Students’ mathematical communication in teams games tournaments (TGT) learning model on trigonometry topic

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Abstract. This study aims to observe the result of students’ mathematical communication in a Teams Games Tournament (TGT) type cooperative learning model. This study uses a qualitative descriptive method in which the result of the observation and investigation of the students’ mathematical communication will be described. This research subjects were the first semester college students of class A in school year 2019/2020. There were 30 students who were taking the Trigonometry learning material in the Mathematics Education study program of Math and Science Faculty in Universitas Negeri Malang. The learning process was done by applying the TGT type cooperative learning method. The results of this research showed that the learning model had a positive influence on most of the students’ mathematical communication, especially on their oral and written mathematical communication aspects. On the oral aspect, on average, the students had a good communication skill with several indicators as follows: grammatical skills; sociolinguistic skills; and strategical skills. The students were expected to have a mathematical thinking and reasoning skills. Whereas on the written aspect, the indicators were as follows: interpreting mathematical ideas rationally, changing mathematical problems into mathematical models, and expressing mathematical ideas in the form of a description. From the results of this study, it was obtained that most of the students had good written mathematical communication skills. It can be concluded that the TGT learning model had a positive influence on the students’ mathematical communication skills.

1. Introduction

Education is the most important part for the advancement of a civilization in each country, including Indonesia. It has been stated in Permendikbud No. 22 Year 2016 (Regulation of Indonesia Minister of Education and Culture) that education is a conscious, structured, and planned process to actualize learning conditions and processes to make students actively improving all their potentials, having religious spiritual spirit, self-control, personality, intelligence, noble character, and all skills needed for themselves, society, nation, and country. According to [1], the future development is an education-supported development that will be able to develop students’ potential, so that the students are expected to be able to apply all knowledges obtained in school in dealing with their problems in life. Furthermore, mathematics is a field of study that plays an important role in education starting from elementary school until college level to provide students with a logical thinking, creativity, critical thinking, and collaborative skills.

Learning models at each education level have been regulated by the government. It has been stated in Permendikbud 18 A curriculum of 2013 that one of the learning models used is direct learning. In
the direct learning, students conduct learning activities by observing, asking questions, collecting information, associating or analyzing, and communicating any of their discoveries in analysis activities.

As stated in NCTM (1998), one of process standards in mathematics is that all the students are expected to have good communication skills. Mathematical communication is one of the important skills needed by the students in learning mathematics [2]. This skill is important because mathematics is a series of abstract ideas that needs to be translated to an understandable language by all the students. Students will be actively involved in mathematics learning when they are able to think their ideas, communicate to others about ideas, strategies, and solutions needed to solve the mathematical problems [3]. Therefore, students’ mathematical communication is one of the main concerns in mathematical learnings in order to improve their thinking skill and to encourage the expression of their ideas [4].

National Council of Teachers of Mathematics (NCTM) stated that mathematical communication was a method of sharing ideas and evaluating the understanding of each other. Qohar & Sumarmo [5] stated that the purpose of mathematical communication is to be able to use mathematics as a communication tool to connect the mathematical ideas, giving expression related to the mathematical ideas, and explaining conditions or problems by using tables, mathematical symbols, diagrams, and even other mediums.

From the observation results of study on September 9, 2019 involving first semester college students of Universitas Negeri Malang, it was found that the lecturer was quite good in implementing mathematical learning. The lecturer implemented an explanation and discussion learning model. The lecturer gave an appreciation in the form of scores to the students who were actively solving problems in front of the class. However, this appreciation method impacted only on a part of the students to became actively coming up to the front of class. This condition caused not all students were able to explain their methods in solving the mathematical problems. It could be concluded that all students did not have the same mathematical communication skill. While students were practicing on individual mathematics tasks, some students used improper methods in solving the problems. The improper methods caused the students to obtain a lesser score in written mathematical communication. In order to overcome the condition, teachers needed a learning model that helped students to explore their mathematical communication skills both orally and in writing.

Students’ mathematical communication skills need to be improved to equalize students’ ability in processing mathematical problems. Mathematical communication skills are the ability to present mathematical ideas verbally, in writing, pictures, graphics and other visual forms [4].

Mathematical communication skills are the main process for improving students’ mathematical thinking abilities [6]. One of the efforts to improve the students’ mathematical communication skills and learning achievements in order to grow significantly is by making changes in the learning model [7]. Scientists have introduced and applied various approaches and learning models as an effort to maximize students’ learning results [8]. Students’ mathematical abilities in the learning process can be improved by writing [9] and cooperative learning [5], [9], [10]. In order to provide a good learning experience, then the learning models selection becomes an important thing to do. A teacher needs to be able to decide a proper learning model for a certain concept [11]. Teams Games Tournaments (TGT) is one of the methods to provide learning materials understanding for the students in order to create qualified human resources [8].

Teams Games Tournaments (TGT) is a cooperative learning model that firstly was introduced by Robert Slavin [12]. This learning model has begun to be widely used by teachers to help them in their teaching processes. Some researchers who used this learning model to improve various students’ skills in their researches were as follows: [13]–[23]. This model uses fun games as the method and consists of five main components as follows: class presentations; groups; games; tournaments; and team recognition that requires the students to get together in small groups [20]. Therefore, students are expected to be able to implement mathematical communication in their class, so that the learning model is expected to be an active learning model that has been designed for improving students’ mathematical communication skills.
According to the backgrounds above, researchers of this study will implement a research to observe the impact of Teams Games Tournament (TGT) learning model on students’ mathematical communication on trigonometry learning material.

2. Methods
This study was conducted to determine the effect of Teams Games Tournament (TGT) learning model on students’ mathematical communication. This study used a descriptive method to described the results of the students’ mathematical communication when the TGT learning model was being applied. The approach method in this study was a qualitative approach method in which the approach was done by collecting qualitative data such as oral words, learning activities, and written tasks. The details will be described in the following descriptions.

Subjects in this study were 29 first semester college students of Mathematics Education Department, Universitas Negeri Malang. Two observers assisted this study for assessing the implementation of TGT learning model and the students who were subjected to the learning model in learning trigonometry material. The observers gave scores to each student in accordance with observation guidelines contained in the observation sheet, which ranged between 1 – 5 points. In addition, the observers also gave some special notes containing findings during the learning processes.

Furthermore, the researchers conducted observation on students’ communication process by recording their discussion processes. Further data was collected by recording how the students communicate to each other during the time they solved the questions and explain the solutions in front of the class. This process was addressed to understand the results of students’ oral mathematical communication. Hereafter, the researchers gave tasks to the students. The tasks were one of the instruments in understanding the results of students’ written mathematical communication.

The obtained data were then qualitatively be analyzed by the following four stages: data collection; data reduction; data presentation; and conclusion. Data collection was done by using all of the notes taken from observation, interview, recording, etc. Data reduction was the selection of data that was relevant to the research. Observation results would be crossed over the documentary photos and students’ results in order to obtain a more accurate and valid data. Results of the qualitative analysis of these data would show the students’ systematic learning process so that the students’ teamwork activity can be identified.

3. Result and Discussion
This research was conducted in two meetings that was aimed to observe the results of students’ mathematical communication in the implementation of Teams Games Tournament (TGT) learning model. The first thing that the researchers did before conducting the research was the observation of the learning process of class A year 2019 that consisted of 29 students. At that time, the students were learning trigonometry course material. Afterwards, the researchers looked for references and chose a proper learning model to find out the students’ mathematical communication evenly. At the end of story, the researchers decided to choose Teams Games Tournament (TGT) learning model to study the students’ mathematical communication. Afterwards, the lecturer prepared a learning plan to be used in accordance with the Teams Games Tournament (TGT) learning model.

This following description describes the students’ learning process. Initially, the students listened the basic trigonometry learning material explained by the researchers. Then the researchers divided the students into 4 groups contained of 7-8 students each. After that, the students were asked to discuss the advanced trigonometry material that had been explained by the researcher. Each student expressed their ideas and discussed to convince each other. They were given their own serial number in the group as their new identities. The discussed material was complex number in trigonometry. In this session, all discussions were recorded for 60 minutes. Students were free to ask the researchers for any difficult material.

The next learning step was the game part. Researchers put 4 chairs in front of the class to be seated by each group representative, who were randomly selected by the researchers. Researchers called a number and then students’ who possessed the serial number were selected as the group representative. The representative students then competed each other in solving the question given by the researchers.
The student who firstly solved the question could explain their solution. If the solution was correct, then the student obtained a winning coupon for the group in that particular session. Otherwise, if the solution was incorrect, then other representatives would get the chance to explain their solution. The group that were able to get the most coupons would be appreciated a prize, so that the students would be more enthusiastic in finishing any of their works.

Some things had been researched by the observers during the learning activity. The following Table 1 describes the observation results of the Teams Games Tournament (TGT) learning process implementation, subjected to 29 college students and observed by two observers. This data will be measured by Likert scale in the range of 1-5 in which the value 1 means very poor, value 2 means poor, value 3 means fair, value 4 means good, and value 5 means excellent [24].

Table 1. The observation results of the TGT learning process implementation

| No | Observed Aspects                                                                 | Score | Percentage | Result     |
|----|----------------------------------------------------------------------------------|-------|------------|------------|
| 1  | Performing routine activities in the early meeting (greeting, praying, and presence) | 4.7   | 94%        | Excellent  |
| 2  | Paying attention and listening to the TGT rules                                  | 4.9   | 98%        | Excellent  |
| 3  | Listening to the basic material from the researchers                            | 4.9   | 98%        | Excellent  |
| 4  | Grouping according to their groups and serial number                            | 4.9   | 98%        | Excellent  |
| 5  | Learning and discussing materials with their group members                       | 4.3   | 86%        | Excellent  |
| 6  | Game. Coming up to the front of class and explaining solution, and paying attention and evaluating (for non-representative students) | 4.8   | 96%        | Excellent  |
| 7  | Completing individual task                                                       | 4.6   | 92%        | Excellent  |

After the data being processed, then the percentage value was calculated. Results of the students’ activity can be seen in this following percentage intervals:

Table 2. The observation results of the TGT learning process implementation

| Interval Percentage | Categories |
|--------------------|------------|
| 0% – 19.99%        | Very Poor  |
| 20% – 39.99%       | Poor       |
| 40% – 59.99%       | Fair       |
| 60% – 79.99%       | Good       |
| 80% – 100%         | Excellent  |

The data shows some results. Routine activities in the early meeting was excellently conducted by the students. Students also excellently paid attention to the TGT rules, listened to the basic material, and learned and discussed the learning material with their groups, played games, and completed the individual task. So that it can be concluded that students followed the learning steps nicely and excitedly. The observers also noted that the students were so active and excited in following this learning activities, for both the representative and the non-representative students.

The next aspects to be observed were the students’ mathematical communication. According to [25], the four indicators of mathematical communication are grammatical skill, discourse understanding skill, sociolinguistic skill, and strategical skill so that the students’ feel challenged to thinking and reasoning mathematically.

In the aspect of grammatical skill, students were able to explain their knowledge to audience correctly and sequentially. In the aspect of discourse understanding skill, while in group and discussing, students were able to understand the problems being faced. Likewise, in the aspect of question and answer, while explaining in front of the class the students understood the discourse of the problem being faced very well. Furthermore, in the aspect of sociolinguistic, students were able to explain with their own sentences to be more understandable even though the language was integrated with abstract mathematical language. Then in the aspect of strategical skill, students were able to do a reasoning while discussing the solution of their problems. They also used some methods to nicely solve their problem. It can be concluded that most of the students who nicely followed the procedures
in Teams Games Tournament (TGT) learning model would have their mathematical communication skills improved.

As for the students’ written mathematical communication skill, can be seen from the four indicators as follows: (1) students were able to interpret mathematical ideas rationally; (2) students were able to change a mathematical problem into a mathematical model; (3) students were able to express mathematical ideas in form of description. Based on the indicators, researchers sampled a solution of a given problem as follow:

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\text{Find trigonometric notation of: } -10\sqrt{3} + 10i
\]

The following are the discussion related to the result of the students’ mathematical communication.

Figure 1. Solution of the first student

In Figure 1, it can be seen that the student was able to interpret mathematical ideas rationally in which the student was able to describe the mathematical problem correctly. Then, in the indicator of the ability to change mathematical problem into mathematical model, the student was able to describe the problem into a Cartesian graph correctly and explicitly so that the position of the solution could clearly be seen. Next, in the indicator of expressing mathematical ideas in form of description, the student was able to obtain the correct answer. So that it can be concluded that in this example, the student obtained an excellent score in written mathematical communication.

Figure 2. Solution of the second student
In Figure 2, it can be seen that the student was able to interpret mathematical ideas rationally. It means that the student was able to describe the mathematical problem correctly. Then, in the indicator of the ability to change mathematical problem into mathematical model, the student was able to describe the problem correctly but not explicitly. The student did not draw the problem into a correct Cartesian graph, even though the position of solution was still clearly located. Next, in the indicator of expressing mathematical ideas in form of description, the student had done well even though the conclusion was incorrect. So that it can be concluded that in the second example, the student obtained a good score in written mathematical communication. However, all the students were able to complete their task and obtained a good average score in written mathematical communication.

4. Conclusion
Based on the results and discussion, it can be concluded that college students’ mathematical communication in a cooperative learning type Teams Games Tournaments (TGT) on trigonometry learning material was categorized as good, in accordance with two observed aspects: oral and written mathematical communication aspects. In the aspect of oral mathematical communication, there are four important indicators as follows: grammatical skill; discourse understanding skill; sociolinguistic skill; and strategic skill for students to be challenged to think and reason mathematically. According to the results and discussion, most of the students were categorized as having a good oral mathematical communication related to all the indicators. As for the students’ written mathematical communication skill, the assessment indicators are as follows: (1) students are able to interpret mathematical ideas rationally; (2) students are able to change mathematical problem into mathematical model; (3) students are able to express mathematical ideas in form of description. According to the data, most of students were categorized as having a good written mathematical communication skill. Overall, it can be concluded that in this study, the Teams Games Tournament learning model is able to give a good effect on the students’ mathematical communication on trigonometry learning material.

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