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The Ability of Problem-Solving for Eighth Grade Student on Cooperative Problem Solving Learning Assisted by GeoGebra 3D

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Abstrak

Mathematics learning is very important given in order to the students can have problem-solving abilities. This study aims to test the effectiveness of cooperative problem solving (CoPS) learning assisted by the GeoGebra 3D on students' problem-solving abilities and describe problem solving abilities in terms of students' GeoGebra 3D usage. This research is a type of quantitative and qualitative. The study was conducted in a junior high school named SMP Islam Al Azhar 14 Semarang in the 2018/2019 academic year. The research subjects were eighth grade students consisting of one experimental class with cooperative problem solving learning assisted by GeoGebra 3D treatment and one control class. Then two students were selected for each of the high, medium, and low GeoGebra 3D usage categories. Hypothesis testing uses one-party proportion test and average difference test. The results of the study showed that cooperative problem solving (CoPS) learning assisted by GeoGebra 3D was effective on students' problem-solving abilities. Students with medium and high usage categories of GeoGebra 3D can reach all indicators of problem-solving even though several indicators of problem-solving are achieved with insignificant errors. Students with medium and high GeoGebra 3D usage categories can implement the steps of problem-solving according to Polya's steps, even they are as good at the carry out the plan step. Students with low GeoGebra 3D usage category cannot carry out the Polya's steps well. Students with low GeoGebra 3D usage category faced difficulties to devise problem-solving plan, carry out problem-solving plan, and looking-back step is not done.

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INTRODUCTION

Today, technology has become a part of our daily lives, one of which is gadgets. Examples of gadgets are cellphones, smartphones, playstations, PSPs, tablets, and laptops. Gadgets are fun for children, especially when used to play puzzles, shoot fast, shoot games, and social media, which can train a child psychomotor to be skilled in the use of gadgets (Sundus, 2018). However, it makes new problems, especially in learning. One of the main causes is that students who have used gadgets spend more time communicating on social media than learning (Harfiyanto et al, 2015). However, electronic devices can also facilitate students to design, explore, experiment, access information and model complex phenomena, as well as facilitate communication between teachers and students (Simuforosa, 2013; Harfiyanto et al, 2015; Sundus, 2018). So that, electronic devices can be used as an alternative to solving problems in learning, especially for geometry material.

Difficulties in geometry material learning correspond to van Hiele's statement as cited by Yilmaz (2015) namely the level of geometrical thinking, mostly at the level of elementary school students, at the first level and the transition period from the second level. Burger and Shaughnessy (1986) also state that the highest level of thinking for junior high school students in learning geometry at level 2 (informal deduction) and most are at level 0 (visualization). This is consistent with the results of observations showing that the level of geometrical thinking of students in SMPI Al Azhar 14 Semarang grade 8 are low and faced difficulties to use the concept in solving problems in the three-dimensional shapes material.

One alternative that can be used is GeoGebra 3D applications. According to Zengin et al (2012), GeoGebra 3D is a dynamic geometry software that has become an important potential tool for enhancing the visual teaching of three-dimensional geometry material. So with GeoGebra 3D, the geometry competencies of students can be developed optimally. In addition GeoGebra is software that can be used for learning and teaching at elementary, junior high, high school and university level (Hohenwarter, 2008; Zengin et al, 2012; Akhirni, 2015; Ekawati, 2016). GeoGebra offers an effective opportunity to create an interactive learning environment and allows students to explore various mathematical concepts (Hohenwarter, 2008). GeoGebra was created to help students gain a better understanding of mathematics (Hohenwarter, 2008; Akhirni, 2015; Ekawati, 2016).

In addition, mathematics cannot be separated from problem-solving (Bicer et al, 2013; Ulya, 2014). Whereas since the 1980s until now, problem-solving is still one focus of school mathematics that becomes the needs of individuals and serves the needs of various sciences, especially social and applied sciences (Brown, 1996; Caballero, Blanco, & Guerrero, 2011; Esan, 2015). NCTM (2000) mentions the standard of problem-solving namely: (1) build new mathematical knowledge through problem solving, (2) solve problems that arise in mathematics and in other contexts, (3) apply and adapt a variety of appropriate strategies to solve problems, and (4) monitor and reflect on the process of mathematical problem solving. Therefore, besides by using technology, certain conditions are needed to overcome the obstacles in geometry learning. Problem-solving can not only be an objective for learning medium but also developing mathematical abilities (Wilson et al, 1993; Esan, 2015).

The using of teaching strategies in groups can develop better problem-solving abilities (Stiff et al, 1993; Esan, 2015). In the cooperative learning model, each group member has the responsibility to participate so that cooperation between students arises. In addition, students are able to share ideas and help each other if they find difficulties in solving problems. Cooperative Problem Solving (CoPS) is a teaching strategy where students work together in groups of various compositions to solve problems together (Heller et al, 1992; Esan, 2015). To be successful in this strategy, students share ideas rather than working alone and helps each another to maximize shared results (Tran, 2014; Esan, 2015; Jacobs, 2016; Alipour, 2016). This strategy is not like expository teaching methods where students work individually or competitively. CoPS adopts the Cooperative Problem Solving model which has 4

stages there are Recognition, Team Formation, Plan Formation, and Team Action where agents, both human and artificial, can be involved in a problem and can solve it cooperatively (Wooldridge, 1999). While the problem solving strategy used is Polya's problem solving step (Polya, 1957; Wilson et al, 1993; Dewiyani, 2008; Esan, 2015), which consists of four problem-solving steps, namely: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back.

In previous studies, it resulted that GeoGebra-assisted instruction was more effective than the usual learning conducted by Zengin et al (2012) and Cooperative Problem Solving (CoPS) into teaching strategies where students worked together in groups of various compositions to solve problems together (Esan, 2015). Furthermore, the development of learning material in the construction of three-dimensional shape with CoPS learning assisted by GeoGebra 3D is designed to stimulate curiosity and help transfer student learning that results in better performance. CoPS assisted by GeoGebra 3D is very important to solve existing problems in learning mathematics at SMPI Al Azhar 14 Semarang. The concepts mastery and problem-solving abilities to realize a quality learning can be supported by using gadgets. The digital class program at SMPI Al Azhar 14 Semarang makes almost all students already have laptops or smartphones, so that the implementation of GeoGebra 3D-assisted CoPS learning can be carried out.

The objectives of this study is (1) to determine the effectiveness of CoPS learning assisted by GeoGebra 3D on problem solving abilities and (2) describe the problem solving abilities in terms of students' GeoGebra 3D usage in CoPS learning.

METHODS

The type of research used is a type of mix method research (a mixture of quantitative and qualitative) with embedded design. This design can also be characterized as a mixed-method strategy that applies one stage of quantitative and qualitative data collection at one time. Quantitative research as a primary method while qualitative research as a secondary method.

There are two stages of research where research begins with a preliminary study to identify problems in the field by conducting studies on data, interviews with teachers, and studies in the literature. In stage two, researchers conduct quantitative and qualitative research in tandem.

Quantitative research to determine the effectiveness of CoPS learning assisted by GeoGebra 3D on problem-solving abilities while qualitative research to determine problem-solving abilities based on students' GeoGebra 3D usage category. Quantitative research use quasi experimental design with nonequivalent control group design in which the experimental class is given by treatment while the learning in the control class is carried out as usual teachers teach.

The population in this study were eighth grade students of SMPI Al Azhar 14 Semarang. From 10 classes of eighth grade students, 1 experimental class was selected which was given by CoPS learning assisted by GeoGebra 3D and 1 control class that was given conventional learning. In qualitative research, the research subjects used were only the classes that received CoPS learning assisted by GeoGebra 3D, that is the experimental class. The research subjects were selected from the experimental class where two independent categories were chosen by two students' problem-solving abilities to be analyzed. Based on the results of questionnaire and suggestions from class teachers, two were selected students with low categories, namely subjects S1 and subjects S2, students with medium categories namely subjects S3 and S4, and students with high categories namely subjects S5 and S6.

The data sources in this study were students where they were obtained from the results of the student's problem-solving ability test, the results of the GeoGebra 3D usage, and the interview results sheet for students' problem-solving abilities. The research instrument consisted of test and non-test research instruments. The instrument of the test is the problem-solving ability test. Non-test research instruments include the scale of GeoGebra 3D usage and interview guidelines for students' problem-solving

ability. Each instrument was carried out a feasibility analysis where the test instruments were carried out construct validity, content validity and trial. The interview guideline instrument is only construct validation and content validation. Data analysis in quantitative research includes normality test, homogeneity test, proportion test and average difference test. Qualitative data analysis follows the concept given by Milles & Huberman (2007) that are data reduction, data display, and conclusions: drawing/verification.

RESULTS AND DISCUSSION

Based on the results of the calculation of mastery learning experimental class by using one-party proportion test obtained the average value of students in the class with CoPS learning assisted by GeoGebra 3D was 77.23 with 22 students who achieved individual completeness. This means that the percentage of students who complete individually on CoPS learning assisted by GeoGebra 3D is more than 70%. So, the problem-solving abilities of students who get CoPS learning assisted by GeoGebra 3D achieve learning completeness. The comparative test in this research is the average difference test of problem solving ability. The average score of students in the class with CoPS learning assisted by GeoGebra 3D was 77.23 and the average score of students in the control class was 70.96. The conclusion is that the average of problem-solving abilities for students in the class with CoPS learning assisted by GeoGebra 3D is more than the problem-solving abilities of students in the control class. Furthermore, the average difference test of two independent samples was used to find out whether the problem ability between the experimental classes was better than the control class students. Based on the SPSS calculation results with the Independent t-test obtained a significance value of 0.067 with α of 5%. This means significance> α, so the average problem-solving ability of experimental class students taught by CoPS learning assisted by GeoGebra 3D is higher than the control class.

Based on the results of the GeoGebra 3D questionnaire in experimental class students obtained the following results.

Table 1. Grouping Students Based on the GeoGebra 3D Usage

Students Category	Students Total	Precentage (%)
High	15	68.18
Medium	5	22.72
Low	2	9.1
Total	22	100

Each category of GeoGebra 3D usage was chosen by 2 students to be analyzed its problem solving abilities in depth. The selection of high category students was obtained from 2 students with the lowest and highest score of GeoGebra 3D usage in the high category. The selection of students in the medium category was obtained from 2 students with the lowest and highest score of GeoGebra 3D usage. While the selection of low category students was obtained from 2 students with the lowest and highest of GeoGebra 3D usage.

Students' problem-solving abilities are assessed based on Polya's problem solving steps. In Figure 1, a bar diagram is presented stating the average score obtained by each group of students based on the GeoGebra 3D usage which refers to four problem solving steps, namely understanding the problem (PS1), devising a problem solving plan (PS2), carrying out the plan (PS3), and looking back by recheck the answers (PS4).

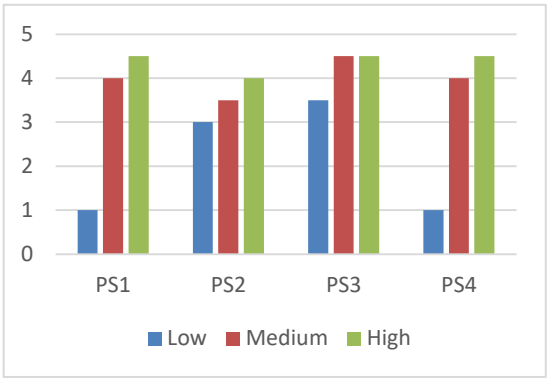

Figure 1. Problem Solving Ability Score

Subjects with low GeoGebra 3D usage category are S1 and S2. S1 and S2 subjects are students who rarely use the GeoGebra 3D application and have difficulty in understanding questions. Subject S1 cannot write down the information in the given problem, so that it faced difficulty when planning problem solving and cannot solve the problem properly. Subject S1only solve problems that similar with what it can remember and do not check answers even though there are still time to work. In the same GeoGebra 3D usage category, subject S2 had a little difficulty in understanding the problem but was able to write the information that was known from the problem even though it was incomplete. The subject S2 had difficulty when explaining the problem solving plan and carrying out the problem solving. Subject S2 rechecks the answers obtained by writing the summarized answers on the answer sheet but does not write alternative answers.

Students with low GeoGebra 3D usage category are only able to solve problems until the understanding the problem step. The patterns of the ability of students with low GeoGebra 3D usage category to solve problems are (1) Students with low GeoGebra 3D usage category can understand the problem. The level of understanding of students' problems is still lacking. Students are able to mention things that are known and asked but incomplete; (2) Students in the low GeoGebra 3D usage category cannot always plan problem-solving. They cannot mention all the formulas needed to solve the problem; (3) The inability of students with low GeoGebra 3D usage category in planning problem-solving results in students being unable to carry out problem-solving plans. Students write several stages of the answer on the answer sheet, but found errors in determining the solution; and (4) Students do not recheck the answers. Students with low GeoGebra 3D usage category have difficulty understanding the problem so that the next stage cannot be done smoothly. It indicates that students in the low GeoGebra 3D usage category have difficulty in solving problems. NCTM problem solving indicators that can be achieved by students with a low GeoGebra 3D usage category are only one indicator, namely building new mathematics through problem solving, while the other 3 indicators cannot be achieved.

The subjects with medium GeoGebra 3D usage category are S3 and S4. Subjects S3 and S4 are students who use the GeoGebra 3D application when experiencing difficulties when understanding questions, especially when visualizing the problems. Subject S3 has a little difficulty in understanding the problem but the subject can mention information that is known and asked about the problem. Subject S3 plans to solve the problem but does not write the formula that will be used in planning. Subject S3 carry out problem solving as planned but there are still errors in writing the formula even though the purpose of the answer is correct. Subject S3 rechecks the answer but subject S3 does not know another way to solve the problem. In the same GeoGebra 3D usage category, Subject S4 had no difficulty in understanding the problem and were able to write information that was known. Subject S4 writes the steps that will be used to solve the problem but does not write the formula that will be used. Subject S4 draws sketches exactly and uses the appropriate formula to solve the problem. Subject S4 rechecks the answers obtained by writing conclusions on the answer sheet but does not write alternative answers.

Thus, students with medium GeoGebra 3D usage category are able to solve the problem until looking back step. Students with medium GeoGebra 3D usage category are able to identify things that are known and asked, draw up a problem-solving plan and implement it, and are also able to check answers. The pattern of problem solving abilities of students with medium GeoGebra 3D usage category in solving problems are (1) Students subjects with medium GeoGebra 3D usage category are able to understand the problem well. Students can determine the information they know and ask for from the problem well; (2) Students plan problem solving precisely, they can determine what formulas will be used to solve problems correctly; (3) Students do not experience difficulties at the carrying out problem solving step. This is because students can plan problem solving well. However, students do not try to make maximum use of time in carrying out problem solving. Students are satisfied with writing an answer

without writing an alternative answer, even though there are still other ways in calculating or drawing, and time is also not finished yet; and (4) Students are able to rechecks the answers that have been obtained, but do not have alternative answers. Students with medium GeoGebra 3D usage category are currently able to reach all NCTM problem solving indicators.

Subjects with high GeoGebra 3D usage category are S5 and S6. Subjects S5 and S6 are students who often use the GeoGebra 3D application when experiencing difficulties when understanding questions. Subject S5 can understand well and can write information that is known in the given problem. Subject S5 writes the steps that will be used to solve the problem but the formula to be used is not written down. Subject S5 can draw a sketch and calculate the questions given as planned. Subject S5 rechecked the answer but the subject did not know another way to solve the problem. In the same GeoGebra 3D usage category, subject S6 also had no difficulty in understanding the problem and was able to write information that was known. Subject S6 writes the steps that will be used to solve the problem and just like subject S5, subject S6 does not write the formula to be used. The S6 subject draws the sketch precisely and calculates with the appropriate formula to solve the problem. Subject S6 checks again from the answers obtained by writing a summary of the answers but does not write alternative answers. Students with high GeoGebra 3D usage category can solve problems until the looking back steps. The pattern of problem solving abilities of students with high GeoGebra 3D usage category in solving problems are (1) Students with high GeoGebra 3D usage category can understand the problem well, they can determine the information that is known and asked in the problem well; (2) Students are able to arrange problem-solving plans appropriately. Students are able to determine the formula that will be used to solve problems appropriately; (3) Students carry out problem solving according to plan. Students have high effort to find as many answers as possible; and (4) Students re-check the answers obtained. From the descriptions above, students with high GeoGebra 3D usage category have good problem-solving ability. Students with high GeoGebra 3D usage category can express problem-solving steps well. All NCTM problem-solving indicators have also been achieved by students with high GeoGebra 3D usage category.

Based on the discussion of problem-solving ability patterns, students with low, medium, and high GeoGebra 3D usage categories obtained information that students with low GeoGebra 3D usage category had difficulty starting to understand the problem, while students with medium and high GeoGebra 3D usage categories were able to solve problems given until the looking back step. In addition, the differences of score in problem-solving steps between students with medium and high GeoGebra 3D usage categories are not too far compared to students with low GeoGebra 3D usage category, even students with medium and high GeoGebra 3D usage categories are as good at the carry out the plan step. So in solving problems, students with high GeoGebra 3D usage category are not always better than students with medium GeoGebra 3D usage category. It happens because there are students who have been able to visualize the problems with their own abilities, only use GeoGebra 3D to make sure the student's visualization is correct or to explore sketches of existing material. The use of GeoGebra 3D applications from these students tends to be less than students who have difficulty in visualization.

CONCLUSION

The results of the study showed that cooperative problem solving (CoPS) learning assisted by GeoGebra 3D was effective on students' problem-solving abilities. Students with medium and high usage categories of GeoGebra 3D can reach all indicators of problem-solving even though several indicators of problem-solving are achieved with insignificant errors. Students with medium and high GeoGebra 3D usage categories can implement the steps of problem-solving according to Polya's steps, even they are as good at the carry out the plan step. Students with low GeoGebra 3D usage category cannot carry out the Polya's steps well. Students with low GeoGebra 3D usage category faced difficulties to devise problem-solving plan, carry out problem-solving plan, and looking-back step is not done.

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