Two-stay two-stray model on improving mathematical communication skill of elementary school students

E Suwangsih1, *, M R Budiarti1, K Ruskandi1, Y Hendawati1 and N W A Majid2

1 Study program of Elementary School Teacher Training, Universitas Pendidikan Indonesia, Indonesia
2 Study Program of System and Information Technology Education, Universitas Pendidikan Indonesia, Indonesia

*ernasuwangsih@upi.edu

Abstract. The basis of this research is to observe the importance of improving the mathematical communication skill of elementary school students. In this case, this research attempted to discover learning alternative that could improve mathematical communication skill of students by employing Two-Stay Two-Stray (TSTS) cooperative learning model. This research aimed to examine students’ mathematical communication skill and mathematics learning improvement by employing TSTS model. The employed method was a quasi-experiment of the non-equivalent pretest-posttest control group design. The participants for this study were the 5th-grade students of one of the public elementary schools in one of the districts in Purwakarta Regency. In this study, 26 students were employed as participants for each experimental and controlled group. This research discovered that: 1) students’ mathematical communication skill improvement that was taught using TSTS learning model was higher compared conventional model; 2) TSTS model was found influencing the improvement of students’ mathematical communication skill; 3) students’ mathematics learning activity and process was more active and improved with TSTS model.

1. Introduction
Mathematical communication is one of the skills that is explicitly listed in Education Unit Level Curriculum (KTSP, Kurikulum Tingkat Satuan Pendidikan) 2016. Previously, the National Council of Teachers of Mathematics (NCTM) (2013) explained that communication skill is one of the mathematical skills that are compulsory to be acquired by students [1]. It suggests that mathematical communication skill is crucial to be learned by students.

There are two important reasons about why communication skills on mathematics: 1) mathematics is essentially a language and it is more than a support instrument for thinking, finding a pattern, problem-solving, or concluding. Mathematics is a priceless instrument to communicate various ideas clearly, precisely, and simply; 2) mathematics and mathematics learning are at heart, social activities. As a social activity, the interaction between students, as it is for the interaction between students and teachers, is important in developing students’ mathematics potential [2]. Thus, it can be concluded that mathematical communication skill is more than an act of expressing an idea, but it is also a part of students’ ability in expressing and explaining situation, diagram, or real object into a symbolic language, idea, or mathematical model.
Based on the interview with the headmaster and the teachers of one of the elementary schools in Purwakarta Regency, it is revealed that many students are struggling in learning mathematics. In this case, several problems were found, which are: students tend to memorize the formulas of the provided mathematical problems. Consequently, if the sentence delivery of the problem is different, even though it is the same problem, students are having a hard time to solve it; 2) students are struggling to solve real-world problems; 3) some of the students who excel in mathematics are having difficulty in expressing ideas. Therefore, mathematical communication skills should be trained since early age.

TSTS is a cooperative type learning model that is considered suitable to give an opportunity and encourage students to train their mathematical communication skills. TSTS learning model is expected to be an alternative to develop students’ mathematical communication skills. One of the reasons is because TSTS is a learning model that promotes group activities in solving problems. In addition, TSTS model also provides freedom for students to exchange experience and ideas in solving a particular problem, of course, with teacher guidance.

TSTS influences students’ mathematics communication skills improvement [3]. It can be seen by observing the post-test average score ratio at the end of the group study experience, which is the score of 74.06 was obtained by the experimental group while the control group score was 66.5. Based on the problem description, it is suggested TSTS could be the alternative for mathematics learning. By employing TSTS model, the learning process is expected to be more active so that students are not struggling in expressing their mathematical ideas. Moreover, TSTS model implementation is also expected to develop their mathematical communication skill.

2. Literature review
TSTS model is a cooperative learning model that was developed in 1992 by Spencer Kagan. This model could be implemented in all subjects and education levels. In its implementation, TSTS is a learning model that prioritizes group activity in solving problem. In this case, the solution to the problem will be delivered as information by two members of a group to other groups that visit them while the other two members of the group receive information from group that they visit. It can be seen that TSTS model offers each group an opportunity to exchange information with other groups [4]. In this case, the received or delivered information is in a form of the worksheet of each group.

In its implementation, TSTS model has six stages, which are class presentation, grouping, teamwork, two stays, two strays, and reporting team. The advantages of employing the TSTS model is that the learning process will be more communicative, active, and systematic. It will also train students mentally and also demand them to find and deliver information that they get from the other groups so that it will stimulate their sense of responsibility.

Communication skill is essential to be learned by students in order to develop their understanding of mathematics implementation. Mathematics is a language and language is the best topic of the community [5]. Therefore, it is easy to understand that communication is the heart of learning, teaching, and accessing mathematics. In addition, the standard of communication for the first to the seventh grade is mathematics teaching and the emphasis in the following students’ skills [1]:

- Skill to coherently (logically and systematically) and clearly communicate their mathematical thinking to their classmates, teachers, and other persons
- Skill in using mathematics language correctly in expressing ideas
- Skill in organizing their own mathematical thinking through communication
- Skill in analyzing and evaluating mathematical thinking and strategy that are used by others.

On the other hand, students would be shocked if they are asked to present their analysis or explanation of their answer in mathematics learning [6]. One of the reasons is because students are rarely asked to explain their answer in mathematics learning, thus they are not used to talk about mathematics. Therefore, in learning, students are required to get acquainted in presenting arguments of their answers and also in expressing opinion to other students’ answer [7]. Thus, the learning process will be easier to remember.
Mathematics communication skill is not just about expressing an idea, but it also covers students’ skill in expressing, explaining, describing, listening, asking, and cooperating [8]. There are several mathematical communication skills: the ability to express a situation, graphic, diagram, or real object into language, symbol, idea, or mathematical models; the ability to explain idea, situation, and mathematical relation both written and spoken; ability to listen, discuss, and write about mathematics; ability to read with the understanding of written mathematics representation, creating conjecture, developing an argument, formulating a definition, and generalizing; and the ability to re-tell a mathematical description or paragraph in their own words.

Mathematical communication is an asset in completing, exploring, and investigating mathematics and it is also a medium to socialize with their friends, exchanging idea, assessing, and strengthen their ideas to convince others. Mathematics communications skills is an ability to express mathematical ideas, both spoken and written, and the ability to understand and accept mathematical ideas of other students thoroughly, analytically, critically, and evaluative to practice their understanding [9]. Generally, there are five aspects of mathematical communication skills, which are representing, listening, reading, discussing, and writing.

3. Method
Quasi-experiment and nonequivalent pretest-posttest control group design were employed in this study. The pretest was conducted beforehand to discover the samples’ initial skill. Then, the experiment group underwent a learning process using the related model while the control group was experienced learning process using the conventional model. The last process in the research was a posttest to observe the samples final skills.

A public elementary school in Purwakarta Regency of the 2017/2018 period was chosen. In addition, the mathematics class with the main topic of fraction addition and subtraction was also chosen. Moreover, in this research, a non-probability sampling technique with purposive sampling type was employed. The techniques were chosen based of several considerations; 1) the elementary school has been often chosen as a location for learning simulation so that the student's characteristics are already known; 2) the students have skills in mathematical learning and they also have creative ideas. Also, there are four classes of the fifth grade. However, in this research, only two of the classes were chosen as the participant. These two classes are V-B, as the experimental group and V-D as the control group where each of the class has 26 students.

The instrument of the research was a subjective test in form of an essay test with nine problems. Also, there were non-test instruments in form of observation sheets for teachers and students’ activity with non-test instrument documentation. Before the instrument test was employed, a test was also conducted in order to determine the validity, reliability, and difficulty of the instrument test. The instrument test was also in form of descriptive statistics that covers the lowest and highest score, standard deviation, and class average scores in order to assess the skill gap between the two classes. Then, the analysis was conducted followed by inferential statistics process that covers a normality test, homogeneity testing, t-test, normalized gain index test, and the Mann–Whitney U test. In addition to data analysis, observation result calculation of teachers and students’ activities were also conducted with the guideline in the observation sheet and a certain calculation.

4. Result and discussion
Both inferential and descriptive statistical analysis of the pretest and posttest of each group were required before the difference between experimental and controlled groups can be determined. In inferential statistics, normality test was taken to draw conclusions of the pretest data distribution of each group, which was found normal. It was also found that, by using the homogeneity test, the variant of both groups was homogenous. Lastly, the t-test conducted on pretest data revealed that there were no differences of the average score of the mathematical communication skills between the group who employed TSTS model and the group who employed conventional model. Similarly, on the posttest data, the normality test revealed that both of the group distribution was normal. It was also found that
the variants of the groups were homogenous. However, the t-test analysis on the posttest data discovered that there were differences of the student's mathematical communication skill average score between those who employed the TSTS model and those who employed conventional model. The pretest and posttest results of both groups are presented in the following figure:

![Figure 1. Students’ mathematical communication skills pre-test and post-test average score differences.](image)

The above figure shows the posttest result of the students’ mathematical communication skills between the experimental and the controlled group. It reveals that the group who employed TSTS model obtained higher average scores than the group who employed conventional learning method. TSTS learning model influence students’ mathematical communication skills.

The improvement of mathematical communication skill can also be analyzed by implementing the normalized gain index. The recapitulation results of the normalized gain index of both groups are presented in the following table 1:

| Criteria | Model TSTS | Conventional Model |
|----------|------------|---------------------|
|          | Frequency  | Percentage (%)      | Frequency  | Percentage (%) |
| High     | 2          | 7%                  | 2          | 7%             |
| Medium   | 20         | 78%                 | 6          | 23%            |
| Low      | 4          | 15%                 | 18         | 70%            |

By employing the TSTS learning model, it was found that students’ mathematical communication skill was increased. The next analysis was conducted in order to reveal whether the TSTS model influences students’ mathematical communication skill improvement or not. Using simple linear regression, it was revealed that both on pretest and posttest, the experimental group obtained 0.000 significance score, which is lower than the determined significance score of 0.05. This score shows the TSTS model influences the elementary school students’ mathematical communication skill improvement. In addition, the r-square shows the score of 0.706 that indicates TSTS model influences students’ mathematical communication skill improvement by 70.6%. Moreover, the regression test found the $F_{\text{observed}}$ score of 57.651 and $F_{\text{table}}$ score of 2.66. It further shows that $F_{\text{observed}} > F_{\text{table}}$ or 57.651 > 2.66, which suggests that $H_0$ is rejected and $H_1$ accepted. It means that TSTS models have an influence on the improvement of elementary school students’ mathematical communication skills.
It is known that the TSTS model influences the improvement of elementary school students’ mathematical communication skills. For the learning activity that employs the TSTS model, the students learning activity improvement can be observed in the following figure:

![Figure 2. Students’ learning activity improvement that employed TSTS model.](image)

### 5. Conclusion and suggestion

This research regarding the influence of TSTS model on improving mathematical communication skill of elementary school students produces the following conclusions:

- It was found that the TSTS model has a higher result in improvement students’ mathematical communication skill rather than the conventional model. It is proved by pre-test and post-test average scores of the experimental group that is higher than the controlled group. It is also proved by n-gain scored that is considered as medium improvement and Mann–Whitney U test result that obtained the signification score that lower than 0.05, which indicates a difference in the average score skill improvement between the students who employed TSTS model and those who employed the conventional method.

- It was found that TSTS influences the elementary school students’ mathematical communication skills improvement. Based on the calculation, the influence score is quite high so that TSTS significantly influences the improvement of students’ mathematical communication skill.

- It was found that by employing the TSTS model, students’ activities are livelier and positively increase the mathematics learning process. It was proven by fact that every meeting shows a significant increase and makes students’ livelier.

Based on the research, there are several suggestions that the authors would like to present:

- Thorough preparation such as mastering teaching material, preparing an interesting learning process that could arouse students’ curiosity, and carefully planning the timetable so the learning process would be effective and as planned are required for the teachers who plan to implement TSTS model.

- For researchers who are planning to conduct study on TSTS model by measuring the similar skill in the future, it is required to master the subject matter thoroughly, possessing a good class management skill, conducting reanalysis on the skill that is planned to be measured, and preparing more complete and related literature in order to fix the previous study that had been conducted.

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