International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 14, Issue 2, 2020

The Effect of Learning Using Think-Pair-Share and Make a Match Models on the Students' Mathematical Communication Skills

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Communication is one of the most important abilities mastered by students in mathematics learning. This study aimed to explore and describe the mathematical abilities of verbal and written communication in mathematics learning using Think-Pair-Share and Make a Match models. The implemented research design was experimental teaching. This research design was conducted through 3 steps including teaching preparation, teaching experimental, and analysis processing teaching, with descriptive type and mix approaches. Class VII-A students of Junior High School Muhammadiyah 2 Malang was used as the subjects in this study. Verbal communication data was collected through observation. Written communication data was collected through students' writing after working on student worksheets, presentation of group work results, and the answers from written tests. The data was then analysed descriptively. The results of the research demonstrated an increase in student's verbal mathematical communication skills with sufficient categories. Whereas, students' written mathematical communication skills were considered in good categories.

Keywords: *Verbal mathematical communication, written mathematics communication, Mathematics learning, Think Pair Share Model, Make a Match Model.*

Introduction

Mathematical learning can be interpreted as a conversation with a specific purpose about a mathematical subject where there are contributions and interactions (Truxaw, Gorgievski, & DeFranco, 2008). In learning mathematics, students can make guesses, talk, ask, and agree or disagree about problems in developing mathematical concepts (Stein, 2007). It implies that learning mathematics is a social activity due to its interaction among students and between students and teachers. Mathematical learning contributes to a deeper mathematical analysis for teachers and students (Manouchehri & John, 2006). One component that makes high quality mathematics learning is by facilitating communication (Schwols & Dempsey, 2012). Through mathematical communication, teachers can foster students' involvement and participation while focusing on conceptual understanding (Pourdavood & Wachira, 2015).

Mathematical communication is an important process for learning mathematics because through communication, students reflect on, clarify, and broaden their ideas and understanding of mathematical relationships and mathematical arguments (Ontario Ministry of Education, 2005). In addition, communication is also very important in mathematics (NCTM, 2000; Gordah & Nurmaningsih, 2015) because mathematics is a language for communicating ideas clearly, precisely, and accurately. Student involvement in mathematical communication influences mathematics achievement (Koichu, Berman, & Moore, 2007; Kosko, 2012; Mercer & Sams, 2006),develops a deeper understanding of mathematics (Hufferd-ackles, Fuson, & Sherin, 2016; Staples, 2007), and enables the expression of ideas through oral, written, and visually communication to describe in different types and formulate questions related to everyday life into mathematical models (Surya & Rahayu, 2014). Mathematical communication is a conversation that talks about mathematical material in the form of ideas, concepts, or problem solving strategies both verbally and in writing (Khaulah, 2016; Purwandari, Astuti, & Yuliani, 2018; Tinungki, 2015).

The skills required for students to conduct written communication include reading and writing, while verbal communication consists of listening and speaking **(**Sammons, 2018**).** Fahradina & Ansari (2014) further stated that verbal mathematical communication indicators include discussing mathematics, communicating mathematical ideas, asking questions about mathematics, and interpreting and evaluating mathematical ideas. The written mathematical communication indicator develops student's mathematical ideas through pictures, graphics, symbols, and mathematical notations, communicating students' mathematical thinking in writing, and writing about mathematics with comprehensive understanding of a mathematical presentation (Permata, Kartono, & Sunarmi, 2015).

Based on the explanation above, mathematical communication is one of the important skills that must be mastered by every student. Yet, the fact is that students have not mastered

mathematical communication well. The low mathematical communication skills can be seen from the TIMSS report which states that students' mathematical communication skills in Indonesia are different from other countries (Nayazik, 2016). The low mathematical communication in mathematics learning occurs due to several factors. First, the role of the teacher is more dominant, and information only goes one way from teacher to student. Second, the teacher rarely engages in group learning and eventually makes interaction between students. Third, students and teachers are still very limited which results in weak mathematical communication students (Zakiah & Kusmanto, 2017). Teacher-centred learning makes students less active because students only accept whatever has been explained by their teacher (Mahmud & Hartono, 2014).

The important factor that can affect student's mathematical communication is a learning strategy that stimulates students to discuss, illustrate ideas, express opinions, so that their mathematical communication skills are shaped (Wahyuni, Utami, & Husna, 2016). One model of learning that can make students active, creative, and communicate their ideas is the cooperative learning model *Think-Pair-Share* (TPS) and *Make a Match* (MaM). The reason for the combination of *Think Pair Share* and *Make a Match* is due to its common that can make students understand the problems given by the teacher before they get together with a partner or group to unite opinions so that they can develop mathematical communication.
Cooperative learning is carried out through sharing among students to have them realise mutual understanding (Yansa, 2018) *Think-Pair-Share* is an activity that promotes students to better understand the problems that have been given by the teacher and then share thoughts with other students to unite opinions in solving problems (Tint & Nyunt, 2015; Barragato, 2015). Soleha (2016) states that the *Make a Match* (MaM), as cooperative model, is learning that emphasises social aspects and the ability to interact in addition to the ability to think quickly through games to find a partner through the card's assistance. The implementation of this model is that students are told to find a card that matches the card that has been held for the time provided. Students who can find a pair of cards first will be rewarded. Implementing MaM could increase students' learning activities cognitively and physically. Besides, it is fun with the elements of play in it **(**Huda, 2014**).**

Some studies related to communication in learning have been conducted. Zaini and Marsigit (2014) examined students' mathematical reasoning and communication with realistic mathematical and conventional approaches. Kosko and Wilkins (2006) examined mathematical communication and its relation to the frequency of manipulative use. Ranti (2015) examined mathematical communication using the writing to learn strategy. Veloo, Md-Ali, and Chairany (2016) conducted research on understanding and communicating Mathematics with the Teams Game Tournament model. Halimah and Sukmayadi (2019) studied the verbal communication skill of teachers by Jigsaw Cooperative Model. In addition, several studies related to cooperative model for writing the article based on interpersonal

learning skills (Sutarman, Sunendar, & Mulyati, 2019). The TPS model was linked to student learning outcomes and activities (Afoan, Sepe, & Djalo, 2016; Asdar, 2016; Hutahaean, Sutawidjaja, & Susanto, 2016). Jelatu, Kurniawan, Kurnila, Mandur, and Jundu (2019) studied the comprehensive understanding of students on trigonometry concepts by collaborating the TPS and mobile learning (m-learning). Ardiyani, Gunarhadi, and Riyadi (2018) conducted research on the Think-Pair-Share and Student Teams Achievement Division models with a realistic mathematical approach to student learning outcomes and activities. Alodia, Yuliani, and Puspitawat (2016) conducted research on the Make a Match cooperative learning model to practice higher-order thinking skills. Handayani, Sumadi, and Nugraheni (2018) conducted research on the application of the Make a Match cooperative learning model and Point Counter Point to student learning outcomes. In such notion, there are no studies specifically examining mathematical communication with the TPS and MaM models. This study aims to analyse the mathematical communication skills of Junior High School students in learning Mathematics with Think Pair Share and Make a Match models.

Research Methodology

This study aimed to see the development of students' verbal and written mathematical communication skill through the learning process with *Think-Pair-Share* and *Make a Match* model. The research design used is experimental teaching (Gravemeijer and Cobb, 2008). This type of research is a descriptive study because the conditions under study are reported as they are and the object or subject under study is described based on the real event and condition during learning process. The approach used in this study is mixed approach, both qualitative and quantitative. It is because the data obtained are in the form of verbal and numeric based on circumstances and events that occur during the learning process (Sugiyono, 2014).

The subjects in this study were students of class VII-A Junior High School Muhammadiyah 2 Malang with 16 students. This group consisted of 10 males and 6 females with an average age of 13 years and age range of 12 to 14 years.

The collected data in this study were verbal and written communication of students. Verbal communication data were collected through observation during the learning processes. The observation sheet was developed based on the verbal communication indicators according to Fahradina and Ansari (2014). Verbal communication data collection was carried out by two observers. While written communication data was collected through students writing after working on student worksheets, presentation of group work results, and answers from written tests. The written communication skills were measured using indicators developed by Permata et al. (2015). The research instruments are as follows:

Students' Verbal Communication of Mathematics Observation Sheet

This verbal communication of mathematics observation sheet is used during the learning process. The observed aspects are seen in Table 1.

Table 1: Evaluation Sheet of Verbal Communication Skill of Mathematics

Indicators	**Observation Aspects**	**Score** **4 3 2 1**
Discussing mathematics	The accuracy in delivering an opinion verbally about mathematics idea	
Communicating mathematics ideas verbally	Explaining the concept and resolution	
Asking questions about mathematics	Generating the questions verbally about materials which do not yet understand	
Interpreting and evaluating the mathematics idea	Concluding the answer and giving the response to other students' explanation	

The Evaluation Sheet of Students' Verbal Mathematical Communication (Written Test Sheet)

Mr. Nadir has a rectangular apple garden. The length of the garden is three times its width and a circumference of 72 m. If Mr. Nadir's garden produces 3 kilograms of apples per 1 m^2, then how many kilograms of apples does he harvest?

Based on students' written answers from the test questions, then to analyse student's mathematical communication skills in writing, Table 2 is used.

Table 2: Evaluation Sheet of Written Communication Skill of Mathematics

Indicators	**Observation Aspects**	**Score** **4 3 2 1**
Developing mathematic ideas of student through writing	Writing mathematic ideas based on questions	
The accuracy using pictures, graph, symbol, and notation of mathematic	Writing by using notation, symbol, and describing a problem in the form of accurate pictures based on mathematic principles	
Communicating the mathematic ideas clearly through writing	Changing the analysis problem into mathematic model	
Writing about comprehensive	Presenting through written mathematics	

understanding of written mathematic presentations		

To determine verbal and written communication skills, each indicator or aspect observed was scored. Score 1 was given to students who did not do the activity. Score 2 was given to students who did not do the activity but still unclear and inaccurate. Score 3 was given to the students who do an unclear or incorrect activity. Score 4 was given to students who carried out activities clearly and precisely. Furthermore, communication skills were determined by the formula KK = P / S × 100%, where KK states the value of student's mathematical communication skills, P is the total score obtained by students and S is the maximum score. Communication skills are categorised as very good if 80% ≤ KK ≤ 100%, good if 70% ≤ KK <80%, enough if 60% ≤ KK <70%, and less if KK < 60% (Ministry of Education and Culture, 2014).

The research procedure follows the experimental teaching phases, namely teaching preparation, experimental teaching, and analysis processing teaching (Gravemeijer & Cobb, 2008). The teaching preparation activity began by observing the learning process in class VII-A of Junior High School Muhammadiyah 2 Malang. The results of observations noted that learning in the classroom was dominated by teachers who applied conventional learning using the lecture method followed by giving questions without including the role of students in delivering material. This learning made students less active and had difficulty in expressing arguments, asking questions, or answering questions from the teacher. Furthermore, research instruments and learning implementation plans using *Think-Pair-Share* and *Make a Match* models syntax is compiled in Table 3.

Table 3: The Model of Think-Pair-Share and Make a Match Syntax

No	Phases	Activities
1	Introduction	1). Teacher recites salaam to student and ask student to pray. 2). Teacher conducts apperception by correlating the materials with student's prior experiences 3). Teacher explains the aim of the learning 4). Teacher informs the learning process would be using think pair share and make a match, then giving the timeline of each activity 5). Teacher gives the motivation in order to increase enthusiasm among student
2	Main Activity (*Think*)	1). Teacher delivers the materials 2). Teacher gives the card (such as domino cards which contains different topic in each side) to the student, therefore each of them obtain one card. (*Make a Match*) 1. 3). Student thinks the answer/question contained in the card.

		(*Make a Match*)
	(*Pair*)	1). Students look for pairs who have cards that match the card. (*Make a Match*) 2). Students who can find their partners before the deadline will get a reward. (*Make a Match*) 3). Students sit in groups according to the cards that have been matched. (*Make a Match*)
	(*Share*)	1). The teacher gives assignments in the form of material to be discussed and a worksheet that will be solved and presented to the class 2). The teacher asks students to discuss with the group. 3). Students discuss with the group verbally to unite opinions about the sub material discussed and each student writes the results of the discussion on a piece of paper. 4). The teacher asks one of the groups to present the results of the discussion verbally and write it on the board. 5). Other groups that are not presenting provide questions or input to the groups presenting.
3	Closing (Rewards)	1). The teacher gives appreciation to students (who can find their partner before the specified deadline) and group presentations. 2). The teacher provides confirmation of the truth of questions and answers. 3). The teacher and students conclude the material that has been submitted. 4). The teacher gives written test questions that will be done by each student (individual) 5). The teacher asks for an answer sheet of written test questions that have been done to be collected. 6). The teacher tells the material to be discussed at the next meeting. 7). The teacher ends the lesson.

In the experimental teaching phase, the mathematics learning process was carried out on students of class VII-A Junior High School of Muhammadiyah 2 Malang with the syntax of Table 3 on the flat geometry, triangular, and rectangular shapes material with three meetings. Each meeting used 2 x 40-minute sessions and students were divided into four groups with each group consisting of four students whose abilities are heterogeneous.

Activities in the analysing the phases of teaching processes were to write down the results that carried out during the study and the analysis of the results of students' mathematical communication skills with Think-Pair-Share and Make a Match models.

Results

Verbal Mathematical Communication Skills

The students' mathematical communication skills were obtained from discussions, presentations, and student asking questions or expressing their opinions during the learning process from the first meeting to the third meeting. Mathematical communication skills of students during the three meetings were displayed on Table 4.

Table 4: Student Communication Skill of Mathematic in Verbal Aspect

Indicator	**Score in Meeting (%)**			**Score Average in each Indicators (%)**	**Category**
	I	II	III		
Discussing Mathematic	74.9	76.7	875	79.7	Good
Communicating athematic Ideas	62.5	73.3	76.8	70.9	Good
Asking about Mathematics	53.1	60	64.3	59.1	Insufficient
Interpreting and Evaluating Mathematic Ideas	45.3	65	67.9	59.4	Insufficient
The average on each meeting (%)	58.9	68.8	74.1	67.7	Sufficient

Table 4 shows that there was an increase in the verbal communication skills of all indicators from the first meeting to the third meeting, from insufficient category at meeting I, sufficient at meeting II and good at meeting III. Discussions about mathematics occurs when students search and find pairs of cards that match their cards (*Make a Match*) or when discussing with their group mates (*Pair*). This is demonstrated by conversations with sub-material square, rectangular, parallelogram, and rhombus:

Student 1 : I got a card that said parallelogram and the other side layered flat, formed from four same length sides and four angles of equal 90º.
Student 2 : It seems like it suits my card. In my opinion, a flat shape formed from four same length sides and four equal angles of 90º is the definition of a square.
Student 1 : Let me see your card. Oh yeah, that means our cards are a match, we're one group. Now we are just looking for more cards that read the definition of parallelogram.
Student 2 : Yes, come on.

Communicating students' mathematical ideas verbally was done when students presented the results of discussions done with their group friends (*Share*). This could be demonstrated

through the presentation that they delivered in front of the class and is apparent in the statement that "*According to the results of our group discussion, the properties of a square that are four sides are the same length, four angles are right-angled, have 4 fold symmetries and rotational symmetry level 4*".

Asking questions about mathematics occurred when students asked questions about what they did not understand during the discussion or when their friends finished delivering the results of their presentations. One form of questions asked by students was "*Sir, then what is the difference between square and rectangle?*".

Interpreting and evaluating mathematical ideas are related to the ability of students to infer answers and provide responses to what has been conveyed by their friends. One of them is the statement of students when concluding the concept of the circumference of a flat figure, "*The circumference of a flat figure is the sum of all sides on the flat figure*".

Written Mathematical Communication Skills

Students' written mathematical communication skills were viewed from the presentation (when students write the results of the discussion on the whiteboard), and a written test at the end of each learning session. The test was in the form of description, with 1 question. The test results obtained were analysed to describe the level of student's mathematical communication skills in writing. The students' mathematical communication skills in writing during the three meetings were displayed in Table 5.

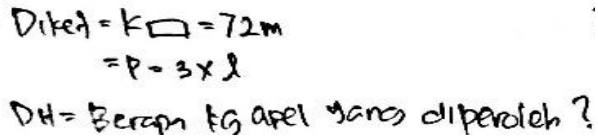
Table 5: The Student Communication Skill of Mathematic through Writing

Indicators	**Score in each meeting (%)**			**Score average each indicators (%)**	**Category**
	I	**II**	**III**		
Developing mathematic ideas	70.3	75	73.2	72.8	Good
The accuracy using pictures, graph, symbol, and notation of Mathematic	79.7	80	76.8	78.8	Good
Communicating the mathematic ideas clearly through writing	93.8	93.3	76.8	88	Very Good
Writing about mathematics with comprehensive understanding about mathematics presentation	65.6	65	62.5	63.4	Sufficient
Average score in each meeting (%)	77.4	78.3	72.3	75.9	Good

Table 5 shows that the categories in each meeting were good and two indicators were good, one was very good, and one was sufficient. A decrease in skill at the third meeting occurred, yet overall, students' written communication skills were good.

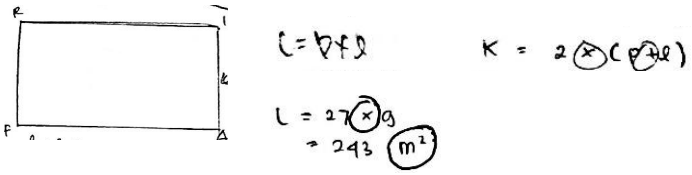
Developing mathematical ideas in writing could be seen when students understood the problem by writing what was known and asked and when solving problems. The statements on the circumference of a 72 *m* rectangle and three times the width is written by student K = 72 *m* and p = 3 × l as shown in Figure 1. This activity was also carried out by students when solving problems.

Figure 1. Developing mathematic ideas through writing



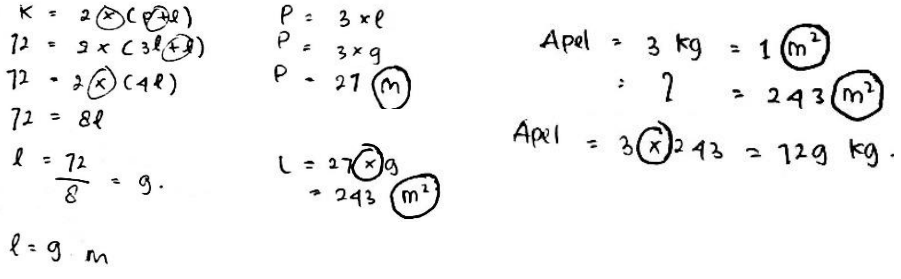
The accuracy in using pictures was done by visualising a square. While the use of symbols or notations when students communicated in writing about the circumference, area, length, width, multiplication operations, units of kilograms, and area units showed in succession with K, L, p, l, ×, *kg* and m^2 as in Figure 2. This was done by students in understanding and solving problems.

Figure 2. Using pictures, symbols, and notations.



Communicating mathematical ideas accurately through the application of concepts in problem solving was presented in Figure 3. The clarity was seen in the sequence of work and units used. The order in finding the area was done by using what is known, namely, the circumference and the relationship between length and width. To find what was asked using the area was obtained in the previous step and the data in the problem. While clarity in communicating mathematical ideas used units of length and width (*m*), area (m^2), and weight (*kg*).

Figure 3. Communicating mathematical ideas



Writing about mathematics with a comprehensive understanding of a mathematical presentation was achieved when students gave units to the results of operations, for example p = 27 *m*, L = 243 m^2 or Apple = 729 *kg*. Additionally, writing conclusions was based on this work. Therefore, the apples produced were 729 kg. In addition, this ability was carried out by students when presenting groups in class.

Discussion

In this study, students' verbal communication skills improved in all aspects of the indicator from the first meeting to the third meeting. It occurred eventually at the first meeting when all groups still looked passive in group work. This occurred for some students during a chat with their friends, others do it individually. In the second meeting, the atmosphere in the classroom was already seen to be more conducive than the first meeting. The students had begun to actively discuss with their group friends even though there were still some students who were talking. While at the third meeting, all students were actively involved in discussions with their group friends. Each group competes to become the fastest and best group in solving the problems given by the teacher. Thus, the percentage obtained was higher than the previous meeting which was 74.1% in the good category, although overall it was categorised as sufficient. However, the result of asking about mathematics and interpreting and evaluating mathematic ideas were insufficient, which was the same result as the research of Vale and Barbosa (2017).

This means that students are quite capable of expressing their opinions related to rectangular and triangular material and explaining concepts verbally using language that is easy to understand. The students were found to also be capable of asking verbally about what has not, and concluding answers in the form of mathematical ideas or responding to other students' explanations quite well related to rectangular and triangular matter. The results of this study are in accordance with Pratiwi (2015) which stated that the application of *Think-Pair-Share* learning models using a scientific approach from meeting to meeting has increased. Tinungki (2015) stated that cooperative learning can encourage students to help each other, discuss and debate together, and to sharpen the knowledge they have today. Therefore mathematical communication skills can be well shaped. In addition, the results of this study are also in line with the findings of Jusmiana & Nursakiah (2016) which revealed that learning mathematics using the Make a Match model is better than direct learning.

Mathematical communication skills of students in writing increased from the first meeting to the second meeting and decreased percentage at the third meeting. Nevertheless, overall mathematical communication skills in writing are considered good. This means that students have good ability to write mathematical ideas, write using notations, symbols, and draw clearly and precisely, present them with written mathematical presentations, and change the

problem description into mathematical models related to rectangular and triangle material. The results of this study are in line with Faizah (2018) who concluded that student's written mathematical communication skills using Think-Pair-Share learning models are in the good category. Afthina, Mardiyana, and Pramudya (2017) and (Nayazik, 2016) also said that learning mathematics using Think-Pair-Share models is better than direct learning. However, the result of study of writing about mathematics with comprehensive understanding about mathematics presentation was sufficient, that as line as Vale & Barbosa (2017). It can be said that cooperative learning by playing has a positive influence on student's verbal and written mathematical communication skills (Halimah & Sukmayadi, 2019; Sutarman et al., 2019).

Conclusion

Student communication skill of mathematics, in a verbal aspect, consists of four indicators including opinion, delivery, accuracy, and explaining the concept is considered in good category. In generating questions and concluding the answer or giving responses to others, student explanations are considered insufficient. Overall, the student communication skill of mathematics is considered sufficient. The teacher, therefore, should facilitate the students to ask questions or give a response during learning process. Student communication skills of mathematics in the written aspect such as writing the mathematic ideas, using notation, and accurate symbols are considered in good category. In addition, changing the analysis problems into mathematics model is considered in very good category. Meanwhile, presenting the written mathematics is considered sufficient. Generally, the student communication skill in written aspects is considered in good category.

The result of this study gives the alternative for teachers in designing materials, media, and developing the curriculum to use Think-Pair-Share and Make a Match in the learning process. However, teachers should consider the model based on the problem’s characteristic, teacher’s role, learning environment, and teaching instrument. This result should be further demonstrated that the Think-Pair-Share and Make a Match positively affect the student communication skill of mathematics. This can be achieved by looking for the differences of education level and involving more participants, allowing a larger period of time, and other mathematics materials in order to gain more comprehensive output of research.

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