Need analysis for developing Geogebra assisted mathematics learning tools to improve mathematical understanding of senior high school

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Abstract. The aim of this study is to analyze the initial needs of the development of GeoGebra assisted mathematics learning tools to improve students’ mathematical understanding abilities. The population of this study were students from SMA Negeri 6 Banda Aceh and Mathematics teachers from four schools in Banda Aceh and Tanjung Pura. Purposive sampling method was used to take the sample. Data collection were collected by observation and interview. All the data were analyzed descriptively. The findings revealed that mathematics learning in 11th grade high school students can be developed with the help of GeoGebra. Students feel interested and motivated to take part in assisting GeoGebra. It also found that GeoGebra assisted mathematics learning tools are needed to improve students’ mathematical understanding because the students’ mathematical understanding ability is still low.

1. Introduction
Mathematics learning has an important goal which is to analyze and to understand mathematical concepts and procedures in solving mathematical problems [1]. Students should learn mathematics by understanding, so that students are actively able to build new knowledge from previous experiences [2]. Mathematical understanding ability is one of the basic abilities that should be possessed by students. The purposes are to achieve other abilities and to understand mathematical material in higher level.

Mathematical understanding has two categories, namely instrumental understanding and relational understanding. Instrumental understanding is the understanding which is only on the use of a procedure and is unable to explain the reason why the mathematical procedure is used. While, relational understanding is an understanding that uses mathematical procedures in solving mathematical problems and understands why the procedure is used [3].

One of the materials in mathematics that requires a relational understanding is the transformation of geometry. However, mathematical understanding of geometrical transformation material is still considered difficult to the students. Students have difficulty in understanding the concepts and variations that arise. Students also feel difficult in identifying the geometrical transformation which includes reflection, translation, rotation and combination of these transformations [4-7]. The occurrence of these problems is caused by the students’ understanding in learning geometry transformation is still instrumentally, not relationally [3]. Most of the students are familiar with the
transformation of geometry directly on the ready-made formula given by the teacher. This causes the learning process obtained by the students to be less meaningful. Conceptual development is needed rather than just giving formulas that will be more meaningful when they develop formulas, and they gain an understanding of the relationships that exist and can be directly involved in a real process of doing mathematics [8].

Geometry transformation has an important role in students’ mathematical development. Especially in mathematics learning, the transformation of visualization geometry is an important part that needs to develop the mathematical understanding skills. Referring to the theory of Van Hiele, there are five stages of learning in geometry, namely the introduction stage (visualization); the analysis stage; the sequencing stage; the deduction stage; and the accuracy stage. In this case, visualization in learning transformation geometry has an important role to improve students’ mathematical understanding [9]. Visualization is very helpful in increasing students’ mathematical understanding. Visualization can be raised by using the right media. Based on the explanation above, the use of instructional media is much needed. The government recommends that teachers should use the technology in learning [2] [10]. Learning on transformation geometry material can be maximized with the help of technology in the form of software as a learning medium. The use of dynamic geometry software can help students to understand transformation geometry. One of them is GeoGebra.

GeoGebra is an effective learning media for mathematics. Some results of the research that has been done about GeoGebra-based on learning have given positive results for students and teachers [11,12]. In GeoGebra, there is a DGS (Dynamic Geometric System) system that is able to visualize mathematical problems geometrically. With the visualization, the students will be able to follow actively what they are learning. The role of teachers in learning that uses GeoGebra is only act as facilitator. Because, basically with the convenience offered, students can work independently with their groups and can also conduct experiments. The other advantages of using GeoGebra are; it can create independent activities of students so that they are able to construct the understanding and also visualize a form easily.

Based on the explanation of the problem, researchers want to develop learning tools assisted by GeoGebra to improve mathematical understanding of senior high school. The problem formulation in this research is how the need for GeoGebra assisted mathematics learning tools to improve students’ mathematical understanding abilities.

2. Method
This study is research and development study. Research and development is an activity of developing a product based on the results of the research, which is tested, evaluated, and systematically refined to obtain valid, practical and effective criteria [13].

The research model used by the researchers to develop GeoGebra assisted mathematics learning tools to improve students’ mathematical understanding is based on the Plomp research model. The stages of this research according to Plomp consists of three stages: first, preliminary research stage which consists of analyzing needs and context, reviewing the literature, developing a conceptual or theoretical framework for research. Second, Prototyping phase (phase of making prototypes) iterative research phase of the research consists of iterations, each consisting of a small cycle of research with formative evaluation as the most important research activities aimed at improving and perfecting interventions. Third, assessment phase summative evaluation to conclude whether the solution or intervention meets the specified specifications [14]. However, this research is only limited to the first stage, namely the preliminary research stage which includes curriculum analysis, student analysis, and environmental demand analysis.

The focus of this study is to determine the needs and carrying capacity of GeoGebra assisted mathematics learning tools to improve students’ mathematical understanding. This research was conducted in May 2019. The research was conducted at four schools in Banda Aceh and Tanjung Pura. The sampling technique uses a purposive sampling method. The samples were four mathematics
teachers and four high school students. Research data were collected by observation and interview and analyzed descriptively.

3. Results and Discussion
The aspects that analyzed in this study included curriculum analysis, student analysis, environmental demand analysis, and subject matter analysis.

3.1. Curriculum Analysis
Curriculum analysis is based on the curriculum that applied to the school. From the four schools studied, all use the Curriculum 2013. The curriculum specifically in mathematics on geometry transformation material contained the demands of the Curriculum 2013, the objectives of Curriculum 2013, as well as some basic competencies that had to be achieved. These competencies are summarized in the compulsory syllabus of subjects in year 11 senior high school. The standard competencies and basic competencies are shown in the following table:

**Table 1. Curriculum Analysis**

| No. | Theme                        | Summary of Reading Results                                                                 |
|-----|------------------------------|-------------------------------------------------------------------------------------------|
| 1.  | Demands of Curriculum 2013   | 1. Students are prepared to face the challenges in the future through knowledge of attitudes, skills and expertise to adapt and to survive in an environment that continues to evolve according to the times.  
|     |                              | 2. Students are prepared to be transformed from productive age human resources into human resources who have competencies and skills through education.  
|     |                              | 3. Students are prepared to follow the flow of globalization and various issues related to the environment, the rise of creative and cultural industries and the development of education at the international level.  
|     |                              | 4. Teachers are required to be able to form students who are able to compete internationally at the intellectual level.  |
| 2.  | The Aim of Curriculum 2013   | To prepare the Indonesian nation to have the ability to live as individuals and citizens who have productive, creative, innovative and effective faith, and are able to contribute to the social life, nation, state and civilization of the world. |
| 3.  | Availability of Standard Competencies and Basic Competencies in Transformation Geometry material | Standard of competencies 4: Processing, reasoning, and presenting in concrete and abstract realms related to the development of what they learned in school independently, and being able to use methods according to scientific rules.  
|     |                              | Basic Competencies :  
|     |                              | 3.5 Analyze and compare transformations and transformation compositions using matrices.  
|     |                              | 4.5 Resolve problems related to geometric transformation matrices (translation, reflection, dilation, and rotation).  |

Learning tools are important in preparing and developing the learning plans, objectives and materials that will be done, achieved, and given in learning. Learning tools consist of Learning Implementation Plan, Student Worksheet and Learning Outcomes Test. This learning tool will help teachers to prepare classes better and evaluate students’ understanding and abilities as a whole. So far, teachers only use conventional learning models without being supported by appropriate media. According to the teachers, it happened because they do not have complete learning tools. This is due to time constraints and the availability of learning tools. The ability of teachers to develop learning
tools that are in accordance with the characteristics of students is also still low. Thus learning tools are needed that can help the students and teachers in optimizing learning in the classroom. The use of media such as GeoGebra has never been used before, so it needs to be applied by the teachers in the classrooms, so that the construction of mathematics can run well and properly.

3.2. Student Analysis
Student analysis is done to adjust students’ understanding of mathematical concepts with the design of the development of learning tools. Student analysis of mathematics learning is:

| Teacher | Student |
|---------|---------|
| Similarity | - Students only use books provided by the school, so the questions discussed in learning are only routine. |
| | - Students still lack understanding of mathematical concepts. It can be seen from the daily assignments given by the teacher where most students still get grades below the standard determined. |
| | - Most of the students do not yet know why a procedure is used. They only use the ready-made formula given by the teacher. |
| | - Learning mathematics is difficult to understand. |
| | - During this time in learning mathematics students have never used a mathematical application such as GeoGebra. |
| | - Students say that learning mathematics assisted by GeoGebra is very interesting and can motivate them to be more maximal in learning mathematics. |

3.3. Environmental Demand Analysis
Stages of environmental demand analysis is a stage that examines the implementation of learning activities with the design of the development of learning tools. The results of the analysis of environmental demands obtained based on observations and interviews are that teaching and learning activities that take place do not start from an understanding of a concept, but are immediately introduced to a ready – made mathematical formula. This causes students’ understanding of a concept is still low. Then, the process of learning mathematics is still focused on only one book. The teachers have never taught mathematics using technology. Therefore, the teachers expects a learning tools with a specific learning approach or model that is linked to technology such as GeoGebra, so that the teaching and learning process can help students to understand a mathematical concept easily.

4. Conclusion
Based on the findings above can be concluded that mathematics learning in 11th grade high school students can be developed by using GeoGebra. Students feel interested and motivated to take part in assisting GeoGebra. GeoGebra assisted mathematics learning tools are needed to improve students’ mathematical understanding because the students’ mathematical understanding ability is still low.

5. Suggestions and Recommendations
Development of learning tools needs to be done to help teachers and students achieve maximum learning outcomes. For this reason, researchers suggest to continue this research by designing GeoGebra assisted mathematics learning tools to improve students’ mathematical understanding abilities.
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