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# The Influence of the Application of the Cooperative Learning Model Type Teams Games Tournament (TGT) on the Mathematical Communication Skills of Students

**Bela Amelia*, Kasman Ediputra, and Zulhendri**
Mathematics Education, Universitas Pahlawan Tuanku Tambusai, Bangkinang, Indonesia
*belaamelia1611@gmail.com

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**Abstract**

This research was motivated by students' low mathematical communication skills and the fact that the learning models used by teachers were not yet varied. Therefore, researchers tried to apply the TGT type cooperative learning model. This research aims to determine whether or not the TGT type cooperative learning model influences students' communication skills in vocational schools. This research is quasi-experimental research using a nonequivalent control group design. The population in this study was all students in class. Data was obtained from the initial and final ability tests in the form of mathematical communication questions. Data analysis was carried out using the t-test. Based on the data analysis and discussion results, a conclusion was obtained, namely that the mathematical communication skills of students who took part in learning using the TGT type cooperative learning model were higher than those using conventional learning.

**Keywords:** cooperative learning model; mathematical communication skills; mathematics learning; teams games tournament

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## INTRODUCTION

Mathematical communication is a skill that emphasizes speaking, writing, illustrating, and explaining mathematical concepts (Hartinah et al., 2019; Hasanah et al., 2020; Weaver, 2017). Students' mathematical communication skills can be developed through the learning process at school, particularly during mathematics lessons. One of the elements of mathematics is logical reasoning, which enhances students' thinking abilities. Thus, mathematics is crucial in developing students' mathematical communication skills (Kaya & Aydin, 2016; Putri et al., 2020; Siregar, 2018).

Mathematical communication is the ability of students to express their mathematical ideas to others, both verbally and in writing (Lomibao et al., 2016; Rusdi et al., 2016; Suhenda & Munandar, 2023). Mathematical communication skills are important for students because they indirectly foster their self-confidence (Aulia et al., 2021; Fay et al., 2022; Hendra & Rahayu, 2020). This is due to students' positive perceptions of themselves and their abilities, which reduces their fear of making mistakes or anxiety when solving mathematical problems. This confidence is reflected in their behaviour in everyday life.

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Based on the above, mathematical communication skills consist of verbal and written communication. Verbal communication in mathematics involves conveying information and mathematical ideas clearly and systematically through discussions and presentations. Efforts to enhance mathematical communication are essential for students' success in learning. However, students' ability to communicate in schools is still suboptimal.

According to Subandi et al. (2018), there are two reasons why mathematical communication is important: Mathematics helps discover patterns, solve problems, and serve as a social activity in mathematics learning, such as student interactions and teacher-student communication. These interactions are crucial for guiding students in understanding concepts or solving problems.

According to the standards set by the National Council of Teachers of Mathematics (NCTM), there are four indicators of communication: (1) organizing and integrating mathematical thinking through communication, (2) communicating mathematical thoughts coherently and clearly to peers, teachers, and others, (3) analyzing and assessing others' mathematical thinking and strategies, and (4) using mathematical language accurately to express mathematical ideas. Meanwhile, Cai, Lane, and Jacobsin (as cited in Heryan, 2018) define indicators of mathematical communication as (1) writing mathematics, (2) illustrating mathematically, and (3) mathematical expression.

Banani & Aman (2022) Proposed four strategies to develop students' mathematical communication skills: (1) Assigning adequate tasks to make students or discussion groups more active, (2) creating a conducive environment for students to express their ideas freely, (3) encouraging students to explain and provide arguments for their results and ideas, and (4) guiding students to process various ideas and thoughts actively.

A preliminary study conducted at Bangkinang State Vocational High School of Health and Tourism, involving an interview with a mathematics teacher, Mr FP, revealed that students struggle to solve problems and express their ideas. This is due to several factors, including mathematics teachers' use of conventional teaching methods and students' lack of curiosity in mathematics. Students tend to be passive in class, failing to communicate the material they have understood or not understood.

The low level of students' communication skills requires greater attention from various parties, particularly researchers. One approach to improving students' mathematical communication skills is actively engaging them in classroom learning. Creativity in teaching is essential to encourage students' active participation (Haryono & Tukiyo, 2022).

The cooperative learning model, TGT, effectively addresses these issues. The TGT cooperative learning model had a more significant impact on students' mathematical communication skills than conventional teaching methods (Laily et al., 2020). The students engaged in TGT learning exhibited superior mathematical communication skills compared to those in direct teaching (Azizah, 2023). Most TGT-related research focuses on primary, junior, and senior high school students. At the same time, this study examines vocational school students whose characteristics differ according to their specialized fields.

The TGT cooperative learning model is easy to implement. It involves all students without status differences, peer tutoring, and elements of games and reinforcement (Hidayat et al., 2018). Learning activities designed with games in the TGT model allow students to learn more relaxingly while fostering responsibility, teamwork, healthy competition, and active involvement in learning (Widhiastuti & Fachrurrozie, 2014).

The TGT model organizes students into small, heterogeneous groups of three to five members. Academic tournaments are used, where students compete as team representatives to achieve results comparable to their previous performances (Adha et al., 2023; Amaluddin et al., 2022). Each group studied the material together and prepared in a game format with numbered questions to test knowledge gained in class and group work. Correct answers

earn scores that contribute to weekly tournaments. During tournaments, students are grouped into different tables based on performance levels, and the winning teams are rewarded with certificates or prizes (Nuraida, 2021; Pahleviannur, 2022).

The TGT model promotes effective and efficient communication within small teams. Students become more active in solving problems, asking questions, expressing ideas, and learning to respect each other (Laily et al., 2020). Its advantages include increased task time, deeper mastery of material within a short period, active student participation, improved social skills, higher learning motivation, better academic outcomes, and enhanced empathy, sensitivity, and tolerance (Lamusu et al., 2024).

Exponential functions, a topic studied by Grade X students, require mathematical communication between peers and teachers. This topic enables students to relate it to other core materials and real-life applications (Zulherman et al., 2021). Based on the research background, this study aims to analyze the influence of the TGT cooperative learning model on students' communication skills at vocational school.

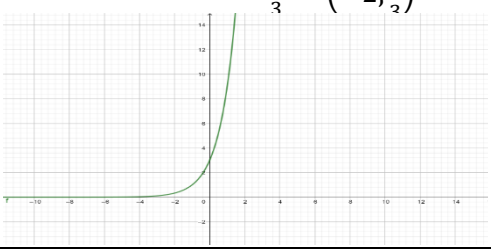
## METHOD

This research employs a quasi-experimental design using the nonequivalent control group design (Sugiyono, 2014). This design involves one experimental group and one control group, both given a pre-test and a post-test. The pre-test determines the initial conditions and whether significant differences exist between the experimental and control groups. The post-test assesses the final conditions of both groups after the treatment (Lestari & Yudhanegara, 2017). The treatments given to the experimental and control groups differ.

This study's population consists of all Grade X students at Bangkinang State Vocational High School of Health and Tourism. The sample includes two classes: Pharmacy 2, which serves as the experimental group with 26 students, and Pharmacy 1, which serves as the control group with 26 students. The study focuses on the topic of exponents.

The instruments used in the research include an initial ability test and a final test to measure students' mathematical communication skills in both the experimental and control groups. Table 1 contains the material and answer keys for the mathematical communication skills test.

Table 1 Test questions and answer key for mathematical communication skills

| No | Questions | Answers | Scores |
|---|---|---|---|
| **1** | The value of $6^2 \times 6^3 = \cdots$ | $6^2 \times 6^3 = 6^5 = 7776$ | 4 |
| **2** | The value of $\left(\frac{3^4 \times 4^4}{3^3 \times 4^4}\right)$ is $\cdots$ | $\left(\frac{3^4 \times 4^4}{3^3 \times 4^4}\right) = 3^{4-3} \times 4^{4-4} = 3 \times 1 = 3$ | 4 |
| **3** | Draw a graph of the function $y = 3^{x+1}$! | $y = 3^{x+1}$<br>For example x = 1, then $y = 3^2 = 9 \rightarrow$ 1,9)<br>x = -1, maka $y = 3^{-1+1} = 3^0 \rightarrow (-1,1)$<br>x = 0, maka $y = 3^1 = 3 \rightarrow (0,3)$<br>x = 2, maka $y = 3^3 = 27 \rightarrow (2,27)$<br>x = -2, maka $y = 3^{-1} = \frac{1}{3} \rightarrow \left(-2, \frac{1}{3}\right)$<br>  | 4 |

| No | Questions | Answers | Scores |
|---|---|---|---|
| **4** | Determine the solution set $49^{3x-4} > 7^{x^2}$ ! | $49^{3x-4} > 7^{x^2}$<br>$\leftrightarrow 7^{2(3x-4)} > 7^{x^2}$<br>$\leftrightarrow 7^{6x-8} > 7^{x^2}$<br>$\leftrightarrow 6x - 8 > x^2$<br>$\leftrightarrow x^2 - 6x + 8 < 0$<br>$\leftrightarrow (x - 2)(x - 4) < 0$<br>So the solution set is $x = 2\ dan\ x = 4$. | 4 |
| **5** | If $x_1$ and $x_2$ is a solution to the exponential equation with $3^{2x^2-5x+3} = 2^{2x^2-5x+3}$ , with $x_1 > x_2$ **then** the value of $5x_1-1$ is… | $2x^2 - 5x + 3 = 0$<br>$\leftrightarrow (x - 1)(2x - 3) = 0$<br>Then , x=1 and x = $\frac{3}{2}$ , because $x_1 > x_2$, then $x_1 = \frac{3}{2}$ and $x_2 = 1$<br>$5x_1 - 1 = 5\left(\frac{3}{2}\right) - 1 = \frac{13}{2}$ | 4 |
| Total score | | | 20 |

The quality of the test items used in the study is in Table 2.

Table 2 Quality of the questions used

| Questions | Validity | Reliability | Discrimination Index | Difficulty Index |
|---|---|---|---|---|
| 1 | Valid | Reliable | Very Good | Easy |
| 2 | Valid | | Good | Medium |
| 3 | Valid | | Good | Easy |
| 4 | Valid | | Good | Easy |
| 5 | Valid | | Good | Medium |

The data analysis in this study was conducted using the SPSS program. The data analysis techniques employed include Descriptive Statistical Analysis and Inferential Statistical Analysis. Descriptive statistical analysis is used to analyze data by describing or depicting the collected data as it is, without intending to make generalizations (Najmi et al., 2021). Data processing involves determining central tendency and data dispersion measures, such as the mean, median, mode, maximum value, minimum value, standard deviation, and variance (Lestari & Yudhanegara, 2015).

Inferential statistical analysis aims to analyze data by making generalizations about the sample data so that the results can be applied to the population with the help of SPSS (Juwita et al., 2017). The calculations for inferential statistical analysis must meet several assumptions, including the normality test used and the Kolmogorov-Smirnov test. The normality test using SPSS 24 is performed to determine whether the distribution of the analyzed sample data is normally distributed. The homogeneity test assesses whether the variances of two or more distributions are equal (Rinaldi et al., 2022). The homogeneity test is a prerequisite test for parametric statistical analysis in comparative techniques (comparing), and the t-test is a statistical test that compares two groups to determine whether there is evidence that the population means are significantly different (Matitaputty et al., 2023).

## RESULT AND DISCUSSION

This study was conducted over six meetings. In the control class, the conventional teaching model was applied (without treatment). In contrast, the experimental class implemented the cooperative learning model known as TGT (receiving treatment), resulting in the experimental class performing better than the control class. The topic taught in both classes was exponents. The subjects included 52 students, with 26 students in the control class and 26 in the experimental class.

The first meeting was used to conduct a pre-test for classes F1 and F2. Meetings two through five were dedicated to implementing learning, using the cooperative learning model TGT in class F2 as the experimental class and conventional learning in class F1 as the control class. The sixth meeting was used to conduct a post-test for classes F1 and F2. During this meeting, the researcher administered a daily test that also served as the post-test, consisting of 5 questions. The results of the data analysis from SPSS 24 regarding the pre-test and post-test scores are in Table 3.

Table 3 The results of the pre-test and post-test scores

| Statistics | Pre-test Scores | | Post Test Scores | |
|---|---|---|---|---|
| | Experimental Class | Control Class | Experimental Class | Control Class |
| Mean | 44.04 | 48.39 | 80.19 | 69.04 |
| Maximum | 60 | 60 | 95 | 85 |
| Minimum | 20 | 35 | 70 | 55 |
| Standard Deviation | 10.394 | 7.646 | 6.705 | 8.605 |
| Varians | 108.038 | 58.462 | 44.962 | 74.038 |

### Prerequisite Tests for Analysis

The data analysis in this study employed normality tests, homogeneity tests, and hypothesis testing, which will be explained as follows:

### Normality Test

The normality test was conducted on two sets of data: the pre-test and post-test data for both the experimental and control classes. In this study, normality was assessed using the Kolmogorov-Smirnov test. This normality test is performed to determine whether the sample being studied is normally distributed. The criteria for interpretation are as follows: if the significance value is greater than 0.05, the data can be considered normally distributed; if the significance value is less than 0.05, the data is considered not normally distributed. The results of the normality test can be seen in Table 4.

Table 4 Results of normality test using kolmogorov-smirnov test

| Test Result | Class | Pretest | | | Posttest | | |
|---|---|---|---|---|---|---|---|
| | | Statistic | df | Sig. | Statistic | df | Sig. |
| | Control | 0.150 | 26 | 0.200 | 0.165 | 26 | 0.066 |
| | Experimental | 0.123 | 26 | 0.134 | 0.142 | 26 | 0.189 |

Based on Table 4, it can be concluded that the pre-test statistical value for the control class is 0.150, and the pre-test statistical value for the experimental class is 0.123. The significance of the normality test using the Kolmogorov-Smirnov test indicates that the pre-test results for the control class have a significance value of 0.134, which is greater than 0.05, and the pre-test results for the experimental class have a significance value of 0.200, which is also greater than 0.05. Meanwhile, the post-test results for the control class have a significance value of 0.189, which means it is greater than 0.05, and the post-test results for the experimental class have a significance value of 0.066, which is also greater than

0.05. Thus, it can be concluded that all data from both the experimental and control classes show significance values greater than 0.05 and are normally distributed.

**Homogeneity Test**

The homogeneity test is conducted to determine whether the variance of the data from the sample being studied is homogeneous. Homogeneity can be tested using Levene's test. In this study, data can be considered homogeneous if the significance level is greater than 0.05; however, if the significance level is less than 0.05, the data is considered not homogeneous. The results of the homogeneity test can be seen in Table 5.

Table 5 Results of homogeneity test

| **Livene's Test** | **Pretest** | | | **Livene's Test** | **Post-test** | | |
|---|---|---|---|---|---|---|---|
| 0.167 | df1 | df1 | sig | 0.670 | df1 | df2 | sig |
| | 1 | 50 | 0.147 | | 1 | 50 | 0.109 |

Based on the homogeneity test Table 5, the pre-test results for the control and experimental classes have a significance value of 0.147, greater than 0.05. Meanwhile, the post-test results for the control and experimental classes have a significance value of 0.109, which is also greater than 0.05. Therefore, it can be concluded that both data sets are homogeneous.

**Hypothesis Test**

The hypothesis test in this study uses a parametric statistical test, specifically the Independent Samples t-test. This test determines whether the hypothesis is accepted or rejected. The decision criteria for the independent samples t-test are as follows: if the significance value (2-tailed) is less than 0.05, then $H_0$ is rejected, and $H_1$ is accepted. Conversely, if the significance value (2-tailed) is greater than 0.05, then $H_0$ is accepted, and $H_1$ is rejected.

Table 6 The result of test using independent samples t-test

| **Levene's Test for Equality of Variances** | | | | | |
|---|---|---|---|---|---|
| | | **Sig .** | **t** | **df** | **Sig.(2-tailed)** |
| **PostTest** | Equal variances assumed | 0.109 | 5.214 | 50 | 0.000 |
| | Equal variances not assumed | | 5.214 | 47.183 | 0.000 |

Based on Table 6 of the hypothesis test using the independent sample t-test, it is known that the results of Levene's test indicate homogeneity between the two data variances. The calculated t-value is 5.214 with a significance (2-tailed) of 0.000 < 0.05, which means that $H_0$ is rejected and $H_1$ is accepted.

It can be concluded that there is an effect on the mathematical communication skills between students in the control class, which did not receive treatment, and the experimental class, which was taught using the Cooperative Learning Model Type TGT. The TGT learning process created a pleasant, engaging, and more active learning environment. This aligns with Aje (2022), who stated that the TGT model can create a fun atmosphere for students. It is widely known that mathematics is a difficult subject that many students do not favour, so the TGT model can attract students, making them more active and interested in mathematics. This statement is also supported by research directed by Galura (2016), indicating that the TGT learning model encourages students to be more active in the learning process.

TGT is a tournament used in classroom learning by forming heterogeneous groups. According to Lestari (2022), TGT refers to a cooperative learning model with a small group

system of 3 to 5 students of diverse gender and ability levels. Moreover, this TGT model can be implemented in classrooms because it is relatively easy to apply and is particularly effective for teaching mathematics. Purwanto (2023) explains that the TGT model is a beneficial teaching model that is easy to implement. In TGT learning, all students are involved in a group system, fostering collaboration during the learning process in a competitive atmosphere. Students work together to listen to the teacher's explanations, complete assignments, and compete to finish these tasks to earn points (Sa'id & Aini S., 2024).

This study found that the mathematical communication skills in the topic of exponents using the cooperative learning model type TGT were higher compared to those using conventional methods. After the pre-test, the experimental class's average mathematical communication skills score was 44.04, while the control class had an average of 47.69. After the post-test, the average score for the experimental class was 80.19, while the control class scored an average of 69.04.

Based on the t-test calculations for mathematical communication skills between the experimental and control classes, the calculated t-value is 5.214, with a significance level of $0.000 < 0.05$. Therefore, $H_0$ is rejected, and $H_1$ is accepted, indicating that the mathematical communication skills of students using the cooperative learning model type TGT are greater than those of students using conventional teaching methods. This also significantly affects students' communication skills when using the cooperative learning model type TGT compared to conventional learning.

## CONCLUSION

Based on the data analysis, it can be concluded that the mathematical communication skills of students who participated in learning using the cooperative model type TGT were higher than those of students who used conventional learning methods. This demonstrates that the cooperative learning model type TGT impacts the mathematical communication skills of grade X students at SMK Negeri Kesehatan dan Pariwisata Bangkinang on exponents. Therefore, there is a need to enhance the implementation of the cooperative learning model type TGT to improve student collaboration. Initially, students' ability to work with this learning model may lead to noise within the group, but it eventually fosters a closer collaboration among group members. This study focused solely on one subject and one class, so it is hoped that future research can expand the subjects and the number of students involved.

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