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Analysis of Mathematical Communication Ability and Curiosity Through Project Based Learning Models With Scaffolding

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Abstract

This study aims to: (1) test the effectiveness of project based learning model with scaffolding in improving mathematical communication skills, and (2) to describe mathematical communication skills and students' curiosity through the project based learning model with scaffolding. This research uses approach of mix method of sequential explanatory type. The subject of the research are the students of VIIA class of State Junior High School 18 North Halmahera academic year 2016/2017. Techniques of collecting data by using tests, observations, questionnaires and interviews. Data were analyzed by descriptive analysis and statistical test of t comparison and regression effect test. The results showed that the model of project based learning with scaffolding was effective on mathematical communication ability. Mathematical communication skills and the curiosity character of upper and middle group students are categorized as good and in the high category, while the lower group is considered poor and still in low category.

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INTRODUCTION

Mathematics is one of the most important disciplines. Mathematics is full of symbols and symbols that require a high mathematical understanding. Mathematical understanding can be enhanced by expressing mathematical ideas to others (Qohar, 2011). The ability to express mathematical ideas to others both orally and in writing is called mathematical communication ability. Many are expressed that communication is an important part of mathematics education (NCTM, 2000; Cai and Lester, 2010; Kosko and Wilkins, 2010; Qohar, 2011; Qohar and Sumarmo, 2013). In recognizing the importance of mathematical communication skills so educators need to seek learning by using approaches that can provide opportunities and encourage students to practice communication skills.

The mathematical communication ability on the material quadrilateral in the class VIIA class of State Junior High School 18 North Halmahera is still low. The result of observation shows that only 13.33% of students are in good category, while 40% are in enough category and 46.67% of students are in less category. Based on the above observations, it is concluded that there are still many students who have scores below 70 and students' mathematical communication skills at State Junior High School 18 North Halmahera is still relatively low.

The results of interviews with students of State Junior High School 18 North Halmahera which mentions that students have difficulty solving math problems due to lack of practice questions related to how to communicate what has been learned, in terms of mathematical communication. This is evident from the way students solved math problems, where students were not yet familiar with identifying what is known, asked and what math ideas were needed in problem solving.. The low curiosity of students towards mathematics learning is also revealed through the fact that many students do not do homework and collect tasks beyond the prescribed time limit. In addition, teachers have not used learning methods that can encourage students to have mathematical communication skills and engage students actively so as to generate curiosity.

One of the goals of learning mathematics according to NCTM is learning to communicate that is mathematical communication (Gordah and Astuti, 2013). Mathematical communication is a way for students to express mathematical ideas either orally, written, drawing, diagrams, using objects, presenting in algebraic form, or using mathematical symbols (NCTM, 2000; Hirschfeld and Nebraska, 2008). Through communication skills, students can convey their ideas to teachers and to other students which means that students' communication skills must be improved (Fahradina, Ansari and Saiman, 2014). Another opinion states that the ability of students' mathematical communication is very necessary to be developed, because through mathematical communication students can perform the organization of mathematical thinking both orally and in writing (Suhaedi, 2012). The reality in the field shows that students' mathematical communication ability in Indonesia is still low (Prayitno, Suwarsono and Siswono, 2013).

One aspect of learning is the cognitive aspect. The expected learning outcomes of this aspect is the ability of mathematical communication. Having the ability to clearly communicate mathematical ideas is one of the capabilities contained in Permendikbud year 2016 Number 21 for elementary level of junior high school students (Kemendikbud_RI, 2016). The idea of mathematics can be clearly communicated, if students already have a good mathematical understanding. The mathematical communication ability of the students reflects the level of understanding of mathematics and the location of the learners' misconceptions (NCTM, 2000). The ability of mathematical communication is the ability to reflect

understanding of mathematics and is the power of mathematics (Syaban, 2008). Therefore it is important for teachers to know the students' mathematical communication skills in mathematics learning. By knowing the students' mathematical communication ability, the teacher can trace and investigate the level of mathematical understanding and the location of the learners' concept mistakes that can be used as the source of information and reference materials in the selection of appropriate learning model.

Mathematical communication is one of the studies in the development of mathematics curriculum in schools. Mathematics learning in class (NCTM, 2000) should enable students to: (1) organize and consolidate mathematical thinking and communicate to other students; (2) expressing mathematical ideas coherently (logically arranged) and clear to other students, teachers, and others; (3) increasing or expanding students' mathematical knowledge by thinking of the thoughts and strategies of other students; (4) using mathematically correct language in various mathematical expressions.

Based on the aspects of mathematical communication capabilities formulated by NCTM above, there are four steps that have been adapted to the ability of mathematical communication, among others: (1) investigation, namely the ability of students in conducting investigations to solve math problems both in writing that students can conduct an investigation about what is known and asked in the problem to solve the problem, (2) analysis, ie the ability of students in explaining, writing with symbol/notation, or making sketches or drawings of mathematical ideas to solve problems, (3) evaluation, ie the students' ability to evaluate mathematical ideas and (4) inference, ie the ability of students to communicate again the answer.

Mathematical communication can assist students in improving understanding, establishing mutual understanding, empowering students as learners, providing a comfortable learning environment, and assisting teachers in identifying students' understanding and misconceptions so as to find ways to guide students (Mckenzie, 2001). Recognizing the importance of mathematical communication skills so as educators need to seek learning by using approaches that can provide opportunities and encourage students to practice communication skills.

Students experience difficulties in learning mathematics, so researchers interested in finding solutions to help students who have difficulty learning math by using the concept of scaffolding strategy. Scaffolding provided by teachers/students who are more able to students who have difficulty that is by providing a large number of assistance at the early stage and gradually reduced assistance until eventually they released and able to solve their own (Anghileri, 2006). Scaffolding helps students who have difficulty reaching the expected goals and help students think in solving difficult problems to the most difficult (Wood, Bruner and Ross, 1976; Waiyakoon, Khlaisang and Koraneekij, 2015). Scaffolding is provided to help students build an understanding of new knowledge and processes (Stone, 2004).

Permendikbud year 2013 Number 65 mentions in the standard of basic and secondary education process that to encourage students to produce creative and contextual work, both individual and group, it is suggested to use learning approach which produce work based on mathematical communication (Kemendikbud_RI, 2013). In relation to the project based learning process, when working within the team, students discover the skills of planning, organizing, negotiating and making task issues to be worked on, who is responsible for each task and how information will be collected and presented (Ngalimun, 2015). If it is difficult for students to solve it themselves it is necessary to provide full and continuous learning assistance, in this case scaffolding help students build an understanding of new

knowledge and processes (Bature and Jibrin, 2015; Qamar and Riyadi, 2016).

The objectives of this research are (1) to test the effectiveness of Scaffolding-based project Based Learning model in improving mathematical communication ability, and (2) to describe mathematical communication skill and curiosity character of students through project based learning model with Scaffolding.

METHODS

This research includes mixed methods using sequential explanatory models by combining quantitative methods and qualitative methods in sequence (Creswell, 2015). Quantitative methods in this study are used to determine the effectiveness of project based learning with scaffolding. Learning device is used for research that is syllabus, teaching materials, RPP, LKS, and test of mathematical communication skill which have been validator for validation then used in research. The population in this study is all students of class VII of State Junior High School 18 North Halmahera in the even semester of Lesson 2016/2017. Determination of research subjects using purposive sampling technique. In this research is taken one sample class as experiment class. Furthermore, the experimental class is given a questionnaire of curiosity, project based learning treatment and given a test of mathematical communication ability.

Data collection techniques in this study consisted of: observations, questionnaires, tests, and interviews. Analysis of quantitative data is by using the average test of mathematical communication using t test, classical mastery test using Z test, average difference test using independent sample t test, influence test using multiple regression test and improvement using gain test. While the qualitative data analysis is done by reducing the data, presenting the data, and drawing conclusions from data that has been collected and verify the conclusion.

RESULTS AND DISCUSSION

This research is described based on the results of research in the following two stages, namely quantitative and qualitative. Both stages of the study were conducted to answer the problem formulation. Prior to conducting the research, a test of validition learning devices with an average grade of 4.17 or belonging to either category The validators' assessment result of learning tools can be seen in table 1 below. In the quantitative research phase, the researchers tested the effectiveness of project based learning with the help of scaffolding on the students' mathematical communication ability through the completeness test and the average difference test.

Table 1. Assessment Results of Learning Devices

Learning Media	Mean	Criteria
Syllabus	4.24	Excellent
Lesson Plan	4.05	Good
Student Worksheet	4.17	Good
Teaching Suplement	4.21	Excellent
TKKM	4.11	Good
Interview Guidelines	4.2	Excellent
Questionnaire	4.22	Excellent
Observation Sheet	4.17	Good

A class is said to be complete learning (classical completeness) if in the class there are ≥ 75% of students who have completed learning. This test is conducted to find out whether the value of TKKM students who get a minimum of more than or equal to KKM reaches at least 75%. With: n = 30; $\pi\_0 = 0.75$; x = 25. So we get the value of $z_{count} = 1.89$. Compared to $z_{table} = 1.64$ with error level 5% or 1.054 > 1.64, then the proportion of students who score TKKM more than or equal to KKM = 70 has exceeded 75%. The results of previous research also revealed that students who were given treatment project based learning complete classically that has exceeded the value of 70% (Dewi and Mulyono, 2017).

Test the difference in mean ability of mathematical literacy. Based on the calculation result, the mean score of students in the learning class of project based learning model with scaffolding is 80 and the average score of students in the class with expository learning is 75. So $t_{count} = 2{,}002 > t_{table} = 1.67$. This means that the average mathematical communication ability of the students taught by project based learning model with scaffolding help is more than the average of students' mathematical communication skills taught by other learning.

The effectiveness of the scaffolding-assisted project based learning model in this study is supported by previous research findings that the project based learning model produces better mathematics learning outcomes than conventional learning modelsn (Thomas, 2000; Prabawa and Zaenuri, 2017). Giving scaffolding one of the efforts that need to be developed by teachers so that students' thinking ability in learning mathematics can be improved (Kurniasih, 2012).

Based on the results of the examination of mastery learning, groups of students with PJBL learning scaffolding assisted average TKKM reach Minimum Exhaustiveness Criteria (KKM). While based on the classical completeness test shows that the group of project based learning with scaffolding assisted to achieve classical mastery. These results are supported by previous research on project based learning which emphasizes the effects of the project based learning model on influencing academic achievement (Bilgin, Karakuyu and Ay, 2015).

Based on the difference test the average of two classes given treatment with the control class showed that the class given treatment of project based learning model with scaffolding aid is better than the control class. From the end result the average ability of the experimental class is 80 while for the control class is 75. Thus, the average of the experimental class is greater than the control class. In accordance with the opinion that the learning model of project based learning which is centered on the learner, provides an opportunity for the learner to investigate the topic of the problem, making the learner more autonomous, so as to develop his own knowledge and learning be more meaningful (Fathurrohman, 2015).

Multiple regression test is used to see how the influence of the character of curiosity and mathematical communication skills to students' mathematical communication ability. Obtain R square value of 0.931 or 93.1%. So it can be concluded that curiosity and mathematical communication skills affect the ability of mathematical communication of 93.1% and amounted to 6.9% influenced by other variables.

Based on the result of gain calculation is known that in classical increase of curiosity character and student's mathematical communication skill. At the first meeting to the sixth SA1, SA2, ST1, ST2, SB1, SB2 are 0.60; 0.59; 0.59; 0.64; 0.50; 0.42 including medium category; and also the improvement of mathematical communication skills in selected students computed by the first meeting gain index until the sixth SA1, SA2, ST1, ST2, SB1, SB2 were 0.72; 0.79; 0.67; 0.50; 0.50; 0.48 including high and medium category. This is consistent with the assertion that if students' mathematical communication skills are good then they will produce good mathematical communication skills as well (Septiani, Sukestiyarno and Suyitno, 2013). Visually, the score of students' curiosity increased for the whole meeting is shown in Figure 1 below.

Figure 1. Curiosity Increase

Characteristics of mathematical communication skills are seen from step by step. At the Investigation stage, upper and middle

group students have been able to write down what is known and asked according to the problem correctly, but for the lower group sometimes what is written is not in accordance with the problem. The analysis stage, the students in the upper group as well as the middle group have been able to write the relation of the mathematical idea that is relevant to the problem using the term/symbol of mathematics and picture, in contrast to the students in the lower group which sometimes still not right in writing the relation of mathematical idea relevant to the problem of using the term/symbol mathematics.

Furthermore the evaluation stage (evaluation), students can write the answers that match the purpose of the question. High group students can meet this stage, while middle and lower group students can write answers but sometimes not appropriate/exact with the purpose of the question. For the last stage, the inference, where students can make a written conclusion using their own language and in accordance with the purpose of the question. Most students can fulfill this stage, although some still do not fit the purpose of the problem, especially students in the middle and lower groups.

Characteristics of mathematical communication of experimental class students showed good results every stage of the mathematical communication process, from the upper group, the middle is relatively the same but in the lower group is still lacking. The ability of written mathematical communication can help students in conveying ideas to explain strategies, improve knowledge in writing algorithms, and generally able to improve cognitive abilities (Kosko & Wilkins, 2010).

Figure 2 shows the results of the upper group work. Figure 2 shows the ability of mathematical communication at the stage of investigation, analysis, evaluation and conclusion, is good. SA1 appears to have been identified and questioned correctly, and SA1 also writes, or sketches / drawings of mathematical ideas related to the problem, and is able to communicate back the answer by writing the conclusions using the language itself correctly.

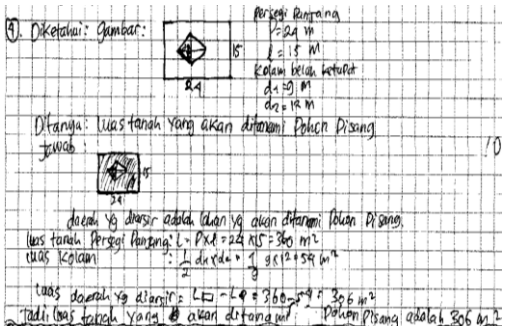

Figure 2. Subject SA1 work

The following is the result of the middle group students' work, ST1, and is presented in Figure 3 ST1 shows the mathematical communication ability at the stage of investigation, analysis, evaluation and conclusion, is good. Similar to the SA1, it also appears that ST1 writes are known and questioned correctly, writes with sketches the mathematical ideas relating to the problem, and is able to communicate back the answer by writing the conclusions using the language itself correctly.

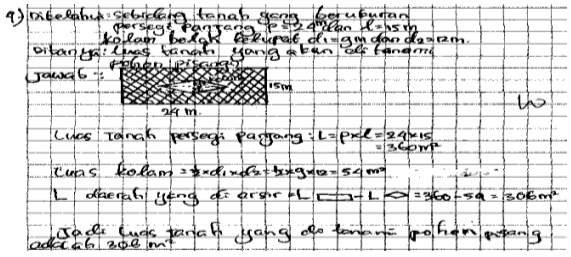

Figure 3. Subject ST1 work 4

Then the results of lower group analysis conducted by SB1 subjects on figure 4 showed a lack of mathematical communication ability.

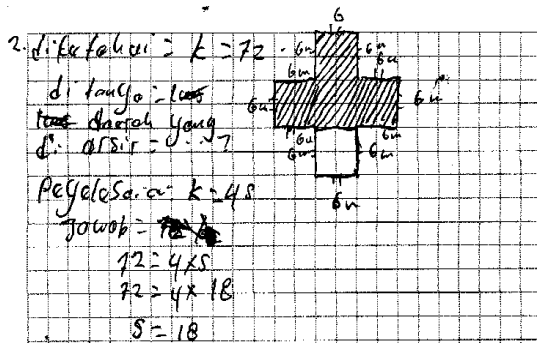

Figure 4. Subject SB1 work

Figure 4 shows that the ability of SB1 subjects is still very poor, apparently the result of the work for the inquiry stage, not in accordance with what is asked of the question. So even though SB1 sketches the picture, it cannot answer the problem yet. Overall, the results of work for the later stages will be influenced by the results in the previous stage. Thus, students' ability to analyze, evaluate and conclude cannot be done.

The characteristics of curiosity in each student were observed differently. The upper group tends to have a good curiosity character ie students with a good curiosity character will seek to obtain information or complete their work. This result is in line with the perspective that teachers need to create a learning process that can involve students with their various characteristics so as to encourage students' curiosity (Heni, Sukestiyarno and Widodo, 2014).

CONCLUSIONS AND SUGGESTIONS

Based on the analysis of research results, students 'mathematical communication ability in scaled-up project based learning model in State Junior High School 18 North Halmahera concluded that project based learning model with scaffolding assisted effectively on students' mathematical communication ability and good mathematical communication characteristics. Characteristics of mathematical communication skills and curiosity of students have increased. The scaled-down project based learning model can be used as an alternative learning model for teachers to be applied in the classroom in order to improve students' mathematical communication skills.

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