Students' Mathematical Communication Ability and Self-Efficacy using Team Quiz Learning Model

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Abstrak
Penelitian ini bertujuan untuk mengetahui peningkatan kemampuan komunikasi matematis dan *self-efficacy* siswa melalui model pembelajaran *team quiz*. Penelitian ini merupakan penelitian ekperimen dengan desain *pre-test post-test control group*. Populasi dalam penelitian ini adalah siswa kelas VII pada salah satu SMP di Banda Aceh dengan mengambil sampel dua kelas melalui teknik *simple random sampling*. Pengumpulan data dilaksanakan dengan menggunakan tes kemampuan komunikasi matematis dan angket *self-efficacy*. Uji statistik yang digunakan adalah uji-t berpasangan dan uji analisis varians dua jalur. Berdasarkan hasil penelitian, diketahui bahwa: (1) Peningkatan kemampuan komunikasi matematis siswa pada kelas model pembelajaran *team quiz* lebih baik daripada siswa pada kelas konvensional; (2) Peningkatan *self-efficacy* siswa pada kelas model pembelajaran *team quiz* lebih baik daripada kelas konvensional; (3) Tidak ada interaksi antara model pembelajaran dengan level siswa terhadap peningkatan kemampuan komunikasi matematis siswa; dan (4) Tidak ada interaksi antara model pembelajaran dengan level siswa terhadap peningkatan *self-efficacy* siswa.

Kata Kunci: komunikasi matematis, *self-efficacy*, model pembelajaran *team quiz*

Abstract
This research aims to examine the improvement of mathematical communication skills of the students who learn using the team quiz learning model. This is an experimental research with pretest-posttest-control group design. The population of this study is all of the seventh-grade students in one of the junior high schools in Banda Aceh. We use a simple random sampling technique to obtain two classes as the research samples. The data were collected using tests of mathematical communication skills and self-efficacy questionnaires. The statistical tests used in this study were the paired t-test and two-way ANOVA. The results show that: (1) The improvement of the students' mathematical communication ability in the team quiz class is higher than the conventional class; (2) The improvement of the students' self-efficacy in team quiz class is higher than the conventional class; (3) There is no interaction between the learning model and the student level towards the students' mathematical communication ability; and (4) There is no interaction between the learning model and the student level towards the students' self-efficacy.

Keywords: mathematical communication, self-efficacy, team quiz learning model

INTRODUCTION

The National Council of Teacher of Mathematics (NCTM) suggests that communication skill is essential in mathematics learning (NCTM, 2000). Hirschfeld-Cotton (2008) argued that the communication process helps to build meaning. When students are confronted with their reasoning and communicating their ideas, they will

develop the real concepts of understanding. Thus, the communication skill is fundamental in mathematics learning.

Students should be skilled in three domains, namely: cognitive, affective and psychomotor domain. In this study, we investigate two domains, namely the cognitive and affective domain. The mathematical communication ability is the cognitive domain examined in this study, while the self-efficacy belongs to the affective domain. Marlina *et al.* (2014) explained that self-efficacy is a belief required by students for their knowledge to be useful. Bandura (2015) emphasized that the higher self-efficacy of the students, the higher the goals they set for themselves. The students' success or failure is affected by how they believe in their own ability. This is supported by the earlier opinion of Bandura (1989) which stresses that the students' belief in their ability has a great impact on their behavior and motivation, which in turn have an impact on their success or failure.

It is the fact that Indonesian students lack mathematical communication skills. Permata *et al.* (2015) found that students' mathematical communication ability has not developed yet. Furthermore, a study conducted by Karlimah & Lestari (2014) identified that some students have limited mathematics communication skills. Handayani *et al.* (2012) revealed that most students are having difficulty communicating mathematical ideas. Sukoco & Mahmudi (2016) also found that students are anxious when the teacher asks them to explain their answers, students had worried of the wrong answer and not being able to explain their results well in front of the class. Based on previous studies mentioned and students' answers, it can be concluded that students' mathematical communication and self-efficacy need a major attention. This is in line with the finding of the previous study conducted in SMP N 7 Banda Aceh, one of the junior high schools in Banda Aceh, when the students responded to the following questions.
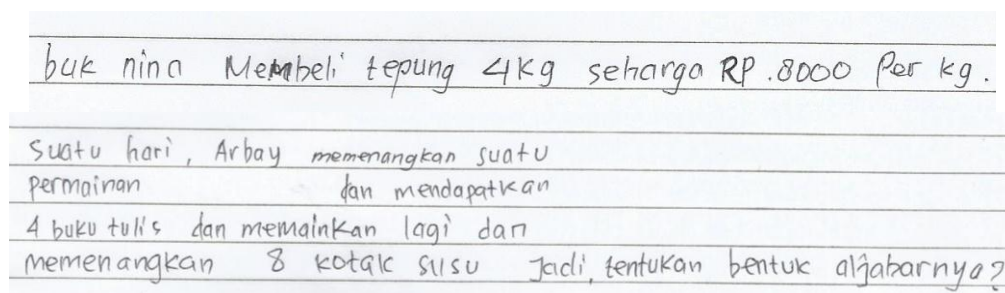
1. Use any variable to write the algebraic form of each of the following sentences.
   a. One day, Mr. Veri bought two bags of rice for the need of circumcision party at home; Mr. Veri's wife thought that rice was not enough. Then Mr. Veri bought another 5 kg. State the story in algebra!
   b. Mr. Tohir's age is three times Udin's age and in the next 10 years, they are 72 years.
2. Create a meaningful story for the algebraic form 4x + 8. Clarify the variable meaning of the story you create.

Some of the students' answers presented in Figure 1 and Figure 2.

Figure 1. Students' answer to Problem 1

Figure 2. Students' answer to Problem 2

The students' answers to Problem 1 indicate that they have problems in declaring a daily-life event in mathematical language or symbols (See Figure 1), while based on the student's answer to Problem 2, it is indicated that the students have problems in explaining ideas, situations, and mathematical relations both orally and written using real objects, images, graphs, or algebraic forms (See Figure 2). The problems were administered to 60 students, and most students had difficulties in communicating mathematical ideas. Therefore, it is important to develop the communication ability because the effective communication learning can increase the students' confidence both in the classroom and in the social life.

One of the efforts used to overcome the problem is by implementing a team quiz learning model. Team quiz is a learning model that may improve responsibility in the learning in an enjoyable and fearless way. Silberman (2001) argued that the procedure used in the learning using team quiz model is as follows:
1. Choose the topic and then presented in three parts;
2. Divided the students into 3 group;
3. Explain the format of the learning and start teaching. Limit the presentation of the material to 10 minutes in less;
4. Ask the group to prepare the quiz requiring a short answer. This quiz should not take a long time to prepare. Team B and C should carefully spend the time to review their note;
5. Team A gives the quiz to team member B. If team B cannot answer, team C is given a chance to answer it;
6. Team A goes on to the next question to the team member C, and repeat the process;
7. When the quiz is complete, continue with the second part of your lesson, and choose team B as the quiz leader; and
8. Once team B completes the exam, continue with the third section and choose team C as quiz leader.

We have experienced in applying the team quiz learning model to the previous research. The team quiz learning model is one of the approaches that can be used to overcome the problems mentioned before. However, in this study, the result of the students has not reached the passing grade. This occurred due to some factors such as teachers not being used to apply the team quiz learning model, teachers were confused about teaching using the 2013 curriculum, classroom atmosphere, and the influence of peers, the method used, and the time spent in the study (Junita, 2014). Students also had difficulty in creating a problem as students did not understand how to create one. Although the students' learning outcomes have not reached the passing grade, it was reported that students' enthusiasm during the learning activity was quite

high. Therefore, we decided to re-use the team quiz learning model in this research but with some enhancement like introducing how to make a good mathematics question, giving some pretest to make them get used to the method atmosphere and giving more time for the student.

The study carried out by Lovenidiana & Rahaju (2014) identified that students' mathematical communication skills both oral and written are categorized as satisfactory by using model quiz teaming. However, the study did not link mathematical communication and self-efficacy. This study aims to determine the improvement of mathematical communication skills and self-efficacy of students through the team quiz learning model. The null hypotheses for this research are there is no difference in the improvement of mathematical communication skills and self-efficacy of students who learn to use team quiz learning models than students who are taught conventionally. Therefore, the research problems of this study are: (1) Whether the improvement of students' mathematical communication skills learning using team quiz learning model is higher than the improvement of students' mathematical communication skills using conventionally learning? (2) Whether the self-efficacy of students learning using team quiz models higher than the self-efficacy of conventional learning students? (3) Is there an interaction between team quiz learning model and student level (high, medium, low) towards the students' mathematical communication skills? (4) Is there an interaction between the team quiz model and the level of students' self-efficacy?

RESEARCH METHOD

This study is an experimental research. It implemented the team quiz model to examine the enhanced mathematical communication skills and self-efficacy. The research design used was a pretest-posttest control group design. This design uses pretest and posttest, and the selection of experimental and control class is randomly assigned, where the class is chosen based on the initial test (Creswell, 2013). The population in this study is the seventh-grade students in one of the junior high schools in Banda Aceh that under researcher supervision.

The instrument of mathematical communication ability used in this study was developed as a description problem using indicators adapted from NCTM (2000) and Ansari (2016). The indicators are: (1) communicating mathematical thinking coherently and clearly to peers, teachers, and others, (2) reading written mathematical presentations and composing relevant questions; (3) explaining ideas, situations, and mathematical relations orally or in writing with real objects, images, graphs or algebraic forms; (4) using mathematical language to convey mathematical ideas appropriately; (e) declaring everyday events in mathematical language or symbols. A problem created was validated by experts to obtain feedbacks including the content validation and language issues. Researchers then revised the problems in accordance with the input provided by the validators. A non-test instrument also used in this study, self-efficacy questionnaire adapted from May (2009) was used. The instrument met the requirement of reliability, with the Cronbach's Alpha of 0.93.

The validity test result of the students' mathematical communication ability test is valid. The reliability is 0.4 and it has different distinguishing power, namely: three problems in the satisfactory category and two problems in the outstanding category. The level of difficulty of problems is also varied that is three problems in the difficult category and two problems in the medium category.

The data analysis used in this study was calculating the pretest, posttest and N-gain score. The N-gain score is a data that is used to analyze the improvement of students' mathematical communication skills so that it can be seen as an increase in both classes. The normality and homogeneity test for the pretest and N-gain score were initially conducted. An independent sample t-test was then carried out to examine the average difference of pretest and N-gain. The average difference of pretest is examining to determine the mathematical communication skills and self-efficacy of each student between the two groups. Two-way ANOVA was also conducted to examine the interaction between the learning process and the student level. The self-efficacy data were converted into interval data using the Method of Successive Interval (MSI) before being analyzed.

The specified criteria for a posed problem that students' made can be seen in Table 1.

Table 1. The criteria for dividing the posed problems into categories

Category	Criteria
Weak	- Lack of understandable problem text. - Incomplete problem. - Lack of question expression. - Unclear expectations. - Lack of connection between the real life and the other ones given at the problem and in conclusion the problem is too complicated. - Being an exercise type problem which is very easy to solve.
Average	- Although the problem text is understandable, lack of using necessary mathematical expressions. - Having ambiguous expression in problem texts. - It is not possible to solve the problem with the information provided in the problem. - In problems which require figures, although the problem text is clear and understandable, there is an inconsistency between the figure and the text. - Being an exercise type problem.
Good	- Having a clear and understandable problem text. - Being suitable to mathematical principles. - Stating clearly what the problem is asking. - The problem is solvable.

Source: Kaba & Şengül (2016)

RESULTS AND DISCUSSION
The Analysis of Students' Mathematical Communication Skills

The results show that the average pretest of mathematical communication skills of experimental and control are 11.48 and 11.33 respectively (the ideal score is 20). This indicates those students' communication skills in both classes before the learning is relatively equal.

The normality test results of N-gain mathematical communication skills of both classes show that the data are normally distributed. Furthermore, the mean difference was conducted using the Kolmogorov-Smirnov test with a significant level of 0.05. H_0 is accepted if the significance level is less than 0.05. The mean difference of N-gain mathematical communication skills is shown in Table 2.

Table 2. The mean difference of N-gain mathematical communication skills

t-test for Equality of Means			Output	Conclusion
t	Df	Sig. (2-tailed)		
2,186	52	0. 033	H_0 is rejected	There is a significant difference

Based on Table 2, it is indicated that the significant value (two-tailed) is 0.033 meaning that the significant value of one-tailed is 0.017. H_0 is rejected (0.017 < 0.05), it can be concluded that there is a significant difference in the students' mathematical communication skills taught using the team quiz learning model than those in conventional learning. There are several factors that contribute to the improvement of mathematical communication ability in the two different classes. In relation to the learning model used, the experimental class had more privileges in the learning, because students are taught to communicate their ideas systematically and correctly. The control class has none of these advantages. This shows that the learning model of team quiz contributes to the improvement of students' mathematical communication skills. This finding is in line with Purnama & Afriansyah (2016) study results reported that students' mathematical communication skills with the cooperative learning of complete sentence and team quiz are in the medium category (satisfactory).

The descriptive analysis of students' mathematical communication ability abilities based on the initial mathematics ability in both classes is presented in Table 3.

Table 3. Descriptive statistics of students' mathematics communication

Initial Ability	N	Experiment Class						N	Control Class					
		Pretest		Posttest		N-gain			Pretest		Posttest		N-gain	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
High	6	11	2,53	19,33	3,50	0,99	0,38	5	11,8	1,30	17,4	1,52	0,65	0,23
Medium	17	11,8	1,91	18,41	2,15	0,81	0,28	18	11,5	1,95	17,5	1,98	0,72	0,29
Low	4	10,8	2,63	19,25	0,96	0.86	0,21	4	10	1,63	16	2,94	0,62	0,3
Sum	27	33,6	7,07	56,99	6,61	2,66	0.87	27	33,3	4,88	50,9	6,44	1,99	0,82
Ideal Maximum Score = 20														

Differences in the improvement of mathematical communication skills between students taught using team quiz model and conventional may be due to different characteristics of the two lessons, wherein the learning of team quiz model there is activity making quiz questions, and the quiz question is made by students after teachers teach how to make a good question. Students are also required to understand the material that has been shared for each group so that students can check whether the answers by other groups correct or not. This activity can improve the ability of students' mathematical communication. Problems created by students are written in origami paper to be given to other groups. Each group makes at least 3 different questions. Here is an example of some questions posed by students (see Figure 3).
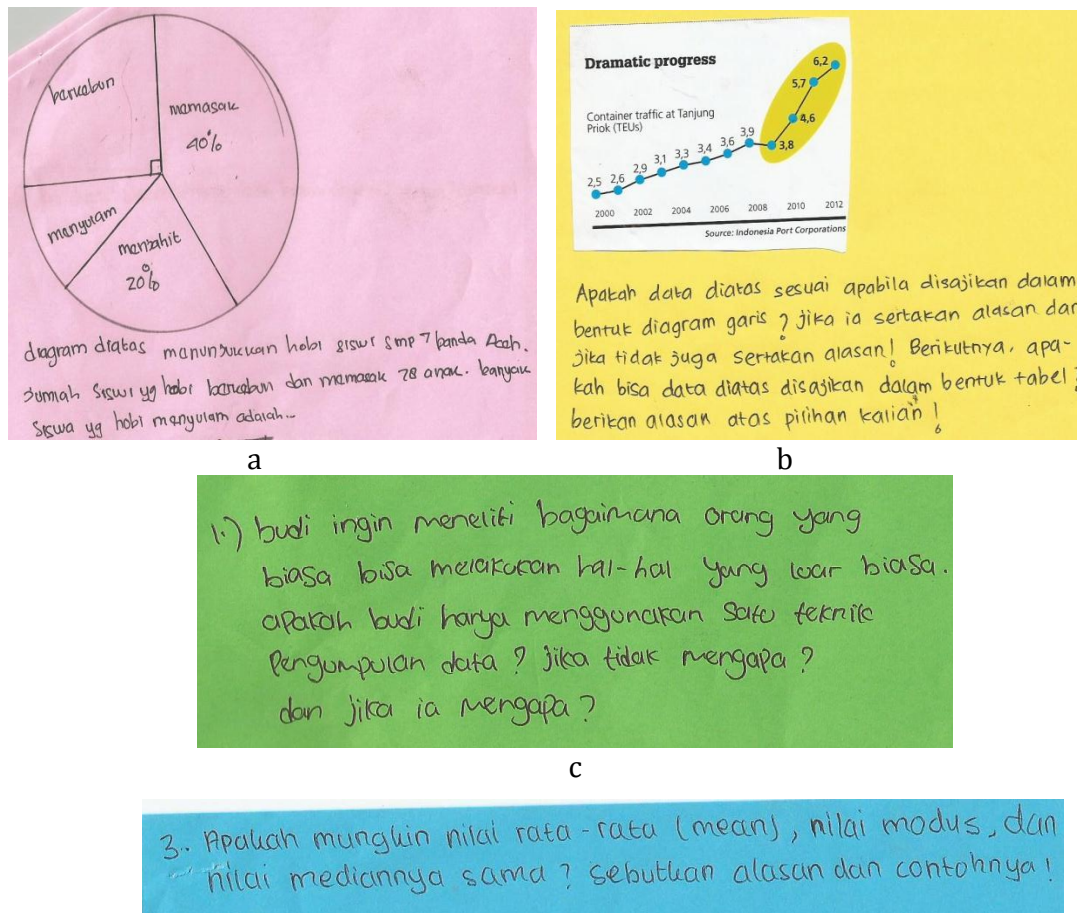
a

b

c

Figure 3. Example of some questions posed by students

From Figures 3.a and 3.c, the mathematics item that the students make is in the average category, which is identical to the mathematics item in the textbook. Although the problems made are understandable the required mathematical expressions are less challenging. While the problem in Figure 3.b and 3.d are in the good category, because the problem posed is clear, can be completed, and in accordance with mathematical principles.

The Analysis of Students' Self-Efficacy

The self-efficacy data was obtained from the self-efficacy questionnaire administered before and after the treatment in both experimental and control class. The descriptive analysis of self-efficacy in both classes is presented in Table 4.

Table 4. Descriptive statistics of students' mathematics self-efficacy

Class	N	Test	Max score	Min score	$\bar{x}$	SD
Experiment	27	Before	43	24	30	5,73
		After	29	19	27,83	7,22
Control	27	Before	38	19	27,53	5,73
		After	48	21	32,6	7,13

The values in Table 4 indicates that mathematical self-efficacy in both control and experiment class is relatively equal. The higher score represents high self-efficacy.

The results of N-gain data analysis for both classes show that the data are normally distributed and has homogeneous variance. Furthermore, the mean difference was analyzed using the Kolmogorov-Smirnov test with a significant level of 0.05. The testing criterion is accepting H_0 if the Sig. is less than 0.05.

Table 5 shows the value of Sig. (2-tailed) is 0.00 and less than 0.05, meaning that H_0 is rejected. This result indicates that the increase in self-efficacy of students taught using team quiz learning models is significantly different from those in the conventional class. The self-efficacy gain is higher in the class using quiz learning model.

Table 5. N-gain difference test results increased self-efficacy

t-test for Equality of Means			Output	Conclusion
t	df	Sig. (2-tailed)		
7,332	52	0.000	H_0 is rejected	There is a significant difference

The increased self-efficacy of experimental class students is due to the fact that students were taught to learn in a structured and meaningful way. This is in line with the findings of Moores *et al.* (2006) suggested that self-efficacy has a strong impact on declarative knowledge, for example, for simple tasks self-efficacy can be a good measure of performance.

The Analysis of Interaction between Teaching Model and Student Level
The Analysis towards Mathematical Communication

Once it was identified that the N-gain group of experimental and control class were normally distributed and has a homogeneous data variance, the two-way ANOVA was carried out to examine the interaction between the teaching model and student level on the improvement of the mathematical communication skills. The results are presented in Table 6.

Table 6. Interaction test results between teaching model and student level on improving mathematical communication skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Learning	0.459	1	0.459	5.542	0.023
Level	0.360	2	0.180	0.218	0.805
Learning * level	0.130	2	0.065	0.783	0.463

Table 6 shows that the value of significant value is greater than α (0.463), indicating that H_0 is failing to reject. This means that there is no interaction between the learning model (teams quiz and conventional) with student level (high, medium, and low) toward the improvement of students' mathematical communication skills. The interaction graph is presented in Figure 4.
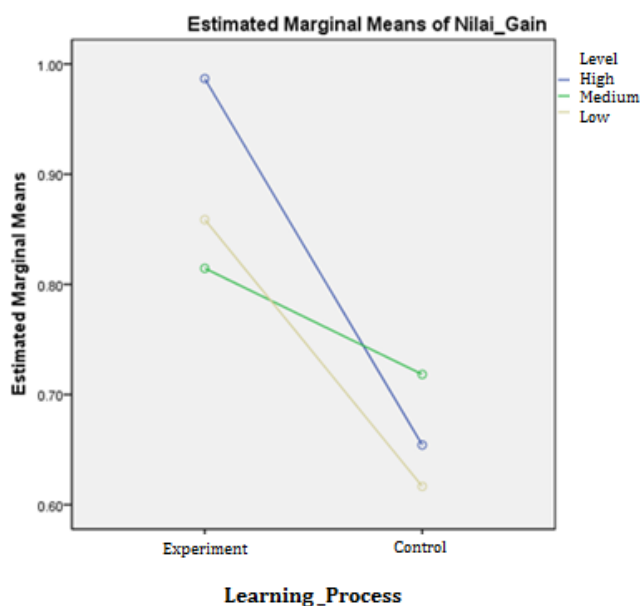
Figure 4. The interaction between teaching model and student level on improving students' mathematical communication skill

Figure 4 shows that there is no interaction between the learning model (teams quiz and conventional model) and student level (high, medium, low) to the improvement of students' mathematical communication skills. In other words, the learning model does not interact with the level of student's initial ability in influencing the improvement of students' mathematical communication. This indicates that there is an increase in the mathematical communication of students at all levels, including high, moderate, or low-level students after the implementation of the learning model team quiz. One of the reasons is that during the learning with the team quiz model the students have been trained to communicate their ideas either orally or in writing. This is in line with the results of the study conducted by Sabil & Winarni (2013) and Sofyan & Sukandar (2015).

The Analysis towards the Self-efficacy

Two-way ANOVA was also carried out to investigate the interaction between the teaching models with the student level towards the student's self-efficacy. The results are summarized in Table 7.

Table 7. Interaction test results between teaching model and student level towards student self-efficacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Learning	0.511	1	0,511	60,003	0.000
Level	0.168	2	0.084	9,876	0.000
Learning * Level	0.011	2	0.006	0.653	0.525

The table indicates that the significant value is 0.525 (greater than 0.05) and therefore H_0 is failed to reject. This can be interpreted as there is no interaction between teaching models with the level of students towards the students' self-efficacy.
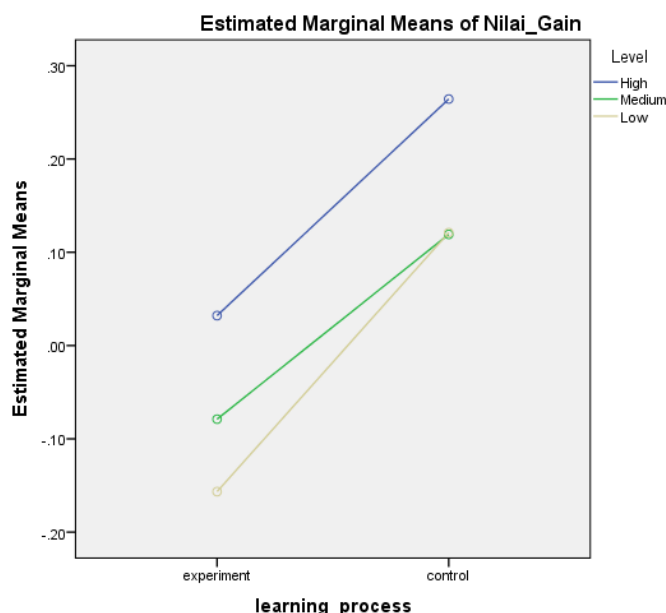

Figure 5. The interaction between learning model and student level towards self-efficacy

Figure 5 shows that there is no interaction between the learning model and student level towards the improvement of students' self-efficacy. In other words, the learning model does not interact with the level of student's initial ability in influencing students' self-efficacy improvement. This means that there is an increase in student self-efficacy for all levels, including high, middle, and low-level students after the implementation of the team quiz learning model.

CONCLUSION

Based on the results of the study, it can be concluded that: (1) the improvement of mathematical communication skills of students taught using team quiz model is higher than those who experienced conventional learning; (2) the increase in self-efficacy of students experiencing team quiz model is higher than those in conventional learning; (3) there is no interaction between the learning and the level of students towards the improvement of students' mathematical communication skills; (4) there was no interaction between the learning and the student level on students' self-efficacy. In addition, further study is required by taking into account that: (1) The team quiz model improve students' mathematical communication and self-efficacy of in this study, therefore, this learning should be continuously developed to examine the impact of this learning model in other research; (2) Further research is expected to develop the instrument tools to analyze the students' skills in arranging problems and mathematical communication; (3) The possible obstacles in the implementation of learning with the team quiz model at the beginning of the learning need to be anticipated by the teacher, students also need to be trained in expressing their ideas; (4) The research related to students' self-efficacy in this study is limited to five

meetings only and therefore, it is necessary to conduct the research over a longer period to examine the factors influencing students self-efficacy.

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