Mathematical reasoning in geometry learning using Information and Communication Technology (ICT)

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Abstract. This study aims to analyze students' mathematical reasoning abilities in Geometry learning using ICT. This type of research uses descriptive qualitative with the intention to describe the students' mathematical reasoning abilities in Geometry learning using ICT. The subjects of the study were the students of class VIII chosen by purposive method. The research phase consists of planning, implementation and reporting phases. The main instrument in the study was to use a mathematical reasoning test. The results showed that in the learning of geometry by using ICT there are some indicators that can affect students' mathematical reasoning abilities. There are indicators of mathematical reasoning that cannot be achieved by students well, proven more than 50% of students achievement of mathematical reasoning ability is still under KKM. The indicator is to manipulate mathematics and provide reasons or evidence against some solutions.

1. Introduction
Mathematical reasoning ability is one of the most important and fundamental skills in mathematics. Based Permendiknas 22 year 2006, mathematical reasoning skills of students are one factor that must be mastered by the students after they learn it. Critical reasoning abilities in mathematics are very crucial because in mathematics learning students do not just memorize or remember formulas but students should use the power of reason to solve a math problem. As mentioned in the Education Ministry stated that "Materials of mathematics and mathematical reasoning are two things that can not be separated, i.e. the mathematics materials are understood through reasoning, and reasoning is understood and practiced through the study of mathematics" [1]. In teaching geometry, mathematical reasoning is also very important because of the geometry provides a rich context for the development of mathematical reasoning, including induction and deductive reasoning, create and validate the allegations, as well as classify and define the geometry objects [2].

Mathematical reasoning skills of students can be improved through learning that requires the involvement of students in constructing their own knowledge. One of them is by using ICT. Learning by using ICT is learning with knowledge of the newest technology that utilizes the computer as a medium of learning aids. The current technology is developing very rapidly, especially for smartphones based on the Android platform. Various applications can be run with android system which can be utilized in education. ICT use became the major importance for primary schools across the world as ICT...
has the potential to foster teaching and learning processes [3]. Many technologies make the way we learn and teach in education. The use of ICT-assisted media is still very promising for education [4]. Some of the applications of ICT can be used in education are Microsoft Power Point, Macromedia Flash and Augmented Reality. ICT based learning is very helpful in education, especially in light of the current researches on the effects of such an implementation [5].

One of the alternatives that can be taken in the learning process is by using mathematic learning media more interactive, which can be utilized to demonstrate or visualize as well as tools to construct the basic concepts that stimulate the development of mathematical reasoning skills of students’ geometry. Armanto said that mathematics in Indonesia tend to be taught in a formal level, the teacher explained the operations and procedures of mathematics, and gave the example, then asked the students to work on a similar matter [6]. Realizing this, you should not directly teach mathematics at a formal level. Learning mathematics should focus on meaningful learning for students. Various studies indicate that a meaningful mathematics learning require active participation of students in learning.

Mathematical reasoning ability is an ability that is necessary and important mathematical owned by high school students. Keraf in Hendriana describes the terms of reasoning (reasoning) in general as: “The thought process that seeks the connection among the facts known to a conclusion” [7]. In mathematics, mathematical reasoning is the process of mathematical thinking in acquiring mathematical conclusions based on facts or data, concepts, and methods that are available or relevant. NCTM does not explain the mathematical reasoning indicators in detail, but suggested outline learning objectives mathematical reasoning and evidence regarding the four items as follows: a) Recognize the reasoning and proof as basic aspects of mathematics; b) Develop and discover mathematical conjectures; c) Develop and assess mathematical arguments and evidence; d) Select and use various types of reasoning and mathematical proof. These items are guidelines, rationale, view how should teach mathematics. The development of children's mathematical reasoning requires appropriate encouragement and feedback from their teacher who can only do this if they recognise mathematical reasoning in children's actions and words [8]. Therefore, the teacher must have a way to increase mathematical reasoning of student. Both in terms of the learning process and of the students themselves.

2. Experimental method
This research was conducted at Junior High School 7 in Padang. The location of the study was chosen because in Junior High School 7 in Padang there are problems of mathematical reasoning. The research method used in this research is descriptive qualitative. This type of research was chosen because it aims to describe the ability of students in solving problems of mathematical reasoning in geometry learning using ICT. Subject in this research is 5 students of class VIII by giving learning geometry by using ICT.

Research phase is divided into three, namely planning, implementation and reporting. At the planning stage, the prepared device is a mathematical reasoning instrument covering the question grid, answer answer sheet and scoring. At the implementation stage, geometry learning is done by using ICT. After completion, students are then given a mathematical reasoning test. At the reporting stage, processed data obtained during the study took place.

Instrument for obtaining data of students' mathematical reasoning abilities by compiling a set of tests. The test device used to collect data in this study is a matter of geometry material in particular to build a flat side room. Data processing to see the ability of mathematical reasoning by looking at student answers on the answer sheet.

3. Result and discussion
Student mathematical reasoning can be improved not only on the activity of students but also of teachers' creativity in the learning process. Stronger involvement of teachers is very important in promoting students' mathematical reasoning ability and overall presented the students with the opportunity to improve the process of their reasoning, a central aspect of the environment that allows them to understand the math [9]. One alternative that can be taken to make learning more interactive math learning is by using the Information and Communication Technology (ICT). Some studies have
concluded that the use of computer-based media will enhance students' understanding in general in the field of mathematics. In any geometry learning, ICT can improve students' mathematical reasoning abilities. Here are examples of problems with mathematical reasoning skills students presented to the Media ICT at figure 1.

Ari will make a chalk box from a sheet of cardboard. The size of the picture is 30 cm x 30 cm. The chalk that can be made is 10 cm side. From the size of cardboard, is that enough to make a chalk that is required? Explain!

**Figure 1.** Some examples of mathematical reasoning ability.

In the figure 1. Is one of the problems given to students in the ability of mathematical reasoning, it appears that the problem has indicators in the ability of mathematical reasoning. Some indicators of mathematical reasoning ability as Table 1.

| No. | Variable | Indicator |
|-----|----------|-----------|
| 1.  | The ability of reasoning in geometry material | Submitting allegations |
| 2.  |           | Provide reasons or evidence for several solutions |
| 3.  |           | Conclude from the statement |
| 4.  |           | Examine a validity of an argument |
| 5.  |           | Find patterns or characteristics of systematic symptoms to make generalizations |
| 6.  |           | Do mathematical manipulation |

From examples of problems of mathematical reasoning ability is seen the thinking process conducted experiments in mind with the results at each step in a string of experiments that have been known by the reasoner from the experience. Some answer from the student about mathematical reasoning at figure 2.

**Figure 2.** Some answer of mathematical reasoning.
The answer from student of mathematical reasoning it’s to less about manipulate mathematics and provide reasons or evidence against some solutions. In accordance with Pereira & Ponte In the current intervention, the set of principles presented constitutes a promising environment to develop students' abilities to make appropriate generalizations and justifications [9]. By generalizing and justifying, students develop their mathematical reasoning and it can be better equipped to deal with mathematical proof later. With this mathematical reasoning abilities, it can take advantage of ICT media as an interaction between the use of technology in the learning process.

Media ICT or learning tool is an important element in learning geometry because the object being studied in the form of an abstract object, so that the necessary devices to enable the students to understand and design the abstract object into concrete one. Learning geometry is active learning, creative, effective and fun if accompanied with an interesting use of learning tools so that the students are able to explore the concept so it can stimulate a high-level thinking skills [10]. One of the ICT media devices that can be used in using ICT media is Augmented Reality.

Augmented reality is a direct or indirect view of a physical, real-world environment which elements are augmented by computer-generated sensory inputs such as sound, video, or graphics [11]. Augmented reality is the technology that augments virtual objects to the real world. This kind of technology can be used in education world to help students in gaining the deep understanding of the lesson and also to make them excited in the study. Augmented reality for geometry could be implemented a lesson for secondary school students to help them understand the geometry of the object. Augmented Reality application for mathematics and geometry are fully functional educational [12]. Learning geometry via computer can motivate students to learn concepts and solve the geometrical problems that are abstract and difficult, not only through analytic offerings but also through visual presentation [13]. Therefore, one alternative that can be used more interactively to demonstrate or visualize the basic concepts that stimulate mathematical reasoning ability in learning geometry is using ICT learning media. Besides, the Augmented Reality Provides reachable course materials as well as increasing students' course success, attention, interaction together with reviews their motivation [14]. Some media use ICT with applications Augmented Reality in education as figure 3.

Figure 3. Using augmented reality.

In geometry lesson, using ICT media can see some students' mathematical abilities, for example the ability of understanding mathematical concepts and reasoning. Geometry mathematical reasoning ability is the ability of students to present from the abstract to the concrete. One of the biggest problems with modern mathematics is to present mathematics as a finished product, ready to wear, abstract and taught mechanistic: the teacher dictates formulas and procedures to students [15].

According to Salinas & Pulido Augmented Reality environment in mathematics education which offers the students important features of mathematical thinking that are reserved just for brilliant minds before, like the one of Germinal-Pierre Dandelin, capable of internal visualizations in the absence of external displays [16]. The technology of Augmented Reality allows us now to deepen in a mathematical thinking that binds to the "magic" this technology offers to our eyes. The pedagogical product we presented here should be considered as an external dynamical visualization fostering the development of internal visualization ability, thereby supporting the role of reasoning abilities for the learning of education. Furthermore, the computer assisted educational procedure undertaken revealed an extended
interest for the tasks involved from the part of the students. It is an ongoing challenge for the reflective teacher to decide how this technology can be the best utilized in education; especially in light of the current researches on the effects of such an implementation.

4. Conclusion
From Literature described previously, it appears that the mathematical reasoning ability is one of the basic competencies of mathematics in addition to the understanding, communication and problem solving. Understanding the concept of learning should be a priority because the main capital to be able to have mathematical reasoning abilities. With mathematical reasoning abilities, it can see mathematical ability in learning geometric abstraction. From the standpoint of psychology, learning geometry is a presentation of visual experience and spatial abstraction, for instance fields, patterns, measurement and mappings. In geometry learning by using ICT, it can help students in understanding a complex and abstract concepts. Several studies have revealed the geometry learning by using ICT was able to improve the quality, effectiveness and students’ interest.

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