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Enhancing the Mathematical Communication Abilities of Eighth-Grade Students through an Ethnomathematics-Oriented Flipped Classroom Approach

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Abstrak. *The results of the preliminary survey conducted at SMP Negeri 5 Metro on August 19, 2025, indicate that the mathematical communication skills of most students are still classified as low. This condition highlights the need for research on the influence of the ethnomathematics-based flipped classroom learning model on the mathematical communication skills of eighth-grade students at SMP Negeri 5 Metro. This study uses a quasi-experimental method with a posttest-only control group design, involving an experimental class with ethnomathematics-based flipped classroom learning and a control class with conventional learning. Data collection techniques were carried out through mathematical communication ability tests, observation, and documentation. Data analysis was conducted through prerequisite tests such as normality and homogeneity tests, followed by hypothesis testing using the t-test. The research results showed that the average score of students in the experimental class was 89.33, higher than the control class at 78.48. The hypothesis testing showed a significance value of 0.002<0.05, so H_0 is rejected and H_1 is accepted. Based on these results, it can be concluded that there is a significant difference in mathematical communication skills between students who participate in ethnomathematics-based flipped classroom learning and those who follow conventional learning, indicating that this model is effective for use in mathematics education.*

Keywords: *ethnomathematics, flipped classroom, mathematical communication.*

INTRODUCTION

Education is a planned process aimed at developing the potential of learners so that they possess knowledge, skills, and attitudes that are beneficial in life. At the national level, education plays a strategic role in shaping character and improving the quality of human resources as outlined in Law Number 20 of 2003 on the National Education System. One of the disciplines that significantly contributes to achieving these goals is mathematics, due to its applicative nature and its ability to train logical, systematic, and critical thinking (Manik et al., 2022).

In mathematics learning, there are several important competencies that students need to master, one of which is mathematical communication skills. This ability reflects students' skills in conveying mathematical ideas or concepts thru various forms of representation, such as notation, symbols, tables, graphs, or

diagrams in a coherent and clear manner (Lubis et al., 2023). The role of mathematical communication skills is not only limited to the conveyance of ideas but also supports the process of concept understanding, reasoning, and problem-solving in learning (Zakiyah et al., 2024).

Although having an important role, students' mathematical communication skills are still relatively low. This is evident from the results of the Program for International Student Assessment (PISA) in 2022, which show that Indonesian students' mathematics achievements are still below the international average (PISA, 2022). This condition is suspected to be related to students' limitations in expressing mathematical ideas both in writing and visually (Kusumah et al., 2020). This finding is reinforced by the pre-survey results at SMP Negeri 5 Metro, which show that the majority of students fall into the low category in mathematical communication skills. Students still experience difficulties in representing concepts, using symbols correctly, and systematically organizing problem-solving steps.

The problem indicates the need for the implementation of more innovative learning strategies that can enhance active student participation. One alternative that can be used is the flipped classroom model. This model transforms the traditional learning pattern by moving the delivery of material outside the classroom thru digital media, while in-class activities are focused on discussions, exercises, and problem-solving (Sudarmanto et al., 2021). With this approach, students have more opportunities to interact and actively communicate mathematical ideas (Syarah, 2023).

The flipped classroom model can be integrated with an ethnomathematics approach to enhance the meaning of learning for students. This approach integrates cultural elements into mathematics education (Kiptiyah et al., 2021), so that the concepts being studied become more contextual and closer to the students' lives. Thru familiar cultural contexts, students are expected to more easily understand the material while also being more confident in expressing their mathematical ideas (Yulianasari et al., 2023).

Several previous studies have shown that the implementation of flipped classrooms is effective in enhancing various mathematical abilities. Students who participate in flipped classroom learning using peer instruction assisted by e-LKPD have superior mathematical communication skills and mathematical disposition compared to those in flipped classrooms without this approach (Sudariana et al., 2023). In line with this, the implementation of the flipped classroom model with the help of Adobe Flash has proven to significantly enhance students' mathematical communication and problem-solving skills compared to traditional learning (Dayurni et al., 2025). In addition, the application of a realistic mathematics approach combined with the flipped classroom model has also proven to be able to improve students' mathematical literacy (Pratiwi, 2022). In line with this, students' understanding of mathematical concepts improves thru the application of the flipped classroom compared to traditional learning (Nurhasanah, 2021).

However, research that combines the flipped classroom with an ethnomathematics approach in the Lampung culture, particularly in the context of mathematical communication skills, is still rare. Therefore, this study was conducted to analyze the impact of ethnomathematics-based flipped classroom learning on students' mathematical communication skills in the topic of relations and functions at SMP Negeri 5 Metro. It is expected that this research will have a positive impact on the learning process by providing benefits to all students, both directly and indirectly. The benefits that can be obtained are:

1. School: Encouraging the improvement of learning quality through strategies that promote student engagement.
2. Teacher: Provide an innovative alternative teaching model that can be used in the mathematics education process. A model that can be used in the mathematics education process.
3. For Students: Provide a learning experience that is more interactive, engaging, contextual, and stimulating to enhance students' ability to communicate mathematically in written form.
4. This study serves as a learning opportunity for researchers because the knowledge gained both inside and outside the classroom can be easily applied.

RESEARCH METHODS

This research applies a quantitative approach with a quasi-experimental method and uses a posttest-only control group design. According to Creswell & Creswell (2023), quantitative research is an approach for testing objective theories by examining the relationships among variables, which are measured using instruments and analyzed through statistical procedures. In this study, the posttest-only control group design was used to compare the outcomes of the experimental and control groups after the treatment, without administering a pretest. The subjects in this study are eighth-grade students of SMP Negeri 5 Metro in the 2025/2026 academic year. Sampling was conducted using the purposive sampling technique, which is a sample determination technique that considers the researcher's assessment of the selected population elements (Asari et al., 2023). Several considerations used include the similarity in average student abilities and teacher support in the implementation of the research. Based on these considerations, class VIII 4 was designated as the experimental class using the ethnomathematics-based flipped classroom learning model, while class VIII 2 was designated as the control class with conventional learning.

The research instrument used is a mathematical communication ability test in the form of essay questions on the topic of relations and functions, as well as teacher observation sheets and student participation to monitor the implementation of learning. The test consists of six essay questions given during the posttest. The preparation of the test instrument is based on the indicators of mathematical communication ability according to (NCTM, 2000) as follows:

1. The skill to express mathematical ideas verbally, in writing, thru demonstrations, and to present them visually;
2. The ability to understand, interpret, and evaluate mathematical ideas both verbally, in writing, and visually;
3. Proficiency in using mathematical terms, notation, and structure to convey ideas, describe relationships, and model various situations.

Then, the test results are grouped based on the categories of students' mathematical communication skills.

This grouping aims to provide a more systematic overview of the students' skill levels, whether they fall into the low, medium, or high category. The classification of students' mathematical communication skills is presented in Table 1 below (Aprilianto et al., 2022).

Table 1. Classification of Students' Mathematical Communication Skills

Range	Category
$x \geq 69$	High
$45 < x < 69$	Medium
$x \leq 45$	Low

Based on the table above, the classification is used to determine the level of students' mathematical communication skills in a more structured manner, making it easier to analyze the posttest results. Furthermore, the teacher observation sheet and student participation were prepared based on the steps of the flipped classroom learning model. The steps of the flipped classroom model used in this study according to (Bishop & Verleger, 2013), namely as follows.

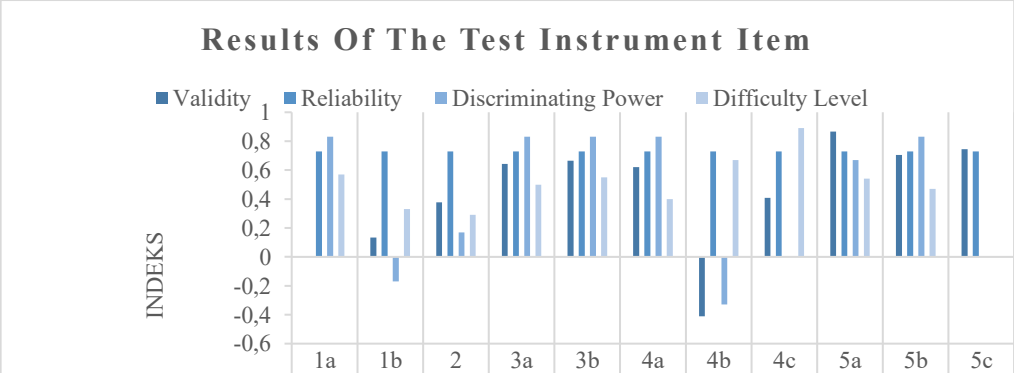
1. Phase zero, before learning, students independently study the material for the upcoming meeting at home using learning resources sent by the teacher at the end of the previous lesson.
2. Phase one, students are randomly divided into several groups to complete tasks related to the material they studied at home. At the beginning of the session, they are also given a quiz to measure their initial understanding of the information they studied at home.
3. Phase two, involves group discussions among students, facilitated by the teacher. On the other hand, the project mentioned in this teaching technique is an activity sheet filled out by students to test their understanding skills.
4. Phase three, the teacher first informs the students in class that a quiz will be held at the end of each session to help them fully understand all the material discussed in class. Here, the teacher's task is to facilitate.

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Mathematical communication ability test data was quantitatively analyzed using SPSS 25. Descriptive analysis was used to determine the minimum, maximum, average, and standard deviation of the posttest results in both the experimental and control classes. To illustrate the score distribution, the posttest results were also divided into high, medium, and low groups. Prerequisite tests, such as the Levene variance homogeneity test and the Shapiro-Wilk normality test, come before hypothesis testing. Since there are less than fifty pupils in each session, the Shapiro-Wilk test is utilized. If the significance value is higher than 0.05, the data is regarded as regularly distributed. To ascertain if the variances of the two groups can be compared, the homogeneity test is performed. The variances of the two groups are regarded as homogenous if the significance value is higher than 0.05.

RESULTS AND DISCUSSION

Before the research is conducted, the posttest instrument is first analyzed thru several testing stages, including expert validity, empirical validity, reliability, discriminating power, and difficulty level. The testing aims to ensure that the instrument used has good quality and is capable of accurately measuring students' mathematical communication skills. The results of the instrument test items can be seen in the following diagram.



	1a	1b	2	3a	3b	4a	4b	4c	5a	5b	5c
Validity	0	0,134	0,378	0,642	0,664	0,621	-0,411	0,409	0,866	0,704	0,744
Reliability	0,729	0,729	0,729	0,729	0,729	0,729	0,729	0,729	0,729	0,729	0,729
Discriminating Power	0,83	-0,17	0,17	0,83	0,83	0,83	-0,33	0	0,67	0,83	0
Difficulty Level	0,57	0,33	0,29	0,5	0,55	0,4	0,67	0,89	0,54	0,47	0

Figure 1. Results of the Item Test Instrument Based on the results of

The instrument test above, the questions are declared valid if they have a value greater than $r_{tabel} = 0.433$. The valid questions are 1a, 3a, 3b, 4a, 5a, 5b, and 5c, while questions 1b, 2, 4b, and 4c are not valid. The results of the reliability test obtained a value of 0.729 with a sufficient category, making the instrument suitable for use. In the discrimination power test, questions 1a, 3a, 3b, 4a, 5a, and 5b are classified as good because they have an index ≥ 0.40. Meanwhile, in the difficulty level test, most of the questions fall into the moderate category with an index $0.30 < P \leq 0.70$, while questions 2 and 5c are classified as difficult and question 4c as easy.

Therefore, it can be concluded that there are six items that are suitable for use in the research, namely question 1a, 3a, 3b, 4a, 5a, and 5b. After the test instrument trial, the research was then conducted. The learning activities in the experimental class were conducted by the researcher, while the learning in the control class was conducted by the subject teacher. This research was conducted in the experimental class and the control class over three meetings with a time allocation of 2×40 minutes to 3×40 minutes, adjusted according to the school schedule. In the experimental class, a flipped classroom learning model based on ethnomathematics was applied thru the use of instructional videos on relations and functions, which were shared with students via WhatsApp for independent study before the face-to-face sessions took place.

The learning process begins with greetings, prayers, checking student attendance, and providing learning motivation. After that, the researcher reviews the material that students have studied at home, followed by an initial test to assess students' preliminary understanding and the formation of discussion groups. Then, students work on activity sheets related to the material on relations and functions, and present the discussion results in front of the class. During the activity, the researcher acts as a guide and facilitator to help the discussion run smoothly and to reinforce the students' understanding.

At the end of the lesson, the researcher and the students summarize the material, provide learning materials for the next meeting, conduct an evaluation, and then conclude the activity with a prayer and farewell. In addition to the

implementation of learning, observations were also made on the teacher's activities and student participation during the learning activities. Observation of teacher activities was conducted to see the level of teacher involvement during the implementation of the flipped classroom learning. The observation results noted by the observer indicate that the teacher's activity score improved at each meeting, namely 3.88 in the first meeting, 3.94 in the second meeting, and 4.00 in the third meeting.

All scores are in the very good category with an average of 3.94. The results indicate that the implementation of the learning process is running well and consistently in each session. Then, student participation observations were also conducted to determine student involvement during learning activities, whether in independent study, taking initial quizzes, group discussions, or participating in learning evaluations. The observation results noted by the researcher showed an increase in student participation scores, from 3.64 in the first meeting to 3.79 in the second meeting and 3.93 in the third meeting. All scores fall into the very good category with an average of 3.79, so it can be concluded that the students were actively and consistently engaged during the learning process. After all the meetings were completed, a posttest was given to the experimental and control classes on Thursday, November 20, 2025. The test consisted of six essay questions used to measure the students' mathematical communication skills.

1. **Data from the Posttest Results of the Experimental Class and the Control Class**

   Based on the posttest results, the average score of students' mathematical communication skills on the topic of relations and functions is presented in the table below.

Table 2. Average Posttest Scores in the Sample Class

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Posttest_Eksperimen	27	75	100	89.33	7.338
Posttest_Kontrol	27	42	100	78.48	15.027

Based on the table, there is a noticeable difference between the two classes. The average mathematical communication ability of students in the experimental class reached 89.33, while the control class was 78.48. The highest score in both classes was the same, at 100, while the lowest score in the experimental class was 75 and in the control class was 42. This indicates that the average ability of students in the experimental class is higher compared to the control class.

2. Results of the Mathematical Communication Ability Test

The average posttest scores indicate a difference, where the mathematical communication ability of students in the control class is lower compared to the experimental class. The results are presented in the following diagram.

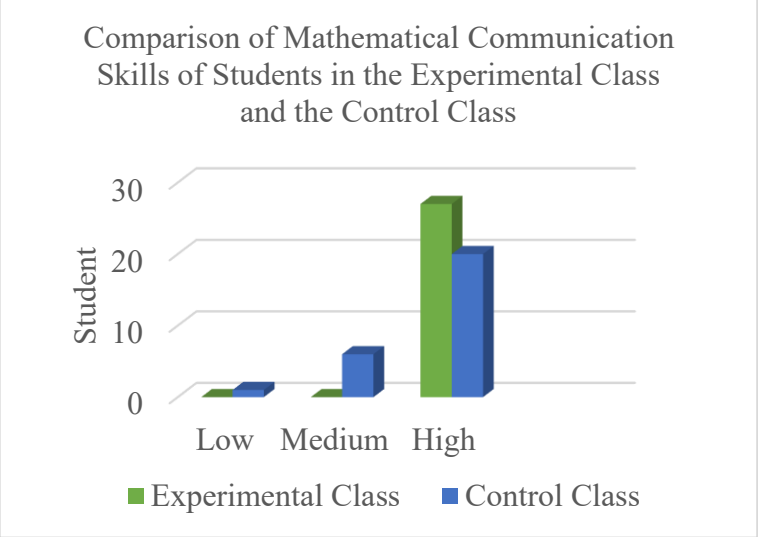


Figure 2. Comparison of Mathematical Communication Skills in the Experimental Class and the Control Class

The diagram in the image above shows a comparison of mathematical communication skills between students in the experimental class and the control class. Most of the students in the experimental class fall into the high category, while in the control class, there are still students who fall into the medium or low categories. This condition indicates that the mathematical communication skills of students in the experimental class tend to be better compared to the control class. This can also be seen in the

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students' answers reviewed based on the indicators of mathematical communication skills as follows:

a. The skill of expressing mathematical ideas in written form and visual representation. In this indicator, students are directed to present mathematical ideas in the form of sets of ordered pairs.

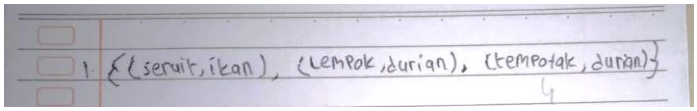


Figure 3. Answers of the experimental class students to question 1a

In the figure above, it can be seen that the students in the experimental class are already able to express mathematical ideas in the form of ordered pairs accurately. This shows that they have understood the concept of relations and are able to present it in symbolic form correctly and structurally.

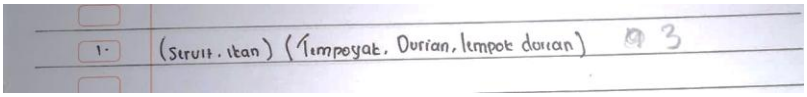


Figure 4. Control class students' answers to question 1a

In the figure above, it can be seen that students in the control class have not yet been able to present mathematical ideas in the form of ordered pairs accurately, as indicated by errors in the arrangement of their members. This shows that the students' conceptual understanding is still not fully optimal.

b. The ability to understand, interpret, and evaluate mathematical ideas presented in written or visual form. In this indicator, students are expected to understand, interpret, and evaluate mathematical ideas presented in written form.

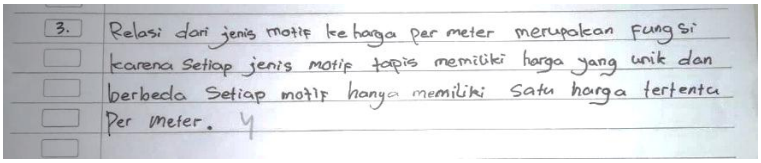


Figure 5. Answers of the experimental class students to question 4a

In the figure above, it can be seen that the experimental class students can provide a logical explanation that aligns with the

mathematical concepts used. This shows that the students not only understand the given problem but are also able to write down the reasoning for their solution clearly and accurately.

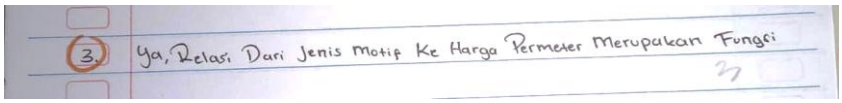


Figure 6. Control class students' answers to question 4a

In the figure above, it can be seen that students in the control class can understand the question's instructions, but the reasoning provided is still somewhat inaccurate and not fully aligned with the correct mathematical concept.

c. The ability to use mathematical terms, notations, and structures in writing to convey ideas, show relationships, and model a problem. In this indicator, students are expected to use terms, symbols, and mathematical structures in writing to express ideas, illustrate relationships, and model a problem.

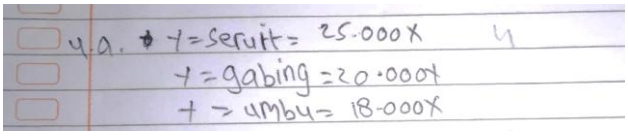


Figure 7. Experimental class students' answers to question 5a

In the figure above, it can be seen that the experimental class students are already able to model the problems presented in the question accurately, although there are still errors in the use of terms and notation. This indicates that the students are beginning to get used to transforming problems into mathematical models.

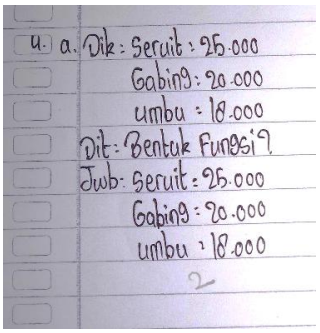


Figure 8. Control class students' answers to question 5a

In the figure above, it can be seen that students in the control class still have difficulty using the correct notation and in constructing mathematical models properly, resulting in answers that do not align with the expected concepts.

Based on the students' answers, in the first indicator, the experimental class students were able to write mathematical ideas in the form of ordered pairs accurately, while the control class students still made mistakes in their composition. In the second indicator, the experimental class students showed better ability in understanding and logically explaining mathematical ideas, while the control class students still did not provide fully accurate explanations. Furthermore, in the third indicator, the experimental class students were able to model problems into mathematical forms, although there were still minor errors in the use of terms and notation, while the control class students still had difficulties in using notation and modeling problems correctly. Thus, it can be concluded that the mathematical communication skills of the experimental class students are superior compared to the control class students across all measured indicators.

3. Hypothesis Testing

The posttest results in the experimental and control classes were analyzed using prerequisite tests, namely normality and homogeneity tests, followed by hypothesis testing and calculations using SPSS software.

a. Normality Test

The normality test on the sample class is conducted using the Shapiro-Wilk test to determine whether the data from both classes are normally distributed or not. The calculation of the normality test results is as follows.

Table 3. Results of the Sample Class Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttest_Eksperimen	.152	27	.114	.932	27	.078
Posttest_Kontrol	.112	27	.200*	.956	27	.298

The table above shows that the significance value (Sig.) in the experimental class is 0.078 and in the control class is 0.298. Since both values are greater than 0.05, it can be concluded that the data is normally distributed.

b. Homogeneity Test

The homogeneity test on the sample class is conducted using the variance homogeneity test to determine whether the two sample classes have the same variance (homogeneous) or not. The results of the homogeneity test on the sample class are presented in the table below.

Table 4. Results of the Variance Homogeneity Test in the Sample Class

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Hasil_Posttest	Based on Mean	10.291	1	53	.002
	Based on Median	10.147	1	53	.002
	Based on Median and with adjusted df	10.147	1	38.338	.003
	Based on trimmed mean	10.472	1	53	.002

The table above shows that the significance value is 0.002<0.05. This indicates that the variances of the two groups are not homogeneous, so the hypothesis testing is continued using the t' test.

c. t' test

The hypothesis test in this study uses the t' test to determine the difference in means between the experimental class and the control class. The t' test was applied because the results of the homogeneity test showed that the variances of the two groups were not homogeneous. The hypothesis used in this study is:

Null hypothesis (H_0): There is no significant effect of the application of the flipped classroom learning model based on ethnomathematics on students' mathematical communication skills.

Alternative hypothesis (H_1): There is a significant effect of the application of the flipped classroom learning model based on ethnomathematics on students' mathematical communication skills.

Table 5. Test Results on Sample Class

Independent Samples Test				
		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
Hasil_Posttest	Equal variances not assumed	3.280	39.587	.002

The table above shows that in the row equal variances not assumed, the significance value is 0.002<0.05, so H_0 is rejected and H_1 is accepted. Therefore, it can be concluded that there is a difference between students who learn with the ethnomathematics-based flipped classroom model and students who learn with the conventional model.

Based on the research results, it shows that the written mathematical communication skills of students in the experimental class are superior compared to the control class. This is indicated by the average posttest score of the experimental class being 89.33, while the control class was 78.48. In addition, the t' test results obtained a significance value of 0.002<0.05, thus H_0 was rejected and H_1 was accepted. Thus, it can be concluded that the application of the flipped classroom model based on ethnomathematics has a significant impact on students' mathematical communication skills.

The improvement was influenced by the implementation of structured flipped classroom learning stages. In the initial stage, students engage in independent learning at home by utilizing instructional videos prepared by the teacher. This activity contributes to increasing students' independence, interest in learning, and readiness before attending classroom lessons (Rahmawati & Nuraeni

2021; Wijayanto et al. 2022; Syafi'i & Fauziyah 2022). Next, in the first stage, classroom learning activities, students are first given a pre-test to determine their initial abilities (Eka et al., 2025).

Then, it continued with random group assignments. At this stage, students begin to express mathematical ideas in writing while being guided to organize their answers in a more structured and systematic manner. In the second stage, group discussions, students collaborate with each other to complete the student activity sheets. This activity makes students more active in exchanging ideas, expressing opinions, and using symbols, notations, and mathematical models accurately (Putri & Sukmaningthias 2025; Sabri et al., 2025). In the process, the teacher acts as a facilitator who directs and guides the course of the discussion (Syafutry & Ananda, 2025). Next, in the third stage, the teacher reinforces the material, presents the conclusion, and conducts an evaluation to ensure students' understanding of the concepts that have been learned (Hanifah & Setiyatna, 2025). Furthermore, the use of the ethnomathematics approach makes learning more meaningful because the material is connected to culture and everyday life (Rosidah et al., 2025), so that students find it easier to understand and express mathematical ideas in writing. Based on the observation results, the activities of the teacher and students are classified as very good and show improvement in every meeting.

The findings of this study can be further explained through the pedagogical characteristics of the flipped classroom model, which shifts the initial acquisition of learning materials to activities conducted before class and allocates classroom time for active learning. Lo et al., (2021), in their review of 33 studies on mathematics flipped classrooms, found that this approach can support students' behavioral, emotional, and cognitive engagement, including classroom interaction, participation, and mathematical understanding. These findings are consistent with the present study, in which students engaged in group discussions, completed worksheets collaboratively, and communicated mathematical ideas in writing. Such activities provide opportunities for students to articulate their reasoning, organize mathematical representations, and explain the procedures used to solve problems.

Furthermore, the difference in posttest scores between the experimental and control classes is consistent with the broader evidence on flipped classroom learning. Strelan et al. (2020), through a meta-analysis of 198 studies involving 33,678 students, reported a moderate positive overall effect of the flipped classroom on student performance compared with traditional teaching approaches. The authors also identified structured active learning and problem-solving opportunities as important contributors to this effect. In the present study, the classroom activities provided opportunities for students to discuss mathematical problems, exchange ideas, and formulate written explanations. Therefore, the observed difference may be understood in relation to the opportunities for active participation and collaborative problem-solving provided by the instructional model. However, the present findings specifically concern written mathematical communication and should not be generalized to all dimensions of mathematics achievement without further evidence.

The integration of ethnomathematics offers an additional explanation for the findings because it connects mathematical concepts with cultural practices and familiar real-life contexts. Orey & Rosa (2016) discussed ethnomathematics as a pedagogical perspective that can connect mathematical knowledge with cultural practices and ways of understanding the world. In the context of the present study, culturally relevant situations may provide students with meaningful starting points for identifying mathematical relationships and expressing them through written representations. When students connect familiar cultural experiences with formal mathematical concepts, they have opportunities to explain the relationships between contextual information, mathematical symbols, and problem-solving procedures. Nevertheless, the specific contribution of ethnomathematics cannot be isolated from the flipped classroom model in this study because both were implemented together.

The relationship between the flipped classroom structure and ethnomathematics is also important. Akçayır & Akçayır (2019) identified improved learning performance among the commonly reported advantages of flipped classrooms, while also highlighting challenges associated with students'

preparation before class. This suggests that the availability of instructional videos alone is not sufficient; students need to engage with the materials before classroom meetings and participate in meaningful learning activities during class. In the present study, the combination of independent preparation, group discussion, teacher guidance, and evaluation created opportunities for students to revisit mathematical concepts and express their understanding. The ethnomathematics context may further support these activities by providing situations that students can interpret and discuss using mathematical language.

The findings also have implications for mathematics teaching. Rather than relying exclusively on explanations delivered by the teacher, mathematics instruction can incorporate pre-class learning resources, collaborative problem-solving, and culturally contextualized tasks to provide students with opportunities to communicate their mathematical reasoning. Fernández-Martín et al., (2020), in their systematic review of the flipped classroom in mathematics education, examined how this instructional approach has been implemented in mathematics learning and discussed its potential contribution to mathematical learning. In line with this perspective, the present study suggests that the combination of structured flipped classroom activities and ethnomathematical contexts is a promising instructional option for supporting written mathematical communication. Future studies could examine the separate contributions of the flipped classroom model and the ethnomathematics approach, include pretest measurements, and investigate how students develop different indicators of mathematical communication over time.

The active involvement of students in discussion activities and task completion directly plays a role in training their written mathematical communication skills. Furthermore, based on the analysis results of each indicator, the experimental class students showed better results in all aspects of mathematical communication compared to the control class. In line with the results of the conducted research, there are several previous studies that are relevant and have similarities with this research. First, the implementation of the flipped classroom model supported by learning media has proven to have a positive impact on

improving students' communication skills and understanding of mathematical concepts (Mukhayat et al., 2024).

Second, the use of a flipped classroom aided by Adobe Flash-based audiovisual media also shows an improvement in students' communication skills and understanding of mathematical concepts (Berlian, 2023). Furthermore, the reasoning ability of students who participated in ethnomathematics-based flipped classroom learning with the help of Edpuzzle showed higher results compared to students who used the Problem Based Learning model (Alsalamah et al., 2022). Other research also states that students who participate in learning with the flipped classroom model achieve higher mathematics learning outcomes compared to students who learn through conventional teaching methods (Pratiwi, 2022). Next, the students' mathematical literacy skills improved after the implementation of a realistic mathematics approach combined with the flipped classroom model (Herutomo & Masrianingsih, 2021).

In line with this, the implementation of the flipped classroom model is able to enhance students' understanding of mathematical concepts better compared to the use of conventional teaching methods (Nurhasanah, 2021). Based on the results of various previous studies, it can be concluded that the flipped classroom model contributes positively to mathematics learning. This model has proven effective in enhancing several mathematical abilities of students, including mathematical communication skills, conceptual understanding, mathematical reasoning, mathematical literacy, and learning outcomes. The effectiveness is further supported by the use of various media and learning approaches, such as audiovisual media, Adobe Flash, Edpuzzle, and the realistic mathematics approach. Thus, the alignment of this research with previous studies further emphasizes that the application of the ethnomathematics-based flipped classroom model significantly influences students' mathematical communication skills.

CONCLUSION

Based on the research results and discussions that have been presented, it can be concluded that the application of the flipped classroom learning model based

on ethnomathematics has a positive and significant impact on the mathematical communication skills of eighth-grade students at SMP Negeri 5 Metro. The implementation of flipped classroom learning based on ethnomathematics helps students to better express mathematical ideas, understand and explain concepts in a systematic manner, and use mathematical symbols and models more accurately. Independent study activities before classroom learning, group discussions, and the integration of cultural elements into the material provide students with opportunities to be more active and confident during the learning process. Therefore, the flipped classroom model based on ethnomathematics can be used as an effective alternative for enhancing students' mathematical communication skills.

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