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Learning Relationship between External and Internal Angle of a Triangle in Dynamic Geometry Classroom

Sariyasa
Jurusan Matematika
Universitas Pendidikan Ganesha
Indonesia
sariyasa@undiksha.ac.id

***Abstract*—This study focused on the use of dynamic geometry software to create a dynamic learning classroom for students of junior high school to reinvent relationship between external and internal angles of a triangle. By conducting explorative investigation aided with GeoGebra-based instructional media, students are able to explore and investigate this relationship so that they can formulate the relationship on their own words. In this way, students build their own understanding of the concepts and, thus the concepts are internalized well and long in the students' cognitive.**

Keywords—instructional media, meaningful, exploration, investigation, GeoGebra

I. INTRODUCTION

Geometry has a special place in the mathematics curriculum. Understanding geometry is essential mathematically, practically, and psychologically. Reference [1] posed that "psychologically, geometry represents the abstraction of visual and spatial experiences like shape, measurement, mapping and pattern. Mathematically, geometry plays an essential role in developing skills for problem solving through, for example, drawings, transformations, vectors and coordinate systems, to name a few". Some natural phenomena or human-made structure can be quickly associated with geometrical objects learned in mathematics. Geometry provides opportunities for learners to develop spatial awareness, geometrical intuition, and the ability to visualize and use geometrical properties in a variety of real-world contexts [2]. The importance of geometry is acknowledged by NCTM stating that "geometry provides a rich context for the development of mathematical reasoning, including inductive and deductive reasoning, making and validating conjectures, and classifying and defining geometric objects" [3].

However, there are some obstacles and challenges in the teaching and learning geometry in the classroom. In most geometry classroom, teachers tend to use the traditional approach, in which teachers deliver the contents of the lesson, supply a few examples and explain the process of finding the solution, and finally students are given problems of the same type done previously. In line with this, [4] stated that "in a traditional geometry course, students are told definitions and theorems and assigned problems and proofs; they do not experience the discovery of geometric relationships, nor invent any mathematics".

In this traditional instruction, learners tend to become passive participants who just merely listen to the teacher's explanation and write down all teaching material; they are even asked to memorize them. Consequently, many learners experience difficulty and feel frustrating in learning geometry. This learning process may discourage learners and may lead to learning outcomes that may not meet mathematics education goal.

To make geometry classroom more meaningful and enjoyable for students, the instruction should be designed to be more student-centered in which students could play more active role in the geometry instruction. Students should be encouraged to make conjecture, to invent, and to problem solve [3]. This is accomplished through discovery approach for which computer is an ideal tool.

In this study, we integrate computer in the geometry instruction by utilizing mathematical software. In particular, we utilized GeoGebra-based media in the teaching of geometry so that a dynamic learning environment is established to conduct explorative and discovery learning. Using this media, students were asked to formulate relationship between external and internal angles of a triangle.

II. METHOD

This study employed a one-shot case study research design that used questionnaire to collect data. The questionnaire was structured using a Likert scales ranging from strongly agree to strongly disagree. There were 20 items in the questionnaire. The data were then analyzed qualitatively. A total of 34 students and one teacher were involved in this study. The school chosen for this study was a state-run junior high school in the city of Amlapura, Regency of Karangasem, Province of Bali. The mathematics teacher in the school used a cooperative-learning approach and the students usually learned and worked in small group.

Due to the limitation of the number of computers, students were divided into groups of three or four and each group shared one computer. During the running of geometry instruction, we gave each group GeoGebra-based media and asked them to do exploration and investigation as instructed on the worksheet. We observed and write down students' activities during learning process. At the end of the geometry instruction, students and teacher were given questionnaire to find out their responses toward geometry instruction aided by GeoGebra-based media.

III. RESULT AND DISCUSSION

The relationship between external and internal angles of a triangle is formulated in a theorem. The theorem says that in any triangle, the measure of the external angle equals to the sum of the measure of the internal on the opposite sides.

Students were encouraged to come to this theorem. To do so, we asked students to explore and investigate by using GeoGebra-based media by dragging the sliders. Students observed and wrote down what has happened on the computer screen. The following figures show the movement of internal angles.

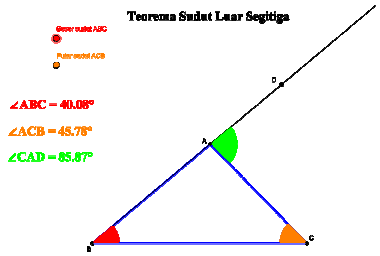

Fig. 1. Initial position

In Figure 1, the green area indicates external angle which is opposite to internal angles shown in red and brown. Students used this media to draw conclusion that the measure of external angle equals to the sum of the measure of internal angles opposite to it. By dragging the read slider, students obtained Figure 2.

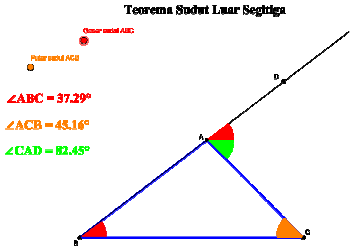

Fig. 2. Red angle covered part of the green angle

Students observed that part of the green angle has been covered by the red angle. Next, students dragged the brown angle and they realized that the green angle is totally covered by the red angle and the brown angle. See Figure 3.

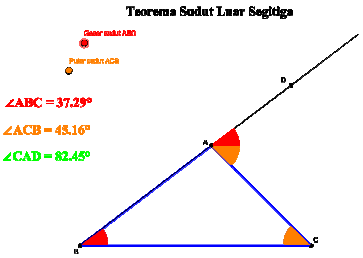

Fig. 3. Green angle were totally covered

Based on Figure 3, students concluded that the measure of the external angle equals to the sum of the measure of the internal angles opposite to it. The shape of the triangle can be changed by dragging the vertex A, B, or C.

This explorative investigation helped students to reinvent the relationship between external and internal angles of a triangle. They were able to formulate the relationship in their own word. This own construction supports longer retention and better understanding of the concept. Reference [5] described that the use of technology in education has promising potency in internalization process. Moreover, understanding of concept is expected to improve students' learning achievement. This is in line with some studies that the use of GeoGebra improved students' learning achievements in mathematics (see for instance [6], [7], [8], [9], [10]).

From our observation, it seems that students are enthusiastic to learn and that most students take part actively in the group discussion. Of course, there are some students that are less active in the discussion. Students have to share one computer with three or four people, even six people in one group. So, students do not have enough time to take turn in doing the exploration and investigation. A few students were not fluent enough to operate GeoGebra so they spend more time to manipulate the media.

From questionnaire, we can extract two kinds of information, namely information about students and teacher responses and information about ease of use of media. The result of questionnaire shows that students feel comfortable when learning geometry is aided with GeoGebra-based media. They also claim that understanding geometry concepts being studied become easier. Geometry instruction becomes exciting and motivating. Regarding the quality of the media, the questionnaire shows that the media is easy to use but it lacks of explanation. They suggest that the media should contain enough explanation and instruction. Students' responses towards the use of GeoGebra-based media are classified as positive while teacher's responses are classified very positive.

IV. CONCLUSION

Using GeoGebra-based media, students were able to arrive at the formulation of a theorem involving external and internal angles of a triangle. Students feel comfortable when learning geometry is aided with GeoGebra-based media. They also claim that understanding geometry concepts being studied become easier. The use of GeoGebra-based media plays important role in assisting students to reinvent and construct geometry concepts. The research result shows that conducting instructional process equipped with GeoGebra-based media establishes a meaningful learning and facilitates students with various characteristics. The findings of this research will be useful to mathematics teachers in running their geometry classroom.

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