How Reciprocal Teaching combined to Scientific Approach Works for Students’ Mathematical Communication?

**Agnes Teresa Panjaitan1,\*, Kamid2, Gugun M Simatupang3, and Ariyadi Wijaya4**

1,4Department of Mathematics Education, Graduate School Program

Yogyakarta State University, Indonesia

2,3Department of Mathematics Education,

Universitas Jambi, Indonesia

\*Corresponding author: agnesteresa35@gmail.com

**Abstract.** This research aims to know how is the effect of reciprocal teaching combined to Scientific approach on mathematical communication for transformation material in one of the form International school in Jambi. This type of research is descriptive quantitative. There are three classes analyzed. Two classes taught by reciprocal teaching while the other class was taught by the direct instruction. The data collection techniques used in this study were test and observation sheet to measure both writting and speaking comprehension. The sampling technique used was simple random sampling. The analysis of data used the t test to get the mathematical communication in written expression. The result shows that the students’ mathematical communication in written expression is better than the direct instucction learning. Yet, for the speaking expression, the difference of both classes is not as well as the written expression. To get the valid result, the research must be done by considering the students’ physical and emotional or the period of the learning. In addition, the teacher can also create the learning kits adjusted to the character of the students.Introduction

# Introduction

As stated in the Department of Education Policy in Indonesia, mathematics is one of the main subject required to the students’ graduation. Mathematics has some aspects to concern about. The National Council of Teachers of mathematics states that Communication is an essential part of mathematics and mathematics education. Communication is not only as the essential part of mathematics, but also as one of the the five process standar highlighted by NCTM [1].

Mathematical communication involves a wide range of cognitive skills. It connects both listening and reading (comprehension) and both speaking and writing (expression) [2]. Both are the integral parts that promote deeper understanding of the concept [1][3]. Mathematical communication skill aims to understand, interpret, exspress, respond, and use mathematical symbols to present ideas in oral and written form [3].

Further, the need of communication help the interactions work in classroom between teachers and students or students to peers. Althought, some students come with good communication skill, others still need help to improve this ability [4]. For instance, some kindegarten to graduate students assume incorrect directly when asking to justify the answer. Perhaps, the reason is students had a little opportunity to explain their ideas in mathematics class [5]. Unless the students since the beginning are given encouragement, support, and opportunities to engage in oral communication learn to communicate mathematically [6].

In Fact, students’ achievement in Indonesia for mathematical communication skill is catagorized as low [7][8]. It is also concluded that students were not interested enough to respond the mathematical communication test [9]. As reported in The Third International Mathematics and Science Study (TIMSS) [10], Indonesian students were on the 36th of 48 countries who participated in mathematical communication test, it was related to the other mathematical abilities. Hence, teachers should find the solution about how to create a link between mathematics and language [11]. Teacher must provide the students clarify their thinking and sharpen their understanding to make sense their world through communication [7][12]. Then, the student must be the center of the learning and active in the learning process.

To achieve this skill, the learning provided by teacher requires to adjust to the students. One of which is reciprocal teaching. Reciprocal teaching is a learning that includes instructional procedures. It is proven that Reciprocal teaching could improve the students’ reading comprehension. It is a well structured strategy that increases student comprehension, the four strategies have four stages like predicting, clarifying, solving, and summarising[13]. Based on the summarising strategy requires learners to evaluate how they contributed to the group task. Then, it is shown that students’ self regulated have no differences between the students who accepted the scientic approach and the students who did not. Further, the differences can be seen in mathematical communication aspects [14]. Yet, the dominant students in discussion are the active students only. Consequently, it still need another type of learning to fasilitate student dekoding the words.

In implementation of curriculum 2013, every school tried to change the method of the learning with scientific approach. It is believed that the scientific approach can facilitate the improvement of knowledge, skill and attitudes. Based on Permendikbud No. 103 0f 2014, the activities proved by scientific approach to students are observing problems, questioning, associating, experimenting, and networking. This approach is related to Bruner’s theory, Piaget theory, and Vygotsky learning theories. The four points of Bruner theory connecting to the cognitive process lead to the scientific approach. Through each step of scientific approach, students are highly involved in communicating mathematical ideas to solve the problems.

The communication score inclined based on the low category to the medium category in analogy ability. Most students are familiar with the routine analogy problems which has the strong effect each other. Students who have good analogy skills is good in communication skills. Thus, the analogy and communication skills are very essential to focus on. It is also facilitated in scientific approach [15]. For all steps in Scientific approach, it can be potentially integrated to the steps in reciprocal teaching such as: clariffying and observing, predicting and associating and experimenting, and summarizing with networking. In addition, the characteristics of both expected to highly increase the students communication mathematical while combining both learning process.

### Method

This study was a quantitative descriptive research with posttest only control group. The research design was *completely randomized design.* If the treatment or the degree of one factor to others, the respond of every treatment is randomized variable [16]. Therefore, there are two classes that used Reciprocal Teaching combined to Scientific Approach while one class used the direct instruction learning. The population of the research was the students from the reguler class, grade 7 in the second semester of SMP Negeri 1 Jambi, the form of International school in Jambi, is a state school that have students in the age of 13-15 years in the academic year 2015/2016. The population of the study was VII A – VII H The sampling technique used was simple random sampling. Based on the simple random sampling, the selected classes for experimental class are VII A and VII B, and the control class was VII C. Before determining the sample, the initial data was collecting to know that the sample represented all the population by examining the normality test, homogeneity test on students’ examination. After implementing the Reciprocal Teaching combined to Scientific and Direct Instruction, a posttest was given in the form of mathematical communication test.

The data collection techniques used in this study were test and observation sheet to measure both writting and speaking comprehension. The total number of the tests is five items that included three indicators such as written, drawing, mathematical expression. The topic for the test was transformation. In the observation sheet, there are eight aspects that were checked to comprehend the mathematical communication in speaking expression. The instrument validity was measured by the content validity and the quality of the instrument was measured by the difficulty level and the index of difficult items. Four items were catagorised as valid. The reliability result showed 0.8 that can be interpreted as high. The documentation was the authentic evidence of the research.

1. **Results and Discussion**
   1. *Results*
      1. *Mathematical communication in written expression*

Based on the hypothesis testing, it is shown that the students’ mathematical communication in written expression is better than the learning using direct instruction. The result of the tests can be seen on the tables below

**Table 1.** The hypotesis-test result between The first experimental class and control class

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **class** | ***N*** | ***S2*** | | ***Tcount*** | ***Ttable*** | **Description** |
| 1st experimental class | 38 | | 81.80 | 1.74 | **1,66** | **H1 accepted** |
| Control class | 39 | |  |  |

There was a significant effect for mathematical communical in the 1st experimental class, (*t*(38) = 1.74), with the students in the first experimental class receiving the higher scores than the experimental class ( = 80.00) The result for the second experimental class compared to the control class, it can be seen in the table 2 (*SD* = 9,04)**.**

**Table 2.** The hypotesis-test result between The Second experimental class and control class

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **class** | ***N*** | ***S2*** | | ***tcount*** | ***ttable*** | **Description** |
| 2nd experimental class | 38 | | 125,76 | 1.78 | **1,66** | **H1 accepted** |
| Control class | 38 | |  |  |

The 38 students in the experiment class and the control class demonstrated a significance difference in performance (*t*(38)= 1.78, *SD*= 11.21). As expected, the experimental class has the higher scores than the control class ( =80.46).

After comparing the experimental classes to the control class, both classes were tested by posthoc test to ensure that there is no differences between both experimental classes. The result of the posthoc test can be seen in the table below

**Table 3.** The hypotesis-test result between The Experimental Classes

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **class** | ***n*** | ***X*** | ***S2*** | | ***tcount*** | ***ttable*** | **Description** |
| 1st experimental class | 38 | 80.00 | | 10,4852 | -0.1912 | 1,66 | H0 accepted |
| 2nd experimental class | 38 | 80.46 | |  |  |

The 38 students from the two experimental classes had a mean of 80 points (*SD* = 3.24). The effect of reciprocal teaching combined to scientific approach, therefore, was significant.

* + 1. *Mathematical communication in speaking expression*

The speaking expression observed by the observer in the learning process in experimental and control class, then five observation existed during the research. The average of all the meeting was analysed and showed on the table 4

**Table 4.** The Result of Observation Sheet in Speaking expression

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | **N** | **Mean** | **Criterion** |
| 1st experimental class | 38 | 3.35 | Good |
| 2nd experimental class | 38 | 3.34 | Good |
| Control class | 39 | 3.22 | Good |

It can be concluded by the table, the scores of mathematical communication in speaking expression is higher the control class.

*3.2 Discussion*

Based on the result, the mathematical communication based on the writing expression in both experimental class (using reciprocal learning combined to scientific approach) is higher than the control class (using direct instruction). It is known that 35 students in the two experimental classes passed the passing grade of the test while in the control class, there are 33 students of 39 students can passed the test. It is supported by Muslim [17], the reciprocal teaching has the strengten to train students’ regulated learning, improve students’ ability in sharing their ideas and opinion, improve the mathematical reasoning and conceptual understanding.

The indicators used to measure mathematical communication based on the speaking expression in this research described by the table below:

**Table 5.** The Description of Indicators of the Observation Sheet

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No | | Aspects | Class | | | | | | | | | |
| 1st experimental class | | 2nd experimental class | | | | | Control class | | |
| Mean | Criterion | Mean | | Criterion | | | Mean | | Criterion |
| 1 | Explaining the mathematical  ideas | | 3.37 | Good | | 3.33 | | Good |  | | 3.18 Enough | |
| 2 | Communicating the ideas | | 3.09 | Enough | | 3.33 | | Good | 2.85 | | | Enough |
| 3 | Creating the flowchart | | 3.58 | Good | | 3.58 | | Good | 2.91 | | | Enough |
| 4 | Explaining the mathematical problem | | 3.68 | Good | | 3.68 | | Very Good | 3.12 | | | Enough |
| 5 | Transfering the problem to the modelling | | 2.95 | Enough | | 2.74 | | Enough | 2.72 | | | Enough |
| 6 | Concluding the solution | | 3.54 | Good | | 3.47 | | Good | 3.22 | | | Good |
| 7 | Presenting the symbols and terms | | 3.54 | Good | | 3.56 | | Good | 2.97 | | | Enough |
| 8 | Explaining the definition correctly | | 3.01 | Enough | | 2.88 | | Enough | 2.77 | | | Low |

The five stages such as Observing, Questioning, Associating, Experimenting, and Networking is included in four steps like Predicting, Questioning, Summarizing, and Clarifying should give the inovative way to involve student to be active in speaking. Nevertheless, the study showed that the difference between experimental class and control class is not that high. Yet, it can be concluded, there is still a different value of the mathematical communication in speaking expression. The other factors considered of the learning process is still needed to be found.

1. **Conclusion and Recommendation**

Based on the discussion, this research presented that (1) mathematical communication of students taught with Reciprocal Teaching combined to Scientific Approach can be improved in Transformation topic, (2) Using reciprocal teaching combined to Scientific approach is better than the direct instruction. To get the valid result, the research must be done by considering the students’ physical and emotional or the period of the learning. In addition, the teacher can also create the learning kits adjusted to the character of the students. Moreover, there is alot of mathematical topics that become a challenge to the further research.

### References

[1] NCTM. 1989. *Curriculum and Evaluation Standards for School Mathematics.* Reston: Virginia.

[2] Sammons, L. 2018. *Teaching Students to Communicate Mathematically*. ASCD: Alexandria

[3] Disasmitowati, C. E., & Utami, A. S. 2017. *International Conference on Research in Education*, **20**(2), 72–84.

[4] Smith, S. 2001. *early childhood mathematics* (2nd Edition). Boston: Allyn and Bacon.

[5] Cai, J., Jakabcsin, M. S., & Lane, S. 1996. *School Science and Mathematics Assosiation*, **96**(5), 238–246 [6] Whitin, P., & Whitin, D. . (2003). Developing Mathematical Understanding along the Yellow Brick Road. *Young Children*, **58**(1), 36–40.

[7] Fachrurazi. (2011). *Jurnal Penelitian Pendidikan UPI*, (1), 76–89.

[8] Hernawati, K., Mahmudi, A., Lestari, H. P. *Seminar Nasional Matematika Dan Pendidikan Matematika*, 713–718.

[9] Purniati. (2003). *Matematik Pembelajaran Geometri Berdasarkan Tahap-tahap Awal Van Hiele dalam Upaya Meningkatkan Kemampuan Komunikasi siswa SLTP*. Universitas Pendidikan

[10] International Association for the Evaluation of Educational Achievement, T[TIMSS] .2007. *Average mathematics scores of fourth- and eighth-grade students,*

[11] Rubenstein, R. N., & Thompson, D. R. 2013. *JSTOR*, **9**(2), 107–112.

[12] NCTM. (1989). *Curriculum and Evaluation Standards for School Mathematics. Reston*. Virginia.

[13] Relly, Y., Parsons, J., & Bortolot, E. 2009. *the 46th Conference of the Mathematica Association of Victoria*, 182–189.

[14] Rachmayani, D. 2014. *Jpu*, **2**(11), 13–23.

[15] Hendriana, H., Putra, H., & Ristiana, M. 2018. ICSME

[16] Montgomery, D. (1997). *Design and Analysis of Experiments*. United States of America: Lehigh Press.

[17] Qohar, A., & Sumarmo, U.2013.*Journal on Mathematics Education*, **4**(1), 59–74.

**Acknowledgments**

This paper cannot be written without the supports from Yogyakarta State University and Universitas Jambi. Special thanks be given to LPDP (Lembaga Pengelola Dana Pendidikan) for funding tthis project and for master study program in Yogyakarta State University for giving the suggestion along the progress