The effect of cooperative learning Type Teams-Games-Tournaments (TGT) on mathematical connection and communication ability in elementary schools

A Muslim*

Pendidikan Guru Sekolah Dasar, Universitas Muhammadiyah Purwokerto, Jl Raya Dukuhwaluh, Banyumas 53182, Indonesia

*arifinmuslim@ump.ac.id

Abstract. This study aims to analyze the effect of increasing the ability of connection and mathematical communication of students through TGT cooperative learning. This study uses a quasi-experimental method. The sample of the study is the fourth-grade students of students of one of the state elementary schools in Bandung with 52 students. The instruments are data collection, namely test instruments, mathematical connection, and communication skills. Through the t-test, Mann-Whitney, and two-way ANOVA, conclusions were obtained, 1) there was a significant difference in the increase in connection skills and mathematical communication of students who received TGT type cooperative learning with students who received classical learning, 2) there was no interaction effect significant between learning and mathematical initial ability to increase students' connection and mathematical communication skill. So this study proves that TGT cooperative learning can be used as an increase in the results of mathematical learning in elementary schools.

1. Introduction

The ability to connect mathematics in elementary school is still relatively low, this is based on the results of research by Ruspiani, who found that students' ability to make mathematical connections was relatively low [1]. The low mathematical connection ability is caused by the classical learning process. In addition to mathematical connection skills, mathematical communication (mathematical communication) in learning also needs to be developed. According to the NCTM "communication is an important part of mathematics" [2]. From the above, it appears that the development of connections and mathematical communication skills is important.

Innovative learning can fulfill several expert opinions, including in the opinion of Brunner, the formation of small groups facilitates the development of mathematical communication skills [3]. Group learning is one of the main elements in cooperative learning because according to Sutawidjaja, cooperative learning is an extension of small group learning (small group work) [4]. There are results of cooperative research applied to mathematics learning, including the results of research from Sitorusua and Suryab which states that “Thus cooperative learning model type Teams Games Tournament (TGT) can significantly affect the creativity of learning Mathematics students of 63.17% can be explained through linear relationship” [5]. Whereas according to Pangestuti et al. state that based on the previous discussion, it can be concluded that the application of Remap-TGT biology learning models can increase the students reading interest [6]. In the opinion and results of the above research, it can be concluded
that efforts to improve mathematical connection and communication skills can apply cooperative learning.

Furthermore, so that students better understand the subject matter and can develop mathematical connections and communication skills, fun activities are needed in the form of games in the form of competitions (tournaments) between teams. One type of pleasant cooperative learning is the cooperative learning model of the Teams Games Tournaments (TGT) type.

2. Method

2.1. Location and population / research sample
The location of this study was conducted at Cikuya 1 Elementary School which is located at Cikuya Village, Cicalengka District, Bandung Regency. The population of this study was all fourth-grade students of Cikuya 1 Elementary School, Cicalengka District, Bandung Regency. Samples of this study were IVA and IVB students. SDN Cikuya 1 as many as 52 students. 26 students from the IVA class were set as experimental classes. 26 other students from the IVB class were determined to control classes.

2.2. Research methods
The method chosen by the researcher in this study was Quasi-Experiment. This method was chosen because the research was conducted in the field of education, where the Experimental Subjects and Control Subjects could be selected not randomly.

2.3. Research variable
The research variables in this study are 1) Independent variable (independent), while the independent variable in this study is the Cooperative learning model Game Tournament Teams Type (TGT), 2) Dependent variable (dependent), while the dependent variable in this study is the ability mathematical connection and communication.

2.4. Research design
The Research Design generally used in this study is Pre-Test and Post-Test. This is consistent with the opinion of McMillan and Sally stating that the design of Pre-Test and Post-Test is very common and useful in education because it is often not possible to randomly assign subjects.

2.5. Research instrument
The research instrument used was a test instrument, in the form of a descriptive test to measure students' connection and mathematical communication skills.

2.5.1. The instrument of mathematical connection and communication ability tests.
The test questions used to measure the ability of connection and mathematical communication of students consist of 10 items in the form of a description. In the preparation of the test questions begin by arranging the problem grid followed by compiling the questions along with the answer key and scoring rules for each item question.

2.5.2. Instrument development process. Before the instrument problem is used in research, the question must be tested first on students who have obtained material relating to this research. This trial was conducted to find out that the instruments made had met good instrument requirements, namely validity, reliability, differentiation, and level of difficulty.

2.6. Research procedure
The procedure in this study consists of three stages, namely the preparation stage, the implementation phase, the data collection stage. The description of the two stages is as follows:
2.6.1. **Preparation phase.** The research preparation phase includes the stages of proposal preparation, seminar proposals, preliminary studies, preparation of research instruments for instrument testing and instrument improvement.

2.6.2. **Implementation phase.** The researcher carried out the TGT Cooperative learning model learning in the experimental class. The following is explained the process of implementing learning in the experimental class. Broadly speaking, the stages are, 1) Identification of the problem; 2) Preparation of teaching materials; 3) Preparation of instruments; 4) Test instruments; 5) Analysis of validity, reliability, distinguishing power and the degree of difficulty of instruments; 6) Research Implementation; 7) initial test (pretest); 8) implementation of learning; 9) final test (posttest); 10) Data Analysis; 11) Conclusion.

2.7. **Data collection techniques**
To obtain the data needed to answer the problems that have been formulated. This study uses three methods of data collection namely tests, interviews and observations.

2.8. **Data processing techniques**
The data obtained in this study are quantitative data in the form of scores obtained by students of the experimental class and the control class on the initial test (pretest) and the final test (posttest). This data processing is intended to test the hypotheses proposed. In this case, there are four main hypotheses to be tested.

3. **Result and discussion**

3.1. **Result**

3.1.1. **Results of mathematical Early Capability Analysis (ECA).** The division of students based on ECA is divided into three groups, namely 1) low group, 2) medium group, and 3) high group. The number of students in each group is different between the experimental class and control class due to the spread of ECA scores in each class differently. In the low-class ECA experimental class there were 3 students, the middle group numbered 19 students, and the medium group numbered 4 people. Meanwhile, in the ECA control class the low group students numbered 4 students, the medium group amounted to 16 students, and the high group numbered 6 people.

3.1.2. **Mathematical connection enhancement analysis results.** The test results of differences in pretest scores on mathematical connection ability between the experimental class and the control class showed no significant differences. The test results of the difference in the average score of n-gain mathematical connection ability between the experimental and control classes showed that there were significant differences. This difference was seen in the average n-gain score in the experimental class and control class, which is 0.517 higher than the n-gain score of the control class's mathematical connection ability which is 0.356. Thus it can be said that there is a difference in the increase in the ability of students to get cooperative TGT type learning significantly better than students who get classical learning.

3.1.3. **Results of mathematical communication capability analysis.** The test results of differences in the pretest scores of mathematical communication skills between the experimental class and the control class showed not significantly different. The test results of the difference in the average score of n-gain mathematical communication skills between the experimental class and the control show that there are significant differences. This difference is seen in the average n-gain score. n-gain score of experimental class mathematical communication ability is 0.5288 higher than the average n-gain score of the mathematical control ability of control which is 0.3881. Thus it can be said that there are differences in the increase in communication skills of students who get cooperative learning type TTT significantly better than students who get classical learning.
3.1.4. Analysis of the effect of interactions between learning and mathematical early ability to increase students' mathematical connection ability. Test the effect of the contraction between learning and mathematical initial abilities on increasing mathematical connection abilities of students using two-way ANOVA, this is done because the requirements of the scores are normally distributed and the variance of the scores is homogeneous. From the results of the two-way ANOVA test, it can be concluded that the hypothesis test proposed is $H_0$ is accepted or there is no effect of learning interactions and ECA groups on the increase in mathematical connection ability.

3.1.5. Analysis of the effect of interactions between learning models and early mathematical capabilities on students' mathematical communication ability. Test the effect of the interaction between learning and mathematical initial abilities on improving students' mathematical communication skills using two-way ANOVA, this is done because the requirements of the scores are normally distributed and the variance of the scores is homogeneous. From the results of the two-way ANOVA test it can be concluded that the hypothesis test proposed is $H_0$ accepted or there is no effect of learning interactions and ECA groups on the improvement of mathematical communication skills.

3.2. Discussion

3.2.1. Increased mathematical connection ability. The positive influence illustrates that TGT cooperative learning activities can be able to improve mathematical connection skills, this positive influence shows that TGT type cooperative learning can improve student learning outcomes.

In Game and Tournament activities, the teacher directs students to be ready to compete through games in the form of tournaments. This game was made to find out how much connection ability students have obtained from classroom presentations and teamwork [4], so this stage is an important activity for researchers to develop students' connection skills.

In the description above, it can be predicted that the submission of problems, questions of mathematical connection, cooperative learning, games and tournaments on TGT cooperative learning on the one hand, and the explanation and examples of mathematical problems in classical learning on the other hand, are factors that can explain one of the results of this study, namely an increase in mathematical connection ability of students who get TGT type cooperative learning is higher than students who get learning with classical learning.

3.2.2. Increased mathematical communication ability. The results showed that there was an increase in mathematical communication in students who received TGT cooperative learning significantly higher than students who received classical learning.

Based on the results of the analysis, it is known that the fundamental difference between students' abilities is in the learning process. Cooperative learning TGT strives to develop students' thinking skills to the fullest, without the influence of the teacher. This means that students are given the opportunity to communicate the answers to problems given freely, without being tied to procedural procedures in solving problems. Students try to find answers to solve problems optimally through group discussions, communicate ideas, share, and try to find the answers given correctly. the results are the same as those felt by Salam et al. finding results that "when the experimental group was experiencing the TGT method they showed outstanding learning outcomes as expected [8]. In the explanation above explains one of the results of this study, namely an increase in the mathematical connection ability of students who have TGT type cooperative learning is higher than students who obtain learning with classical learning.

3.2.3. Comparison of increased connection and mathematical communication capabilities. Comparison of the increase in connection ability and mathematical communication aims to determine the extent of success in the use of cooperative learning types of teams games tournament (TGT) in improving the ability of connection and mathematical communication. This in accordance with the results of the
research from Veloo et al. concluded that “Using cooperative TGT has enhanced student interest to actively learn mathematics with their peers via tournaments” [9].

The implementation of learning in the experimental class uses a lot of concrete media, in addition to learning material, namely the material properties of the cube, the characteristics of the beam, the webs of cubes, and the webs of beams. If it is examined in the achievement of indicators of the ability of connection and mathematical communication of students, those who are more able to easily use concrete media are the indicators of communication skills. Because mathematical communication skills involve more learning media. This is the reason if the use of TGT cooperative learning is higher than the increase in mathematical communication skills compared to increasing mathematical connection skills.

3.2.4. The effect of the interaction between learning and the initial mathematical ability to increase students' mathematical connection skills. The results of the study showed that the application of learning in the experimental class (TGT cooperative learning) and the control class (classical learning) significantly affected students' mathematical connection skills.

Apart from that, the results of the two-lane ANOVA test showed that the ECA group variables (high, medium, and low) did not have a significant effect on improving students' mathematical connection skills. The interaction between learning and ECA groups can be seen from the learning process that occurs in cooperative learning TGT provides questions that are relevant to mathematical connection skills when working in groups or individually, giving rise to strong motivation for students. This is in line with the results from Nadrah et al. research [10], namely “The students who have strong motivation to learn physics and taught using cooperative learning with TGT model have higher learning outcome than the students taught using conventional learning models”. Therefore, during the game and tournament learning stages so students can develop better connection skills.

3.2.5. Effect of interaction between learning and early mathematical ability to increase students' mathematical communication ability. The results of the study showed that the application of learning in the experimental class (TGT cooperative learning) and the control class (classical learning) significantly affected students' mathematical communication skills. If we look at the average n-gain data of the two classes, it can be seen that the average n-gain data of the experimental class is better than the average of the n-gain data of the control class namely 0.529 and 0.388. The average data shows that TGT Cooperative learning is better than classical learning.

Apart from that, the results of the two-way ANOVA test showed that the ECA group variables (high, medium, and low) did not have a significant effect on improving students' mathematical communication skills. This was indicated by data n-gain mathematical communication abilities from low groups, groups medium, and the high group is not too different, namely 0.453, 0.453 and 0.483. The interaction between learning and ECA groups can be seen from the learning process that occurs.

In TGT cooperative learning, the teacher gives questions that are relevant to mathematical connection skills when working in groups or individually, namely during the game learning stage and tournament so students can develop better connection skills.

Learning carried out by students who get TGT cooperative learning is dominated by students who have high mathematical abilities because students with high mathematical abilities can explain their ideas to other students. In line with the opinion of Carpenter and Gorg, activities explain mathematical ideas are part of mathematical communication activities [11].

In all stages of TGT cooperative learning students in the experimental class experienced an increase in each group of students based on students' initial mathematical abilities, namely in the low group students get a n-gain average of 0.537; moderate group students get n-gain mean 0.524; and high group students get a n-gain average of 0.545.

As with learning with cooperative learning of the TGT type, in classical learning, students with high mathematical initial abilities also show an increase in mathematical connection skills that are higher than the low and moderate groups. This increase is seen related to mathematical knowledge readiness.
and learning experience, especially in solving problems what the teacher gives is related to linking the concept of subject matter.

The difference in the increase in mathematical communication skills in the control class in the low, medium and high groups can be seen from the average n-gain obtained, namely in the low group students get an average n-gain score of 0.390; in the middle group students get an average n-gain score of 0.368; in high group students get an average n-gain score of 0.442.

From the description above, shows the acquisition of the N-Gain average in the experimental class and the control class in the low, medium, and high ECA groups that appear to be not too far apart, this is evidenced that there is no interaction between learning and the ECA group towards improving communication skills mathematical students.

4. Conclusion

The conclusion of this study is that the learning outcomes of students who get cooperative learning Teams Games Tournament (TGT) Team type are better than students who get classical learning because it requires increased connectivity and communication of students who get Team Games Tournament (TGT) cooperative learning from students who get classical learning. As well, there is no interaction of learning (TGT type cooperative learning and classical learning) and students' initial mathematical abilities (low, medium and high) to improve mathematical connection and communication skills.

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