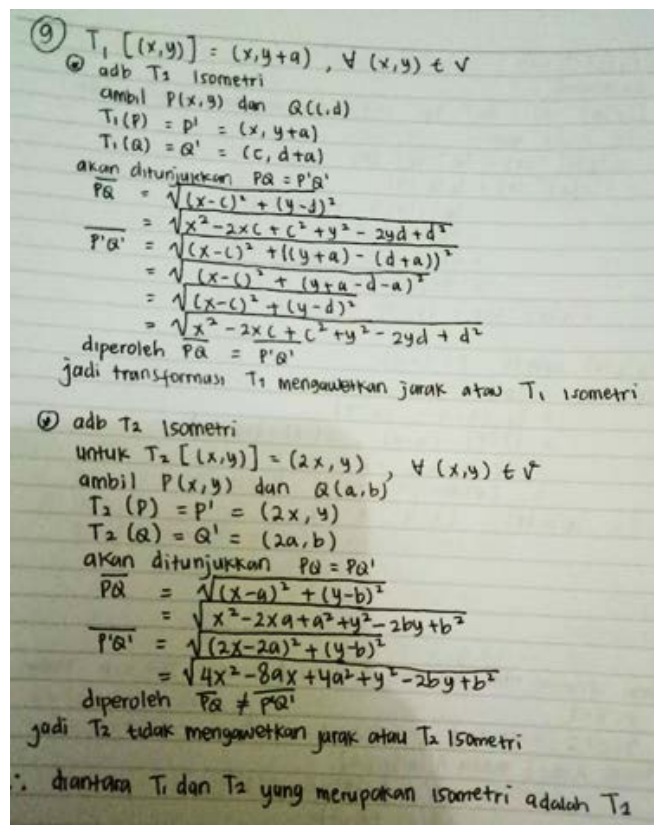


Figure 5. Result of S5

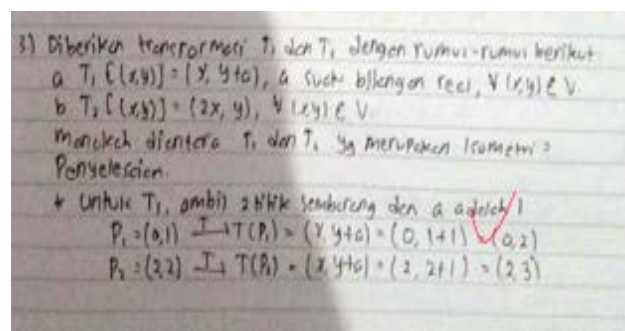


Figure 6. Result of S6

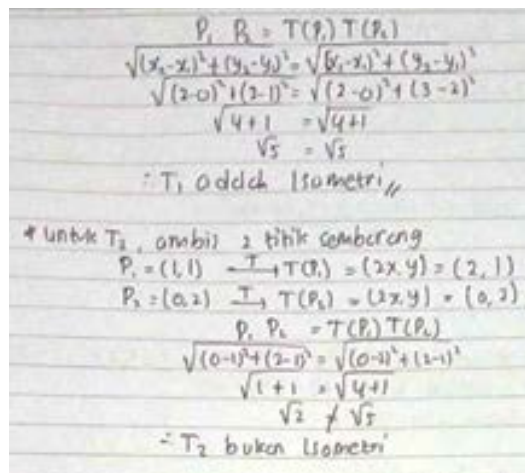


Figure 7. Result of S6

Table 3. Result about Critical thinking ability respondent S5 and S6

Type of obstacle	Identification of obstacles
Conceptual	S5 is the obstacle in writing the terms or identification of the problems given, for S6 has provided the right definition.
Procedural	S5 and S6 can solve the problem, but in the middle of the conclusion there is an error, namely there is no sign that is not the same as for the given equation.
Technical Operational	There are no obstacles

From table 3 above, it is known that students' mathematical critical thinking skills with high mathematical belief from the conceptual side, S5 and S6 experience obstacles to more complicated concepts. However, for procedural obstacles at the end, they often forget the proper conclusions.

## CONCLUSIONS

Research subjects who have low mathematical belief experience learning barriers especially related to procedural problems and operational techniques. They do not understand errors in calculating and more precise problem-solving steps. Research subjects who have mathematical belief are experiencing procedural obstacles such as errors in writing conclusions. And students with high mathematical belief experience conceptual problems in integrating their abilities.

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