



# Analysis of Students' Mathematical Reasoning Ability with the Constructivism Approach through Mobile Learning System

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## Authors' contributions

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** To analyze the mathematical reasoning ability of mathematics education students.

**Study Design:** Qualitative research with a descriptive approach.

**Place and Duration of Study:** The population of all 3rd-semester mathematics education students at Bung Hatta University who take geometry courses is 25 students.

**Methodology:** This research is qualitative research with a descriptive approach. Researchers directly measure the mathematical reasoning ability of students in the mathematics education study program. Judging from the research subjects, the population of all 3rd-semester mathematics education students at Bung Hatta University who took geometry courses was 25 students.

**Results:** From the analysis results, it was found that the achievement of mathematical reasoning abilities for indicators of students' ability to present mathematical statements orally, in writing, pictures, and diagrams indicated by question number 1 was 74% (Good Category). The indicators of mathematical manipulation ability shown in questions number 2 and 5 are 41% (Category Enough), and 42% (Category Enough). And the indicators of students' ability to conclude, compile evidence, provide comments, or evidence from several solutions shown by questions number 3 and 4 are 67% (Good Category) and 58% (Enough Category).

**Conclusion:** The conclusion of this study is to be able to determine the category of mathematical reasoning of the 3rd-semester students of the Bung Hatta University Mathematics Education Study Program.

*Keywords: Analysis; mathematical reasoning ability; constructivism approach.*

## 1. INTRODUCTION

One of the objectives of learning mathematics is to train students' reasoning skills and ways of thinking in concluding, as well as being able to express their opinions with confidence to solve the problems they face. The Principles and Standards for School Mathematics in 2000 revealed that there are five process skills that students need to have through learning mathematics, namely: (1) problem solving; (2) reasoning and proof; (3) communication; (4) connection; and (5) representation [1]. These process skills include high-level mathematical thinking that must be developed in the mathematics learning process. Based on the type, mathematical thinking is classified into five main competencies, namely mathematical understanding, problem-solving, mathematical reasoning, mathematical connection, and mathematical communication. The ability measured in this study is the students' mathematical reasoning ability. Mathematical reasoning skills are needed from an early age through classroom learning so that students can solve problems and apply mathematical concepts. Although mathematical reasoning is an ability that must be possessed by students, in reality in the field there is still learning which causes low mathematics learning achievement [2]. The existence of students' ability to connect between mathematical concepts and objects, can result in students' reasoning abilities of concepts to be broader and deeper. This is also confirmed in the National Council of Teachers of Mathematics NCTM [1], which states that if students can connect mathematical ideas, their reasoning will be deeper and longer-lasting.

The importance of reasoning ability in learning mathematics is stated by Rodrigues et al. [3], which states that learning that places more emphasis on reasoning and problem-solving activities is closely related to high student achievement. According to Rainer and Matthews [4] students who have progressed in learning are students who have a high level of communication skills and reasoning abilities.

The term mathematical reasoning or commonly known as mathematical reasoning in some

literature is called mathematical reasoning. Brodie [5] states that "Mathematical reasoning is reasoning about and with the object of mathematics." This statement can be interpreted that mathematical reasoning is reasoning about mathematical objects.

Turmudi [6] said that mathematical reasoning ability is a habit of the brain as well as other habits that must be developed consistently using various contexts, recognizing reasoning and proof are fundamental aspects in mathematics. With mathematical reasoning, students can make conjectures and then compile evidence and manipulate mathematical problems and draw conclusions correctly and precisely.

Reasoning indicators include: drawing logical conclusions, providing explanations using models, facts, properties, and relationships, estimating answers and solution processes, using patterns and relationships to analyze mathematical situations, drawing analogies, and generalizations, compiling and testing conjectures, providing opponents examples (counterexamples), follow the rules of inference, check the validity of the argument, make the argument valid, and to develop direct evidence, indirect and using mathematical induction [7].

According to Suharman [8], someone who can reason means to have abilities that include:

- a. Unique ability to see problems or situations and how to solve them.
- b. Have good ability in solving problems.
- c. Have the ability to think logically.
- d. Being able to distinguish as well between response wrong or answer correctly.
- e. Able to apply knowledge to specific problems.
- f. Able to put existing information and theories into a new perspective.
- g. Able to store large amounts of information in his memory.
- h. Able to recognize and understand the differences and similarities between various things.

In the process, logical reasoning is an activity of digging up information and translating it to

conclude as a solution. Along with this, Galotti "explains that logical reasoning is an effort to transform the information provided to obtain conclusions" [9]. In other words, logical reasoning is reasoning according to the rules of logic. Thinking and reasoning logically are very necessary for every aspect of everyday life, because logical reasoning is a supporter of the success of an action, especially in making decisions. This is of course very much needed by everyone in carrying out their lives. Therefore, it is proper that the study of this reasoning ability gets more attention at every level of education, especially in Higher Education. Because in higher education, students are adults who should have logical reasoning abilities. Given the pattern of learning that requires students to think and act independently.

Based on the results of observations and interviews conducted with the 3rd-semester students of the Bung Hatta University mathematics education program who took geometry courses, information was obtained that the lecture process was not optimal enough, students still had difficulties in solving the given math problems. Students also still have difficulty in connecting between objects and concepts in determining what formula to use when faced with questions related to proof. This shows that there are still many third-semester students of mathematics education who have low reasoning abilities.

Many studies have been conducted related to reasoning abilities, including the research conducted by Jeannotte and Kieran [10]. In their research said that mathematical reasoning ability is very important in learning. Students must continue to strive to improve their mathematical abilities, teachers can also help to improve these abilities by using various strategies and methods.

Then other researchers, namely Rodrigues et al. [3] stated that many elementary school teacher candidates still lack the level of mathematical reasoning. This lack of mathematical reasoning has to do with generalizing, justifying, comparing, classifying, giving examples, and analyzing [1]. Research conducted by Darmawanti, et al. [11] it was found that the mathematical reasoning ability of 7th-grade junior high school students in a private junior high school in Ciamis was still relatively low. To overcome this, there is a need for a learning model that can improve students' reasoning abilities [11].

Efforts made by lecturers to improve students' mathematical reasoning abilities are to carry out the learning process using a constructivist approach. The constructivism approach makes students more active in the learning process, students find their learning concepts, so that learning becomes more meaningful [12].

Accompanying the development of technology and increasing student learning independence, portable media is used to access an online learning system known as a mobile learning system. So that students can study anywhere and anytime at any time. Based on the results of Cai's research [13] that mobile learning is very effectively used in the learning process and has a positive impact on the development of students' thinking skills [13]. The results of other research conducted by Pensabe-Rodriguez et al. [14] are the use of Mobile Learning Objects (MLOs) obtains a very high perspective of 81%, the mobile learning system that is evaluated has very high acceptance, satisfaction, and application from the perspective of teachers and students.

Based on the findings in the field and the results of previous research, this research is very important to do to obtain data on the mathematical reasoning ability of students of the 3rd semester of mathematics education at Bung Hatta University studying geometry, and as a consideration in the development of mathematics learning. This data will describe the extent of the reasoning abilities of mathematics education students after learning with a constructivism approach through mobile learning.

## 2. METHODOLOGY

This research is qualitative research with a descriptive approach. Before analyzing mathematical reasoning abilities, students first took part in learning with a constructivist approach through mobile learning. The researcher acts as a lecturer in this study. After completing learning with a constructivism approach through mobile learning in 4 meetings, students were given a mathematical reasoning ability test.

Judging from the research subjects, the population is all students of the 3rd-semester mathematics education study program at Bung Hatta University who take geometry courses, totaling 25 students.

Mathematical reasoning indicators (Table 1) adopted by the Regulation of the Director-General of Primary and Secondary Education No. 506/C/PP/2004 [15].

1. Presenting mathematical statements orally, in writing, pictures, and diagrams,
2. Asking alleged (conjecture ),
3. Perform mathematical manipulation,
4. Concluding, compiling evidence, providing reasons, or evidence against several solutions,
5. Conclude the statement,
6. Checking the validity of an argument,
7. Find patterns or properties of mathematical phenomena to make generalizations.

In this case, the researcher took four of the seven indicators above.

### 3. RESULTS AND DISCUSSION

Before analyzing mathematical reasoning abilities, students first take part in learning with a

constructivist approach using a mobile learning system. The researcher acts as a teacher in this lesson. After completing learning with a constructivism approach using a mobile learning system for 4 meetings, students were given a mathematical reasoning ability test. The indicators of mathematical reasoning measured in this study are: 1) Presenting mathematical statements orally, in writing, pictures, and diagrams; 2) Perform mathematical manipulation; 3) Conclude, compile evidence, provide reviews, or evidence against several solutions.

The results of data analysis in table 2 show that indicator 1 is the ability of students to present mathematical statements orally, in writing, pictures, and diagrams shown in question number 1 with an achievement rate of 74%, which means that students are good at achieving the first indicator. Although overall students were able to work on question number one, there were still mistakes made by some students, namely, there were still people who misrepresented the picture to make the known part of the problem.

**Table 1. Distribution of Question on Mathematical Reasoning Indicators**

Mathematical Reasoning Capability Indicator	Aspects observed	Question Number
Present mathematical statements verbally, in writing, drawings, and diagrams	Students can determine what is known in the problem through the given drawing space.	1
Doing mathematical manipulation	a. Students can determine manipulations that are used to solve problems related to the volume of building space.	2
	b. Students can determine the manipulations that are used to solve problems related to the area of the building.	5
Draw conclusions, compile evidence, provide comments, or proof of some solutions	a. Students can determine the right solution to draw conclusions related to the area of the building area.	3
	b. Students can determine the right solution to draw conclusions related to the volume of building space.	4

**Table 2. Percentage of students' mathematical reasoning ability achievement**

Question Number	Many get scores-					Average score	% Achievement	Category
	4	3	2	1	0			
1	8	10	5	2	0	2,96	74	Good
2	0	6	9	5	5	1,64	41	Enough
3	7	9	5	2	2	2,58	67	Good
4	4	8	8	2	3	2,32	58	Enough
5	2	5	6	7	5	1,68	42	Enough

The second indicator of the ability to manipulate mathematics has 2 aspects that are observed which are indicated by questions number 2 and number 5. In question number 2 it reaches a level of 41%, meaning that the level of student achievement in working on question number 2 is in the sufficient category. While in question number 5 with an achievement level of 42% in the sufficient category. In this indicator, students have not been able to determine the manipulations used to solve problems related to the area and volume of the building.

While the ability of students to conclude, compile evidence, provide reviews, or evidence against several solutions indicated by question number 3 is 67% in the good category and question number 4 is 58% in the sufficient category. This means that there are still many students who have not been able to provide the right solution to a problem related to the area and volume of the building so that students are also less precise in concluding the solutions they find.

#### 4. CONCLUSION

The achievement of mathematical reasoning abilities for indicators of students' ability to present mathematical statements orally, in writing, pictures, and diagrams are shown by question number 1 is 74%. Indicators of the ability to perform mathematical manipulation shown in questions number 2, and 5 are 41% and 42%. And indicators of students' ability to conclude, compile evidence, provide reviews or evidence on several solutions indicated by questions number 3 and 4 are 67% and 58%, respectively. The forms of errors made by students are errors in understanding the meaning of the questions, errors in using formulas, errors in performing arithmetic operations, not understanding concepts and difficulties in writing reasons in written form. Based on the form of errors found, in learning, students must be accustomed to expressing their arguments in writing. Concept understanding must be a priority in learning because it becomes the main capital to be able to have mathematical reasoning abilities.

#### CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the authors.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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