Students’ Mathematical Communication Ability using Learning Cycle 7E on Junior High School

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Abstract. This study aims to determine whether there are differences in the effect of applying learning cycle 7E and direct learning to students’ mathematical communication ability in junior high school. This research was conducted at junior high school 16 Surakarta. This study was conducted in the even semester of 2017. This research uses the experimental method. The study sample consisted of two classes taken randomly from the eighth grade. The experimental class is treated 7E learning cycle and the control class is given direct learning. Methods of data collection in this study using the method of documentation and test methods. The data analysis in this research uses t-test. Data obtained from experiment class and control class. The results of this study conclude that there are differences in the effect of applying the learning cycle 7E and direct learning to students' mathematical communication ability. This proves that students' mathematical communication ability using 7E learning cycle is better than students' mathematical communication ability using direct learning. This happens because the Learning cycle 7E there are steps that can be used to improve the ability of mathematical communication such as for elicit, engage, explore, explain, elaborate, evaluate and extend. Learning cycle 7E can be used to improve students' mathematical communication ability of junior high school.

1. Introduction

One of the subjects on geometry and measurement materials is solid geometry. Problems associated with solid geometry are often found in everyday life. The problem is generally in the form of a story. Solving the story problem required mathematical communication ability. Lomibao states that mathematical communication ability is the ability of students to express ideas, describe, and discuss mathematical concepts coherently and clearly [1]. Nartani states that students' mathematical communication ability is the main process that must be possessed by students to improve thinking ability in math lesson [2]. Some research on mathematical communication has also been implemented. The result of Lomibao research is that students with learning mathematics communication have high learning achievement and understanding and students' anxiety can decrease [1]. One of the learning that can be used to improve the mathematical communication is constructivist learning. Constructivist learning has an important contribution to student achievement [3]. In constructivist learning, teachers can design teaching in accordance with learning materials so that students' understanding of the material will last long [4]. Qararah states that constructivism learning is important for students.
Constructivism learning makes students' learning process active where students build new knowledge and prior knowledge [13].

One of the constructivism learning is learning cycle 7E. Some studies have shown that learning cycle 7E is better than other learning. Khaskan's research is comparing the learning cycle 7E and the traditional method of learning mathematics in preparatory year students at King Saud University. The results of the study showed that the learning cycle 7E is better than the traditional method on student's mathematics learning achievement [5]. In Balta study shows the 7E learning cycle is useful for the science curriculum [6]. Shaheen's research results show student achievement in biology lessons taught with learning cycle 7E is better than traditional instructional [7]. The results of Siribunnam's research that analytical thinking, learning achievement and attitudes in chemistry on students who were taught by learning cycle 7E were higher than KWL methods and conventional approaches [8]. However, there are studies that suggest that learning cycle 7E is no better than other learning. Polyiem's research results are learning achievement, science process skill, and moral reasoning on socioscientific issue-based learning better than learning cycle 7E [9].

In this study used learning cycle 7E and direct learning to mathematical communication ability in junior high school on solid geometry materials. This research uses the experimental method. The study sample consisted of two classes taken at random from six classes. The experimental class is given learning cycle 7E and control class is given direct learning. Methods of data collection in this study using documentation method and test method. Documentation method used as initial data. The test method is used as the final test. The final test used is a test of students' mathematical communication ability of the experimental and control classes. An indicator of mathematical communication ability in Nartani research is (1) student can express ideas with verbal mathematical sentences, (2) students can have active discussion about math, (3) Students can formulate definitions and generalizations about mathematics, (4) students can define mathematical definitions using their own sentences [2]. The aspects of mathematical communication in Widjajanti's research are (1) students 'ability in writing statements, reasons, or explanations, and (2) students' ability to use terms, notations, tables, diagrams, graphics, drawings, illustrations, mathematical models, or mathematical formulas [10]. The indicators of mathematical communication ability in this study are: (1) students can express the problem given in the form of drawing, (2) the student can change and interpret the mathematical information of an image in the mathematical representation and (3) the student can express the idea or mathematical idea in the form of mathematical writing. Data analysis in this research uses t-test. The results of this study conclude that there are differences in the effect of applying the learning cycle 7E and direct learning to the mathematical communication ability on solid geometry material. Students’ mathematical communication ability using the learning cycle 7E is better than students’ mathematical communication ability using direct learning. Learning cycle 7E can be used in learning mathematical communication in junior high school students.

2. Experimental Method

Type of research used in this study is the experimental method. This research was conducted at junior high school 16 Surakarta in 2017. Population in this study was all eight graders of junior high school 16 Surakarta consisting of 6 classes. An average number of students per class is 30 students. In this study, two classes were selected as experimental class and control class. Experimental class was treated with learning cycle 7E and control class was given direct learning treatment. Methods of data collection in this study using documentation method and test method. Documentation method used as initial data. The test method is used as the final test. The final test in this study is a test of written mathematical communication ability. Final test consists of 6 item essay test on solid geometry material. An instrument has been validated by a lecturer of Mathematics Education Sebelas Maret University. An instrument has been validated and analyzed. Instrument analysis consists of reliability test with Alpha Cronbach formula. Result of instrument analysis that is $r_{x1} = 0.733$. Reliability value used to describe the usefulness of an item in measurement. It means that the result of measurement having a reliability index 0.70 or more then instrument can be used to measurement [12]. Preliminary analyzes
were performed to determine whether the two samples were from the same initial condition. In the initial analysis using normality test, homogeneity test, and t test. In the final analysis used normality test, homogeneity test and t test.

3. Result and Discussion

3.1. Preliminary data analysis

In this section, we describe the initial data analysis. In this study, preliminary data is taken from final exam score of the previous semester. In table 1, the results of normality test on experimental and control class test were tested with SPSS 16.0.

Table 1. Normality test in the experimental and control class preliminary data

| Class       | Statistic | df  | Sig  |
|-------------|-----------|-----|------|
| Experimental| 0.158     | 30  | 0.055|
| Control     | 0.166     | 24  | 0.087|

Based on table 1 shows normality test in the experimental class that is sig value = 0.05 and the control class sig value = 0.087. On both sig values obtained both of more than 0.05 then data of two classes are said to be normally distributed. Test homogeneity of variants of both classes using Levene’s test with SPSS 16.0. The result of homogeneity variance test is sig value = 0.893. Sig value more than 0.05 then data of both classes have the same variance.

Table 2 describes the t test results with SPSS 16.0 to find out whether there are differences in the experimental and control class.

Table 2. T test on initial ability of experimental and control class

| Class       | N   | Mean | SD   | t-value | df  | Sig  |
|-------------|-----|------|------|---------|-----|------|
| Experimental| 30  | 71.50| 10.351| 0.163   | 0.871|
| Control     | 24  | 71.04| 10.212|         |      |

The results of hypothesis test in table 2 got sig value = 0.871. Sig value more than 0.05 then it can be said there is no difference in both classes. Both classes have the same initial capability. Furthermore, both classes were treated for experimental classes given learning cycle 7E and for control classes were given direct learning.

3.2. Analysis of final data

Table 3 presents normality test of experimental and control class final tests. The final test is obtained from mathematical communication ability test in experimental and control class.

Table 3. Normality test in the experimental and control class final tests

| Class       | Statistic | df  | Sig  |
|-------------|-----------|-----|------|
| Experimental| 0.146     | 30  | 0.102|
| Control     | 0.122     | 24  | 0.2  |

Result in table 3 shows sig value in experimental class is 0.102 and control class is 0.2. Both sig values are more than 0.05 then it is said the final test data is normally distributed. Test homogeneity of
variants of both classes using Levene's test with SPSS 16.0. The result of homogeneity variance test is sig value = 0.111. Sig value more than 0.05 then data of both classes have the same variance.

Table 4 shows the results of t test on the final test of experimental and control class with SPSS 16.0. Final test data is a test of mathematical communication ability in experiment and control class.

| Class      | N  | Mean | SD   | t- value | df  | Sig   |
|------------|----|------|------|----------|-----|-------|
| Experimental | 30 | 72.67| 8.33 | 2.613    | 52  | 0.012 |
| Control    | 24 | 65.33| 11.169 |         |     |       |

The result in table 4 gets sig value 0.012. Sig value is less than 0.05 then it is said there is a difference in the final test of experiment and control class. Based on an average value obtained, it is said that students' mathematical communication ability in experimental class is better than control class.

The result of the research shows that use of learning cycle 7E is more effective than direct learning of students' mathematical communication ability on solid geometry material. This is related to learning cycle 7E in experiment class become more active students. Students become the center of teaching and learning process where students learn by exploring solid geometry material. In elicit step, the teacher gives a question that stimulates the student's initial knowledge. Students answer questions from teachers according to their understanding. Students answer questions from teachers according to solid geometry material in real life. In engaging step, the teacher motivates students by explaining solid geometry material in real life Students see and listen to the teacher's explanation with enthusiasm. Of the two steps, early knowledge of students began to form. In next step the students more easily in investigating the concept of solid geometry. In the learning cycle, 7E students get the initial knowledge that will help him to build further knowledge [5]. Initial knowledge of students makes it easier for students in mathematical communication. Mathematical communication is required in solid geometry. Students can describe the problem of geometry into images. Students can write the problem of geometry drawing on mathematical sentence. Students can express mathematical ideas in writing. In explore step, the teacher provides an opportunity for students to observe and analyze solid geometry samples to determine the parts and their measurements. Students observe solid geometry samples given by the teacher to know the part and size.

In explain step, the teacher assigns a task to students to convey their findings in explore phase. Some students actively convey their idea of geometry size to all students and teachers in the classroom, while some students expressed different opinions. Furthermore, teachers together with students summarize the results submitted by students about a size of solid geometry. In elaborate step, the teacher gives students the opportunity to apply parts and sizes of solid geometry material to some story questions. Students answer some questions given by teachers on solid geometry material. Some students discussed to answer the problem. In evaluating step, the teacher checks the students' understanding by assigning tasks to the students as a form of learning assessment. Each student does the task of the teacher about learning on solid geometry material. In the extending step, the teacher gives some examples of application solid geometry material to more complex issues. Students pay attention to teachers about examples of solid geometry material applications. Furthermore, students try to solve complex solid geometry material problems. Some of these steps make students have good mathematical communication ability. Students are actively discussing mathematical images and writings on solid geometry material. Poliyem states that learning cycle 7E is beneficial for students. Student learning ability can increase. Students gain new knowledge through various learning sources. Students become able to apply learning methods in real life [9]. In control, class is given direct learning to students.

In the first step, the teacher prepares students to learn and convey the purpose of learning solid geometry material. Students prepare to carry out learning and listen to explanations from teachers. In the second step, the teacher explains to the student on solid geometry material. Students see and listen
to the teacher’s explanation on solid geometry material. In the third step, the teacher gives an example and guides students to work on solid geometry material. Students follow example described by the teacher. In the last step, the teacher assigns the task to students as a learning assessment on solid geometry material. Students do the tasks assigned by the teacher. These learning steps make students passive. Students only record, listen and rarely ask questions when students cannot do the teacher’s questions. Students have less discussion with other friends. Teachers are very dominant and students are not asked to be active in a learning process. Some students have difficulty in direct learning. Students have difficulty in changing the problem into mathematical sentences. Students have difficulty in visualizing the problem. In control class of students’ mathematical communication ability are not as good as in experimental class. Based on table 4, average students’ mathematical ability in experimental class is better than control class. Several other studies got results that were consistent with this study. Muyono research is the use of effective learning cycle 7E on self-regulation and problem-solving ability in mathematics learning [12]. Khaskan research is the use of learning cycle 7E is more effective than a traditional method on mathematics learning [5].

4. Conclusion
Learning cycle 7E is effective in learning students’ mathematical communication abilities and on learning geometry material. Learning cycle 7E has effective learning steps. In elicit and engage steps, students’ initial knowledge on the learning materials will be well established. In explore and explain steps, each student will be creative to find the concept of material based on student's initial knowledge. In elaborate and evaluate steps used by students to practice applying learning materials. In the extend step, students can learn more widely and complex. Based on the research findings, the researcher suggested that learning cycle 7E can be used in the learning of solid geometry material. Teachers can use the learning cycle 7E to improve students’ mathematical communication ability. Suggestion for further research is the researcher doing learning cycle 7E on other material and use learning cycle 7E to improve other mathematical ability.

Acknowledgments
The authors thank Sebelas Maret University and junior high school 16 Surakarta due to give permission for this study.

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