Development of Teaching Materials and the Use of ICT to Improve Students' Mathematical Literacy Skills

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Abstract. The low quality of mathematics learning in the classroom is closely related to the low level of students' mathematical literacy skills. Learning by utilizing ICT (Information and Communication Technology) as a medium is very important. ICT can help teachers explain abstract mathematical material so that students can easily understand the material. The results of several studies state that the use of ICT in mathematics learning has a positive impact on reasoning abilities, mathematical communication, problem solving, and mathematical connections, where these abilities are included in the five mathematical literacy competencies. This research is a type of development research using the ADDIE model. The research was carried out in 5 stages, namely: analysis, design, development, implementation and evaluation. From this research, it was found that the use of technology can help students understand abstract things in mathematics material, thereby helping them improve their literacy skills.

Keywords: Literacy, geometry, ICT

1 Introduction

Education is a human right guaranteed by law. According to Law no. 20 of 2003, concerning the national education system, education is a conscious and planned effort to create a learning atmosphere and learning process so that students are active in developing their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and the necessary skills, him self, society, nation and state. From the definition of education above, we can see that the aim of national education is not only to improve students' cognitive abilities, but also to maximize their affective and psychomotor skills.

One of the subjects that plays an important role in education is mathematics. Students can be trained to think logically, critically and systematically through learning mathematics. The current situation is that many students are less interested in mathematics lessons. Most students feel that mathematics is difficult and is not directly related to their lives. This is understandable, because it is abstract and uses a lot of symbolic calculations and the learning is still conventional. This was revealed by [5] that many educators still do not understand how to teach mathematics well and have a direct relationship with students in everyday life. As a result, students experience difficulties in understanding the abstractness of mathematics subjects, which results in low interest and achievement in learning mathematics for students, from the basic level to the high level.

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Geometry is a branch of mathematics whose learning is very easy to relate to students' daily lives, but in reality, in the learning process, students often face problems.

According to [9] students learn geometry by memorizing the properties of geometric objects, not by exploring and investigating geometric concepts. Understanding geometry like this will make students' understanding limited and shallow, when students only memorize that a square has four sides of the same length, then squares and rhombuses will not be able to be differentiated by students. As a result, students' problem solving abilities will be limited to solving problems in everyday life. Understanding of geometric shapes constructed by students is directly related to students' ability to solve problems in learning geometry. As stated in [6] that visualization is needed in solving three-dimensional spatial problems. If this visualization is not provided as a learning medium, then students will have difficulty constructing the space in question, this is due to the students' low ability to understand spatial properties and interpret two-dimensional images.

Responding to the obstacles above, theoretically learning geometry must go through three stages, namely: enactive, iconic, and symbolic [3]. Another thing according to Hiele in [1] is that teaching geometry material should be adjusted to the level of development of students' thinking. These levels are: visualization, analysis, formal deduction, deduction and rigor. These two theories provide an indication that teaching geometry is by showing real objects directly, whether in the form of manual or digital objects, then continuing with the next stage in accordance with these theories. The use of technology and media can help visualization in learning geometry. Increasing visual learning activities in class is highly recommended by mathematics educators to lead students to understand geometric concepts [9].

Seeing these conditions, the presence of media, either manual or digital, has an important role in the process of learning mathematics where the object of study is abstract, especially media that can overcome problems in learning geometry. Nowadays computer-based learning media has developed rapidly. Several software for learning geometry have been developed, including Cabri-3D.

1.1 Mathematical Literacy

In PISA 2015, mathematical literacy is defined as an individual's ability to use, formulate and interpret mathematics in various contexts, including mathematical reasoning and the use of mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. Literacy guides individuals to recognize the role and application of mathematics in life. so that the individual is able to make good judgments and make decisions necessary as a constructive and reflective citizen.

Isnaini (in [4]) defines mathematical literacy ability as students' ability to understand facts, concepts, principles, operations and solving mathematical problems. Another understanding was conveyed by Ojose in [2] that mathematical literacy knowledge is the knowledge to know and use the basics of mathematics in everyday life. Another definition stated by [7] is that an individual's ability to formulate, use and interpret mathematics in various contexts is a mathematical literacy ability that students already possess. From these definitions, it is clear that knowledge and understanding of mathematics is very important, but the ability to apply mathematics for problem solving is much more important.

1.2 Use of ICT in Mathematics Learning

In the field of mathematics, research on ICT and mathematics learning has increased since the eighties, generally focusing more on the use of handheld calculators, internet technology and computer software [10]. Application and technology-based learning media are very necessary in developing teaching. According to [8] learning by utilizing technology as a medium is very important because seen from the perspective of teaching and material, both influence the results and interest of students in learning. [7] states that students need the use of technology to become effective problem solvers, collaborators, communicators and creators. Students can use digital technology to manage, integrate and build information/knowledge.

NCTM (National Council of Teachers Mathematics) has coined the term literacy before it was popularized through PISA. Mathematical literacy abilities include the following five competencies: problem solving abilities, mathematical communication abilities, mathematical reasoning abilities, mathematical connecting abilities and mathematical representations [7].

Based on this background, this paper will describe the use of ICT in geometry learning to improve students' literacy skills. In general, the aim of writing this article is to see to what extent learning mathematics using ICT media has an impact on improving students' literacy skills.

2 Methods

This research is research and development. Development research is a process or steps to develop a new product or improve an existing product, with measurable and guaranteed product quality [11]. The product development process follows the ADDIE model development steps. The five stages are carried out in this model. These stages are: analysis, design, development, implementation, and valuation. In this research, observation, interviews, questionnaires and tests were used to collect data. The development stages in this research can be detailed as follows.

3 Results

Research results have been obtained by using Cabri-3D on geometry material as a learning medium for high school students. This research was designed using the ADDIE model. The results of pretest and posttest data analysis have been obtained. In other words, 1) the learning media developed is valid. 2) the learning media developed is practical. 3) learning media is developed effectively. In this article, we will discuss the effectiveness of learning media to shape students' literacy abilities.

Before giving the pretest, the researcher first explained material related to Pythagoras to remind students of the material. After being given the material, students are given a pretest. From the students' answer sheets, it was found that students had not been able to answer cube material geometry questions correctly. From the students' answer sheets, it was found that one in four students made a mistake in using the Pythagorean formula, this was because the students mistakenly determined which of the shapes drawn in the second dimension had right angles. So, this makes students experience errors in solving the questions given.

After analyzing students' difficulties, students were then given geometry lessons with the help of Cabri-3D media to solve cube mathematics problems. Where through Cabri-3D students get sufficient visual power so that students can recognize geometric shapes in the third dimension with area. In this application, geometric shapes in the form of cubes can be rotated 3600 in all directions so that students can recognize right angles, slanted sides and other sides. In this lesson, students are given an example problem, where the problem given is calculating the length of the diagonal of space. In working on this problem, students are assisted in explaining geometric shapes using Cabri-3D.

Next, students are given a posttest. The results of the posttest work are as follows:

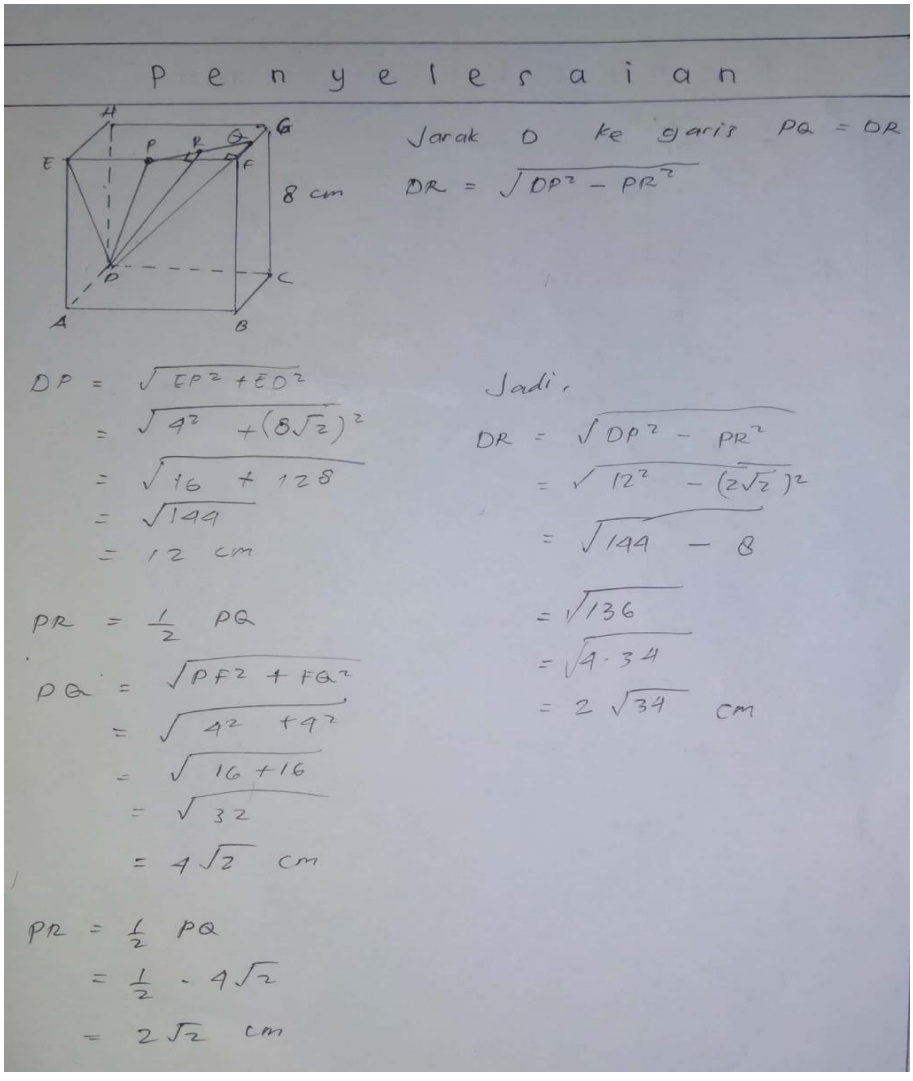

Fig. 1. Student's Answer Sheet

The fig.1. above is the result of an answer done by one of the students after learning geometry using Cabri-3D. From the students' answer sheets, it can be seen that students' understanding and knowledge regarding solving cube problems and using the Pythagorean formula has increased. Where, in this case the students were able to answer correctly the questions the researcher gave. Where students can determine which part will be calculated, students can also determine right angles and students are able to determine which side is slanted and the other side. From this information, students can use the Pythagorean formula in calculations and can get correct results. Based on the description above, it can be concluded that there has been a change and the level of students' understanding has become better regarding spatial shapes after being given an explanation using Cabri-3D.

Furthermore, to find out students' understanding, obstacles and responses regarding building space after being taught using Cabri-3D, researchers conducted interviews with students. The results of the interview are: (P is the researcher and S1 is the first student, S2 is the second student, S3 is the third student)

Q : What were the obstacles when you were working on the pre-test questions given?
S1: I still don't understand how to use the Pythagorean formula to determine the solution because I'm confused about determining the right angle.
S2: Same, I'm also confused about which one is the right angle.
S3: I really don't understand, sir, because from the picture I can't determine the angle, sir, so I'm confused about how to use the formula, sir.
Q : After we taught you how to use Cabri-3D, how did you understand it?
S1: Personally, Sis, I understand better. Because the image can be rotated, it is better to see the angles to find right angles, so we use the Pythagorean formula.
S2: It's easier for me to determine which triangle to calculate, so I know which side is the hypotenuse, long side and short side and the angle so I can use it in the formula, so I don't have any doubts anymore.
S3: When I used Cabri-3D, I understood better, bro, from there I knew which one to put in the formula, the triangles because there was already a picture, I didn't have to imagine anymore, sir.
Q: So, in your opinion, which learning is easier to accept? Using Cabri-3D media or not using media?
S1, S2, S3: Use Cabri, sir.

Based on the results of interviews conducted by researchers, it can be concluded that learning using media will be better and easier for students to understand, especially for spatial shapes which are sometimes difficult for students to imagine. With this Cabri-3D media, students are able to understand more easily.

After analyzing student answers, interviews and observations, from this research it was found that students' mathematical literacy abilities were as follows:

3.1 Communications

Students who have been given learning are able to communicate problems by writing down and mentioning what is known and asked about the problems presented. Students are able to explore the information contained in the questions. When discussing in groups or in class essays, students have the ability to communicate problems to help their friends who do not understand the problems presented in the questions.

3.2 Mathematizing

Students who have been given learning are able to understand problems and model them in mathematical language (mathematizing horizontally). The problems presented can be solved by applying mathematical formulas (vertical mathematizing). When the learning process takes place, students also have the ability to change real problems into mathematical forms that are presented, this is due to the ability to understand and solve the problems that students have.

3.3 Representation

Before learning, there are still several problems that cannot be written down and the conclusions stated in accordance with the question asked with the correct conclusion. However, after learning, students are able to write and state conclusions from all problems according to what is asked.

3.4 Devising Strategies for Solving Problems

Before learning, students can develop strategies for solving problems, but if students do not have sufficient initial knowledge, then students will not be able to develop a strategy for solving them. After students are given learning, students can develop strategies to solve all problems because through the learning carried out by researchers they have increased students' knowledge.

3.5 Reasoning and Argument

After students are given learning, students are able to provide logical reasoning to explore and connect these problems to make conclusions. This can be seen during interviews, where students answer questions from researchers about the reasons for completing the posttest which are written correctly.

3.6 Using Symbolic, Formal and Technical Language and Operations

Before the lesson was given, students were still not fully able to use mathematical symbols, but after the lesson was given, students were able to understand the use of mathematical symbols, where students used them well to help solve problems.

3.7 Using Mathematics Tools

Students before and after learning can use mathematical tools, namely rollers, to draw sketches well.

4 Conclusion

Before learning, students were not able to write down what they knew and were asked, use mathematical formulas (vertical mathematizing), develop strategies to solve problems, provide logical reasoning for their work, and had not concluded the problems given, but after being given learning with the help of Cabri-3D students are able to carry out the seven components of mathematical literacy well.

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