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Developing Students' Mathematical Communication Skills on Geometric Number Patterns Through Group Investigation and Peer Teaching

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Abstract

This study aims to determine the improvement in students' mathematical communication skills in learning geometric number patterns through the Group Investigation model with the Peer Teaching method. The study uses an experimental method. The population in this study includes all 8th-grade students in the middle school. The sample consists of all students in classes VIII-G and VIII-I. The research instrument used to collect data is a test on mathematical communication skills specifically designed for geometric number patterns. Based on the data obtained, it can be concluded that the experimental class performed better than the control class. In the experimental class, there were 4 students with low ability, 16 students with moderate ability, and 14 students with high ability. Meanwhile, in the control class, there were 7 students with low ability, 24 students with moderate ability, and 3 students with high ability.

Keywords: Geometric Number Patterns, Group Investigation Model, Mathematical Communication Skills, Peer Teaching Method

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1. Introduction

Mathematics education plays an essential role in developing students' logical, critical, and creative thinking abilities, as well as improving mathematical communication skills, which are necessary for solving problems and expressing ideas clearly, both orally and in writing. Sugiarto (2020) states that mathematics education has strategic potential in preparing human resources to face the challenges of globalization. Meanwhile, Nurhasanah et al. (2020) emphasize that mathematical communication, as part of social activity, supports a deeper understanding of mathematical concepts. According to NCTM (2000), communication is a fundamental aspect of mathematics learning, helping students to formulate, communicate, and evaluate their mathematical thinking.

However, students' mathematical communication skills remain low, as highlighted in Syafina's (2020) study, which found that students only achieved 45% in solving simultaneous linear equations. Research by Yanti et al. (2019) also showed that students at SMP 1 Margaasih had low understanding of mathematical communication, especially in connecting mathematical concepts to real-world objects.

The Group Investigation (GI) cooperative learning model aims to improve students' mathematical communication skills. Rooted in John Dewey's philosophical views on collaborative learning, GI emphasizes the importance of students communicating their mathematical thoughts. In this model, students are given the opportunity to discover problems independently, seek solutions in an organized manner, and develop critical thinking skills (Saraswati & Saefudin, 2017). Rusman (Situngkir et al., 2019) explains that GI involves students from the planning stage through to the presentation of results in the classroom, making them more active in the learning process.

The Peer Teaching method is an approach in which students actively help their peers who have difficulty understanding the material (Akmal, 2019). Piaget suggested that interaction with peers is key to knowledge formation (Tetiwar & Appulembang, 2018). Peer Teaching encourages students to express opinions and respect others' views, making it easier for them to grasp the material.

The combination of the Group Investigation model and Peer Teaching method is effective in enhancing collaboration, understanding, and communication among students. GI focuses on group work to explore topics, while Peer Teaching allows students to teach each other, reinforcing their understanding. This combination creates a dynamic learning environment that supports both academic and social skill development in students.

Several studies, such as those by Sri Marlisa and Jailani on the use of Group Investigation to improve mathematical communication, as well as research by Ita, Azwar Anwar, and Alfian Mucti on the effectiveness of Peer Teaching in mathematics learning outcomes, support the effectiveness of these two methods.

2. Methods

This This study uses an experimental method with a quantitative approach, aiming to identify the implementation of the Group Investigation learning model with the Peer Teaching method on students' mathematical communication abilities. In this study, the independent variable is the learning model used, while the dependent variable is students' mathematical communication abilities. The study population includes all eighth-grade students at a junior high school in Tasikmalaya City. Sampling was conducted using the simple random sampling method through a lottery, with two classes selected as the experimental and control groups.

The research design used is the True Experimental Design with Pretest-Posttest Control Group Design, where two groups (experimental and control) were randomly selected, and pretests and posttests were conducted. The experimental group received instruction using the Group Investigation model with Peer Teaching, while the control group used the Problem-Based Learning (PBL) model with the discussion method.

Data collection was carried out through tests to measure students' mathematical communication abilities before and after treatment. The research instrument consists of a mathematical communication ability test, which includes 2 open-ended questions. The data obtained were analyzed using several statistical tests: scoring the mathematical communication test using N-Gain to calculate the improvement in ability, normality testing using the Kolmogorov-Smirnov test at a significance level of 5%, homogeneity testing to ensure sample uniformity, and hypothesis testing using a t-test to determine the difference in average scores between the experimental and control groups.

For hypothesis testing of a single mean, the following formula is used according to Sugiyono (2019):

$$t = \frac{\bar{x} - \mu_o}{\frac{s}{\sqrt{n}}}$$

where:
t = the calculated t-value,
$\bar{x}$ = the sample mean,
μ_o = the hypothesized value,
s = is the standard deviation, and
n = the sample size.

The testing criteria state that H_0 if $t_{calculated} > t_{1-a(db)}$ with α = 0.05 In all other cases, H_0 is accepted otherwise. The statistical hypotheses in this study are as follows:

H_0 : The mathematical communication abilities of students who apply the Group Investigation learning model with the Peer Teaching method are not better compared to students who apply the Problem-Based Learning (PBL) model with the discussion method.

H_1 : The mathematical communication abilities of students who apply the Group Investigation learning model with the Peer Teaching method are better compared to students who apply the Problem-Based Learning (PBL) model with the discussion method.

In conclusion, this study aims to provide valuable insights into the implementation of the Group Investigation learning model with Peer Teaching in enhancing students' mathematical communication skills. By examining the impact of this approach compared to the Problem-Based Learning model, the study seeks to contribute to the ongoing improvement of teaching methods that can promote better communication and understanding of mathematical concepts among students. The findings of this research have the potential to guide future educational practices and curriculum design in mathematics education.

3. Results and Discussion

3.1 Results

The results of the pretest-posttest data on the mathematical communication skills of 8th-grade students at a junior high school in Tasikmalaya, focusing on learning using the Group Investigation model with the Peer Teaching method and the Problem-Based Learning (PBL) model with the discussion method, are as Table 1 follows:

Table 1 Description of the Pretest-Posttest Data on the Mathematical Communication Skills of 8th-Grade Students at a Junior High School in Tasikmalaya.

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Experiment	34	7.14	28.57	17.9638	5.38316
Posttest Experiment	34	35.71	100.00	74.3703	17.98631
Pretest Control	34	3.57	21.43	11.9747	5.957661
Posttest control	34	35.71	82.14	52.1012	13.45259

Based on the results of the pretest and posttest data from the experimental and control classes, there is a significant difference in the average scores of students' mathematical communication skills after the implementation of the learning methods. In the experimental class, the pretest score had an average of 17.96 with a standard deviation of 5.38, a minimum score of 7.14, and a maximum score of 28.57. After the learning process, the posttest score in the experimental class showed a significant increase with an average of 74.37, a standard deviation of 17.99, a minimum score of 35.71, and a maximum score of 100.00. This indicates a significant improvement in the mathematical communication skills of the students, where this improvement is related to the understanding of number patterns in the context of geometry.

On the other hand, the control class showed different results. In the pretest, the average score in the control class was 11.97 with a standard deviation of 5.96, a minimum score of 3.57, and a maximum score of 21.43. After the learning process, the posttest score in the control class also showed an improvement, but not as large as the experimental class, with an average of 52.10, a standard deviation of 13.45, a minimum score of 35.71, and a maximum score of 82.14.

Before conducting hypothesis testing on the mathematical communication skills test results for both sample classes, prerequisite tests were first performed, namely normality and homogeneity tests. This was done to determine the statistical test that would be used in hypothesis testing. Before hypothesis testing, a normality test was performed. The normality test aims to determine whether the data distribution is normal or not, so that the appropriate statistical method can be chosen, whether to use parametric or non-parametric statistics. In this study, the Kolmogorov-Smirnov statistical test was used for normality. Since the sample size is greater than 50, the Kolmogorov-Smirnov test is more appropriate for samples with more than 50 participants (Dahlan, Oktaviani & Notobroto, 2014).

The results of the homogeneity test for the posttest scores of the sample classes show that the $F_{calculated\ value}$ is $\leq$ F_{table}, which is $1.225 \leq 3.99$, with a significance level of $\alpha = 0.05$. This means that the variances of the two sample classes are homogeneous. Next, a t-test was conducted, but prior to that, prerequisite tests were performed. After meeting the prerequisites, the t-test was carried out to determine whether there was a significant effect on the improvement of students' mathematical communication abilities in the experimental class and the control class. The hypotheses for the t-test are as follows:

H_0 : The mathematical communication abilities of students who apply the Group Investigation learning model with the Peer Teaching method are not better compared to students who apply the Problem-Based Learning (PBL) model with the discussion method.

H_1 : The mathematical communication abilities of students who apply the Group Investigation learning model with the Peer Teaching method are better compared to students who apply the Problem-Based Learning (PBL) model with the discussion method.

The testing criterion is to reject H_0 if $t_{calculated} > t_{1-a(db)}$ with α = 0.05 In all other cases, H_0 is accepted. The results of the t-test can be seen in the figure 2.

Figure 2. T-Test Results for N-Gain in Mathematical Communication Skills

n-gain	Sig.	t	df
	0.216	4.737	66

Based on statistical testing, the t-test results on the n-gain scores for both sample classes show that $t_{calculated} > t_{table}$, specifically 4.373 > 2.000, with a significance level of α =0.05 and degrees of freedom (df) = 66. This means that we reject H_0 and conclude that there is a significant difference in the improvement of mathematical communication skills between students learning with the Group Investigation model using the Peer Teaching method and those learning with the Problem-Based Learning model using the Discussion method.

Furthermore, the number of students who demonstrate mathematical communication skills under the Group Investigation model with the Peer Teaching method, based on n-gain levels, falls within the medium range when viewed in terms of average scores and standard deviation. This suggests that, on average, students in this model exhibit a moderate level of improvement in mathematical communication skills, as reflected by their n-gain scores that indicates the application of geometry concepts in number patterns.

3.2 Discussion

The results of the testing of the average scores of students' mathematical communication abilities in the two classes show a significant difference between the experimental and control classes. Based on the pretest data, the average mathematical communication score in the experimental class was 17.96 with a standard deviation of 5.38, while the control class had an average of 11.97 with a standard deviation of 5.96. This indicates that the experimental class started with higher mathematical communication abilities compared to the control class.

After the learning session, the posttest results showed a significant improvement in the experimental class, with an average of 74.37 and a standard deviation of 17.99, while the control class showed a smaller improvement, with an average of 52.10 and a standard deviation of 13.45. The greater improvement in the experimental class indicates that the application of the Group Investigation model with Peer Teaching is more effective in enhancing students' mathematical communication skills compared to Problem-Based Learning with a Discussion method.

The implementation of the Group Investigation model with Peer Teaching in teaching number patterns that involve geometric concepts, such as the arrangement of points in triangular and square patterns, allows students to understand how number patterns are formed and organized in geometric space. This approach not only provides numerical understanding but also encourages students to explore the visual and spatial dimensions within number patterns.

According to Geometric Thinking Theory, understanding geometry develops in several stages, starting with visualization (the ability to physically see geometric shapes), analysis (the ability to break down and analyze the elements of geometry), and then abstraction (the ability to formulate patterns or principles in general terms without relying on visual representations) (Zainal,2020). In this context, the application of Group Investigation with Peer Teaching encourages students to move from the visualization stage of geometric number patterns to the analysis and abstraction stages. Students are invited to not only see the points in triangular or square patterns but also to understand how the relationships between these elements form a structured number sequence.

Through group discussions and collaboration, students can identify patterns that emerge from these geometric arrangements and communicate their understanding with their group members. For example, students studying the triangular pattern can explore how the number of points in each row increases consistently or how the arrangement of points forms a number pattern that follows a specific sequence. With the Peer Teaching approach, students have the opportunity to teach their classmates about these patterns, deepening their own understanding and enhancing their mathematical communication skills.

Based on the Kolmogorov-Smirnov test, the pretest and posttest data for both the experimental and control classes are normally distributed, with significance values of 0.092 for the pretest in the experimental class, 0.070 for the pretest in the control class, 0.134 for the posttest in the experimental class, and 0.111 for the posttest in the control class. These values are greater than 0.05, indicating that the data can be considered normal, thus allowing the use of parametric statistical tests.

The variance homogeneity test shows that the calculated F-value = 1.225 is less than the F-table value = 3.99 at a significance level of $\alpha = 0.05$, indicating that the variances of both classes are homogeneous, allowing for further statistical analysis.

In the t-test for the n-gain scores, the calculated t-value = 4.373 is greater than the table t-value = 2.000 at a significance level of 0.05 with 66 degrees of freedom. This leads to the rejection of the null hypothesis (H_0), indicating a significant effect on the improvement of mathematical communication skills between students in the experimental and control classes. This significant improvement shows that the Peer Teaching method in the Group Investigation model has a more substantial effect than the Discussion method in the Problem-Based Learning model.

Based on the distribution of students' mathematical communication abilities after the learning process, most students in the experimental class showed higher levels of mathematical communication skills, with most students being at the moderate level. Students still experience inaccurate measurements when solving geometry problems (Nopriana, Rosita & Halbi, 2022). This indicates that while there was a significant improvement, there is still room for further development. Overall, this teaching model was proven to be effective in strengthening students' mathematical communication skills, especially in the context of number patterns involving geometry.

From the perspective of Geometric Thinking Theory, students' understanding of number patterns in geometric contexts occurs in several phases. Initially, students see these patterns as arrangements of points or geometric objects that are visual. However, through group discussions and explorations, they begin to understand the relationships between these points, how the number of points increases according to certain rules, and how these patterns can be translated into more abstract mathematical concepts. Students are not only learning numbers but also how these numbers emerge and develop in geometric forms, linking visualization with abstraction. The results of this study are consistent with the research by Nopriana et al. (2023), which highlights geometric thinking abilities at the analysis and informal deduction stages.

With the application of Group Investigation and Peer Teaching, students are encouraged to think more critically and creatively about the relationship between mathematics and geometry. This discussion-based learning provides students the opportunity to express and share their ideas in a more open and collaborative manner, which in turn enriches their understanding of broader mathematical concepts.

Based on the findings of this study, it can be concluded that the Group Investigation model with Peer Teaching is significantly more effective in improving students' mathematical communication skills, especially in understanding number patterns that involve geometric concepts. By integrating geometry into number patterns, students not only develop their mathematical communication skills but also deepen their understanding of the connection between geometry and number patterns, as well as how these patterns can be translated into more abstract mathematical concepts. This teaching model successfully led students to understand how number patterns evolve in geometric forms and enhanced their ability to communicate and share their mathematical understanding with their classmates.

4. Conclusions

The results of the research and discussion in the previous chapter, the following conclusions can be drawn (1) There is a difference in mathematical communication between students who receive instruction using the Group Investigation model with Peer Teaching and those who receive instruction using Problem-Based Learning (PBL) with a discussion method. (2) The mathematical communication for instruction using the Group Investigation model with Peer Teaching falls within the medium category.

Conflict of Interest

The authors declare no conflicts of interest.

References

Akmal, N. (2019). Pengaruh Metode Peer Teaching Terhadap Hasil Belajar Mahasiswa Pada Materi Operasi Aljabar. *ITQAN : Jurnal Ilmu-Ilmu Kependidikan*, *10*(2), 69–77. https://doi.org/10.47766/itqan.v10i2.540

NCTM. (2000). *Principles and Standards for School Mathematics*.

Nopriana, T., Rosita, C. D., & Halbi, D. (2022). Implementation of Didactical Design on Circle Material at Junior High School. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *13*(1), 100-112.

Nopriana, T., Herman, T., & Martadiputra, B. A. P. (2023). Prospective Mathematics Teachers'van Hiele's Geometry Thinking and Habits of Mind: A Description of Hard Skill and Soft Skill by Gender. *International Journal of Mathematics and Mathematics Education*, *1*(1), 51–60. https://doi.org/10.56855/ijmme.v1i1.231

Nurhasanah, R. A., Waluya, S. B., & Kharisudin, I. (2020). Kemampuan Komunikasi Matematis dalam Menyelesaikan Masalah Soal Cerita. *Seminar Nasional Pascasarjana 2019*, *2*(2017), 769–775.

Saraswati, A. M., & Saefudin, A. A. (2017). Penerapan Model Pembelajaran Group Investigation Dalam Pembelajaran Matematika Pada Materi Himpunan. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *6*(1), 89. https://doi.org/10.24127/ajpm.v6i1.869

Sugiarto, M. N. (2020). Keyakinan Guru Pada Peranan Teknologi Dalam Pembelajaran Matematika. *Semadik*, *3*(1), 26–34.

Sugiyono. (2019). *METODE PENELTIAN Kuantitaif, Kualitatif, dan R&D*. Alfabeta.

Situngkir, J., Dewi, I., & Medan, U. N. (2019). Upaya Meningkatkan Kemampuan Komunikasi Matematis Siswa Dengan Menggunakan Model Pembelajaran Kooperatif Tipe Group Investigation Di Kelas IX SMP Swasta Gajah Mada Medan. *Jurnal Inspiratif*, *5*, 53–66. https://doi.org/https://doi.org/10.24114/jpmi.v5i1.13525

Syafina, V. (2020). Analisis Kemampuan Komunikasi Matematis Siswapada Materi Spldv. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *7*(2), 118–125.

Tetiwar, J., & Appulembang, O. D. (2018). Penerapan Metode Peer Tutoring untuk Meningkatkan Pemahaman Konsep Materi Perkalian Bersusun Pada Siswa Kelas III SD. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *8*(3), 302–308. https://doi.org/10.24246/j.js.2018.v8.i3.p302-308

Yanti, R. N., Melati, A. S., & Zanty, L. S. (2019). Analisis Kemampuan Pemahaman dan Kemampuan Komunikasi Matematis Siswa SMP Pada Materi Relasi dan Fungsi. *Jurnal Pendidikan Matematika*, *3*(1), 209–219. https://doi.org/https://doi.org/10.31004/cendekia.v3i1.95

Zainal, Z. (2020). Peringkat berpikir geometri siswa berdasarkan teori Van Hiele: Suatu disain video pembelajaran geometri. Global Research and Consulting Institute (Global-RCI).