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Collaboration and Social Interaction in Mathematics Learning in Multicultural Classrooms: A Qualitative Case Study

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ABSTRACT

Mathematics learning in multicultural classrooms requires collaborative interaction that accommodates students' cultural and linguistic diversity. This study aims to explore how cultural diversity shapes collaboration and social interaction in mathematics learning in a multicultural classroom. This study employed a qualitative case study design. The participants were 16 undergraduate mathematics education students at a private university in Metro City, Indonesia. The classroom was categorized as multicultural because the students came from different cultural backgrounds and showed variations in language use, communication styles, ways of expressing opinions, and approaches to group discussion and mathematical problem solving. Data were collected through questionnaires, semi-structured interviews, participatory observation, and documentation. The questionnaire covered three aspects: students' experiences and perceptions of multicultural classrooms, group dynamics in mathematical problem solving, and collaborative projects in mathematics learning. The data were analyzed through data reduction, categorization, interpretation, and conclusion drawing, with source and technique triangulation used to strengthen the credibility of the findings. The results show that cultural diversity did not directly determine students' mathematical problem-solving ability, which was more strongly influenced by their understanding of the material. However, cultural diversity affected the communication process, discussion dynamics, and ways students expressed mathematical ideas. Differences in language, thinking styles, and communication patterns became the main challenges in group interaction. Nevertheless, most students were able to collaborate with peers from different cultural backgrounds. These findings indicate that multicultural mathematics classrooms require inclusive interaction strategies, heterogeneous grouping, and clear classroom communication to support effective collaboration and social interaction.

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INTRODUCTION

The study of mathematics education in multicultural classrooms is not just about the knowledge of mathematical content that students acquire; it also involves how they engage in communicative, collaborative, and participatory activities related to learning. In the era of globalization, classrooms have become places comprising of students belonging to varied cultures, regions, languages, and social contexts. This multiplicity in

the classroom environment could enhance mathematics learning as the students would have different experiences, views, and modes of expression. However, multiplicity could also pose some problems as a result of the lack of mediation of differences in linguistic and communicational practices in the classroom. Multicultural classrooms not only reflect a diversity of cultures, languages, and values but also offer a space for students to learn from differences and develop important social skills. The role of language and culture in mathematics learning (Moschkovich, 2019). Collaboration and social interaction in mathematics learning in multicultural environments are key to creating inclusive, meaningful, and effective learning experiences. Culturally responsive mathematics teaching increases student engagement and provides alternative perspectives on learning pembelajaran (Greer et al., 2009).

There are certain norms present in each micro-culture of each class that affect communication and participation processes. According to such an approach, the involvement of students in math studies depends not only on personal abilities but also on social norms and interaction established in a class. So, the issue of multicultural environment and learning of mathematics includes the process of interaction between students, expression of mathematical concepts and reactions on various views on the subject (Güven & Dede, 2017). In addition, collaboration has been noted as one of the effective ways of teaching mathematics because it helps in discussions, problem solving, idea learning, and building of social skills. Collaborative activity makes it possible for students to state their views, question other people's viewpoints and solve problems collectively (Langer-Osuna et al., 2020). Nevertheless, collaborative activity in heterogeneous classrooms is not similar to collaborative activity in homogeneous classrooms regarding the modes of communication involved. This is because every individual has unique modes of communication that influence their interactions. The role of teachers in supporting social interaction in multicultural classrooms is very important (de Oliveira & Civil, 2020). Both results of this study show that there is a role of culture in a multicultural classroom to be able to create social interaction through cooperation and discussion. Learning mathematics in a multicultural classroom with character offers unique challenges and opportunities to create an inclusive and effective learning environment. In the context of globalization, classrooms in most countries are increasingly filled with students from different cultural backgrounds, languages, and values. The need for an inclusive approach in multicultural mathematics education.

Research results show the integration of students' cultural dimensions into mathematics education has improved their understanding of mathematical ideas, increased their interest in the subject, and broadened their perception of their cultural identity by establishing significant connections between the mathematics they learn and

their cultural activities (Samaupan, 2019). This diversity, if professionally managed, can be a source of strength to enrich the learning experience. However, without the right approach, cultural and linguistic differences can hinder collaboration and social interaction, which are key elements in mathematics learning. The integration of computational thinking with culturally responsive pedagogy significantly contributes to improving students' engagement and understanding of mathematics, particularly problem-solving exercises (Hendri et al., 2025).

Although mathematics is considered a universal language, differences in culture and social background can affect the way students understand, interact with, and internalize mathematical concepts. Teaching mathematics requires focusing on students' cultural identities and utilizing their collective knowledge in a collaborative setting (Langer-Osuna & Nasir, 2016). Research results that students' mathematical identities are shaped by sociocultural interactions, which require inclusive practices (Graven & Heyd-Metzuyanim, 2019). Therefore, it is important to explore how collaboration and social interaction can be facilitated in mathematics learning in multicultural classrooms to ensure that every student feels engaged, valued, and able to reach their academic potential.

Previous research has shown that collaborative learning can improve students' conceptual understanding, social skills, and learning motivation. However, most of these studies were conducted in the context of homogeneous classrooms, where students have relatively similar cultural and linguistic backgrounds. Research results explain teachers in multicultural classrooms must mediate different cultural norms in participation to prevent domination by certain groups (Graven & Heyd-Metzuyanim, 2019). In multicultural classrooms, social interactions become more complex due to differences in culture, language, and ways of thinking. Challenges such as communication misunderstandings, cultural biases, and participation inequalities often arise, hindering effective learning. Multicultural education can increase student engagement, with relationships between students as an important mediator (Abacioglu et al., 2023). Team diversity complicates the already challenging concept of collaborative teaching (Wong, 2023). Therefore, specialized approaches are needed to facilitate the role of culture in positive social interactions in multicultural contexts.

Previous studies have shown that culture, language, and classroom norms influence students' participation in mathematics learning. Language diversity should be viewed as a resource for mathematical reasoning rather than as an obstacle (Planas, 2018). Cultural differences can shape the structure of mathematics lessons, teacher-student interaction, and students' participation in collaborative activities (Clivaz & Miyakawa, 2020). In addition, collaboration mediates the relationship between culture and motivation to learn

mathematics, suggesting that students' cultural background can influence their motivation to learn (Mazana et al., 2024).

These gaps indicate the need for further research to develop relevant and effective approaches in multicultural contexts. These studies suggest that cultural diversity is not merely a contextual factor but an important element that influences how students communicate, participate, and collaborate in mathematics classrooms. However, previous studies have not sufficiently explained how students from different cultural backgrounds negotiate meaning, manage communication differences, and build collaboration during mathematics learning activities. In particular, limited attention has been given to the everyday interaction patterns that emerge in multicultural mathematics classrooms, such as differences in expressing opinions, language use, thinking styles, and group discussion dynamics. Therefore, this study is needed to provide a deeper description of how cultural diversity shapes collaboration and social interaction in mathematics learning, as well as to identify classroom practices that can support inclusive and effective interaction among students from different cultural backgrounds.

The novelty of this study does not lie merely in discussing collaboration, multicultural classrooms, or social interaction as separate topics, since these areas have been widely explored in mathematics education research. Rather, the novelty lies in its specific focus on how undergraduate students in an Indonesian multicultural mathematics classroom negotiate communication differences, thinking styles, and participation patterns during collaborative mathematics learning. This study highlights everyday interaction patterns that emerge in group discussion, such as how students express mathematical ideas, respond to peers from different cultural backgrounds, and manage language-related barriers in problem-solving activities. By focusing on these interaction processes, this study offers a contextual contribution to mathematics education research, particularly in understanding multicultural classroom practices in the Indonesian higher education context. Therefore, the purpose of this study is to describe how cultural diversity influences collaboration and social interaction in mathematics learning and to identify interaction practices that support inclusive participation among students from different cultural backgrounds.

METHOD

This study employed a qualitative case study design to examine collaboration and social interaction in one multicultural mathematics classroom at a private university in Metro City, Indonesia. A multicultural classroom in this study refers to a classroom consisting of students from different cultural or regional backgrounds, with variations in language habits, communication styles, and ways of expressing opinions during group

discussion and mathematical problem solving. The participants were 16 undergraduate mathematics education students selected through purposive sampling based on the criteria that they were enrolled in the observed class, had experience in collaborative mathematics tasks, represented different cultural or regional backgrounds, and were willing to participate. The number of participants was considered sufficient because this study aimed to obtain an in-depth understanding of interaction patterns within a specific classroom case, not statistical generalization. Although a Likert-scale questionnaire was used, it functioned only as an initial mapping tool. The main qualitative data were obtained from students' written explanations, semi-structured interviews, participatory observation, and documentation.

The research instruments consisted of a questionnaire, semi-structured interview guidelines, and observation guidelines. The questionnaire was used as an initial mapping tool, not as a quantitative instrument for statistical scoring. It contained Likert-scale items followed by open-ended questions to explore students' experiences, perceptions, and explanations related to multicultural classroom interaction. The questionnaire covered three aspects: 1) students' experiences and perceptions of multicultural classrooms, 2) group dynamics in mathematics problem solving, and 3) collaborative projects in mathematics learning. The Likert-scale responses were used descriptively to identify general tendencies, while students' written explanations were analyzed qualitatively together with interview and observation data.

The instruments were reviewed through expert judgment to ensure their relevance to the research focus, clarity of language, and suitability for exploring collaboration and social interaction in multicultural mathematics learning. The review focused on whether the items and questions were able to capture students' communication patterns, participation, collaboration, language-related barriers, and interaction during mathematical problem-solving activities. Revisions were made based on the reviewers' suggestions before the instruments were used in the study.

Data were collected in the Geometry learning. The learning activities were observed during four meetings. The observed activities included group discussion, collaborative geometry problem solving, presentation of mathematical ideas, question-and-answer sessions, and peer responses during mathematics learning.

The data collection techniques used in this study were as follows:

1. Questionnaire

The questionnaire was used to map students' experiences and perceptions of multicultural classroom interaction. It consisted of Likert-scale items and open-ended questions. The Likert-scale responses were used descriptively, while the open-ended responses were analyzed qualitatively.

2. Semi-structured interview

Interviews were conducted to obtain deeper information about students' experiences in collaboration and social interaction during Geometry learning. The interviews focused on students' communication patterns, group discussion experiences, language-related barriers, and ways of working with peers from different cultural or regional backgrounds.

3. Participatory observation

Observation was conducted during four Geometry learning meetings to record students' collaboration, participation, interaction patterns, and communication during group discussion and mathematical problem solving.

The data were analyzed qualitatively through the following stages:

1. Data organization

All data from open-ended questionnaire responses, interviews, and participatory observations were organized and read repeatedly to obtain an overall understanding of students' collaboration and social interaction.

2. Initial coding

Meaningful units of data were identified and coded. The coding focused on students' collaboration, communication patterns, participation, language barriers, thinking styles, and teacher facilitation.

3. Categorization

Similar codes were grouped into broader categories, such as forms of collaboration, interaction patterns, communication challenges, participation differences, and strategies for inclusive interaction.

4. Theme development

The categories were interpreted to develop the main themes of the study. The themes reflected how cultural diversity influenced students' collaboration and social interaction in Geometry learning.

5. Interpretation and conclusion drawing

The themes were interpreted in relation to the research focus. Conclusions were drawn by comparing patterns across questionnaire responses, interviews, and participatory observations.

To ensure the credibility of the findings, this study used source triangulation and technique triangulation. Source triangulation was conducted by comparing information from different students. Technique triangulation was conducted by comparing data from questionnaires, semi-structured interviews, and participatory observations. Triangulation

was used to ensure that the findings were supported by different sources of evidence. Triangulation through multiple data sources increases the credibility of qualitative findings (Cohen et al., 2002).

RESULTS AND DISCUSSION

Results

The findings were obtained from Likert-scale questionnaire responses, open-ended questionnaire explanations, semi-structured interviews, and participatory observations conducted during four meetings in the geometry learning. The Likert-scale responses were used only to identify general tendencies, while the main interpretation was based on students' written explanations, interview data, and observation notes. Based on the coding process, the findings were grouped into three main aspects: students' experiences and perceptions of multicultural classrooms, group dynamics in Geometry problem solving, and collaborative activities in Geometry learning.

1. Students' Experiences and Perceptions of Multicultural Classrooms

The findings from the survey showed that there were different experiences of interaction among students with peers of different cultural or regional background. In all, out of the 16 students who participated in this survey, 8 stated that they often interact with peers of different cultural background, 7 said sometimes while one student stated that students rarely interacts. This implies that there was cultural diversity within the geometry class and also it can be seen within the process of learning.

The major finding from this area is that culture was not presented as local mathematics practice but rather the way students communicate, express opinion, ask questions and reply to peers during Geometry learning. It affected the use of language, clarity of communication, confidence in communication and respectful behaviors during group discussion. So, in this study, culture becomes visible during the interaction process of learning, especially when discussing about geometric shapes, explanation on solution steps and different approaches to the same problems.

The findings of the interviews revealed that cultural differences were not considered by the students as the major impediment in comprehending the geometry. However, the students acknowledged the effect of cultural differences on the communication among the group members. As one of the students observed:

> *S3: "Having different cultural backgrounds does not make it hard for me to understand the geometry. The difference comes into play when friends present their views. They may present the view directly, while others may take longer before presenting the view."*

S7: In the group discussion, I can collaborate with friends from different backgrounds, but at times I may request them to repeat themselves due to the difference in the way they speak.

The observation during the four Geometry meetings supported these interview findings. In group discussions, students from different cultural or regional backgrounds were able to work together to discuss Geometry problems. However, the differences appeared in the way they expressed mathematical ideas. Some students explained the solution briefly and directly, while others provided longer explanations before presenting the main argument. These differences sometimes slowed down the discussion, but they also encouraged students to ask clarification questions and listen to alternative explanations.

The observation results show in small group work, students could work in a team to identify geometric properties, interpret figures, and discuss solving process. However, there were some differences due to cultural background in communication process. Some students used brief and direct explanation, and some preferred to use long explanation before providing the main idea. Some students felt sure about voicing their opinion, while some needed to be invited by peers to express their ideas. It means that cultural diversity influenced students' participation in discussion, but it did not hinder their cooperation.

2. Group Dynamics in Geometry Problem Solving

The second aspect concerns group dynamics during Geometry problem solving. The data showed that language habits, accents, communication styles, and different thinking patterns influenced how students understood one another during discussion. In Geometry learning, this appeared when students had to interpret figures, identify known information, explain properties, and justify solution steps. The interview data showed that students often used additional strategies when verbal explanation was not sufficient. One student stated:

S5: "When discussing Geometry problems, I usually understand better when my friend explains while drawing the figure. If it is only explained orally, sometimes I do not immediately understand the meaning."

Another student explained:

S11: "In my group, some friends start solving the problem by drawing first, while others directly talk about formulas or properties. At first, it is confusing, but after we discuss it, we can compare which way is easier to understand."

It can be observed that students did not depend only on oral language in order to solve Geometry problems. In working in groups, they made use of diagrams, symbols, arrows, labels, and written solution processes to explain their thought process. If a student

explained his/her answer poorly, other students would ask him/her why such property was used or how he/she could come up with a particular conclusion from the diagram. This means that in learning Geometry through collaboration, there was discourse, which included explanation, representation, questioning, and justification.

In the observation process, it was noted that participation in groups was not always even. There were some students who dominated the explanation of diagrams and solution processes, but the less vocal ones would participate by verifying the answers, recording the group's work, or asking questions. Nevertheless, when the lecturer asked each group member to explain part of the solution, many students became active participants in the discussion. This shows the significance of the lecturer's facilitation in order to foster even participation in multicultural group interaction.

3. Collaborative Activities in Geometry Learning

Third dimension refers to collaborative work in relation to the studying process of Geometry. As it was shown by the results of the questionnaire and interviews, most of the respondents found the collaboration with peers from other regions and cultures useful because it enables them to get various explanations, compare different approaches to solving problems and perceive the problem from different perspectives. Nevertheless, the respondents stated that it is important for people in a group to use understandable Indonesian language and listen to each other.

One of the respondents stated that:

S2: "Collaboration with my friends from other cultures and regions allows me to learn different approaches to solving Geometry problems. Sometimes the approach of my friends differs from my own, thus we can discuss our thoughts thoroughly."

The following respondent added that:

S9: "In my opinion, the most important thing about working in groups is using the language which everybody understands. Sometimes if the explanation is too fast and too local, friends cannot catch the idea."

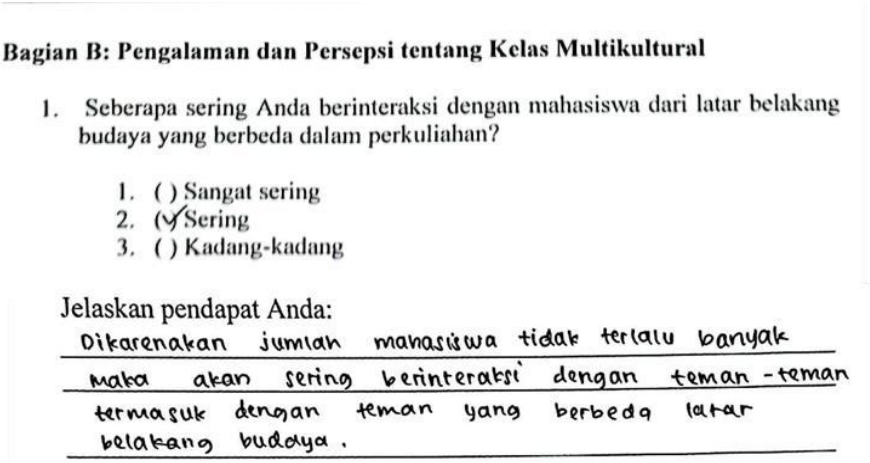
Thus, it can be stated that the geometry lessons where students worked collaboratively were more efficient because students were engaged in the activities such as identifying the properties of figures, explaining their solution, presenting their strategy and group solution. In some cases, the students within groups divided themselves into the particular roles within the group: someone was drawing the figures, someone else was explaining the reasoning and one person was writing the solution. As a result, students could do the task and discuss it in their group.

Nevertheless, it became clear that the heterogeneity of the grouping did not make the process inclusive. Sometimes, there were students who dominated the whole process of discussion while others remained passive. The intervention from the side of the lecturer was needed in order to motivate all the students in the discussion and to encourage them to express their opinion, ask questions and support their position. In this way, if the lecturer addressed the shy students and asked them to explain the meaning of some particular diagram or property, they joined the discussion actively.

Discussion

1. Cultural Diversity as Communication and Participation Practices in Geometry Learning

The findings indicate that cultural diversity in this study appeared mainly in students' communication habits, ways of expressing opinions, participation patterns, and responses to peers during Geometry learning. Students did not perceive cultural or regional differences as a direct obstacle to understanding Geometry material, but these differences influenced how mathematical ideas were explained, clarified, and accepted in group discussions.



Bagian B: Pengalaman dan Persepsi tentang Kelas Multikultural

1. Seberapa sering Anda berinteraksi dengan mahasiswa dari latar belakang budaya yang berbeda dalam perkuliahan?

   1. ( ) Sangat sering
   2. (✓) Sering
   3. ( ) Kadang-kadang

Jelaskan pendapat Anda:
Dikarenakan jumlah mahasiswa tidak terlalu banyak maka akan sering berinteraksi dengan teman-teman termasuk dengan teman yang berbeda latar belakang budaya.

Figure 1. Example of Questionnaire Results on Experiences and Perceptions of Multicultural Classroom

As shown in Figure 1, students' responses indicate that interaction with peers from different cultural backgrounds occurred in the classroom, although the intensity varied among students. This finding is consistent with studies showing that culturally and linguistically diverse classrooms require equitable communication, inclusive participation, and recognition of students' cultural resources in mathematics learning

In the aspect of experience and perception of multicultural classes, respondents were given 4 related questions. From the questionnaire given, information was obtained from respondents who often interact with students who have different cultural

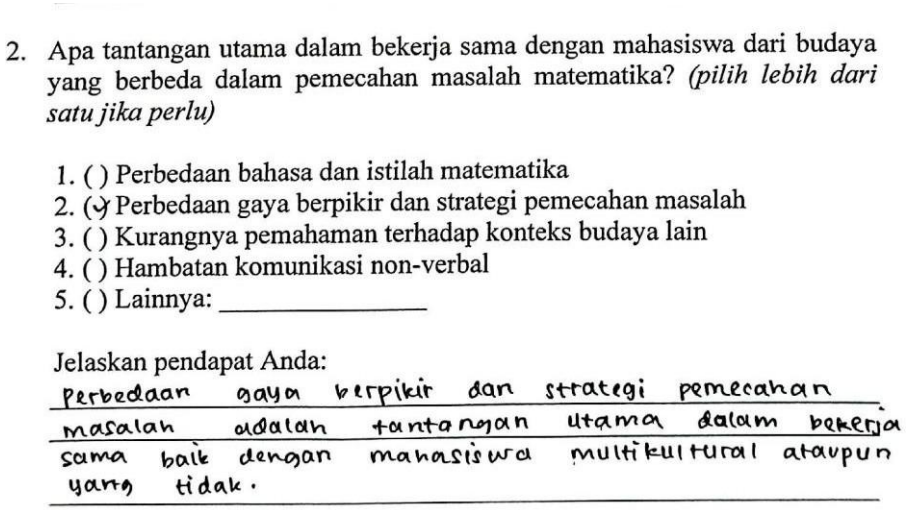
backgrounds. Of the 16 responses, 7 people said sometimes, 8 people stated often, and 1 person stated rarely. In classroom learning, students often conduct collaborative interactions and discussions with friends of different cultures. Discussioare carried out in group discussions and class discussions. Cultural diversity in the classroom, according to respondents, does not have a significant influence on solving the given mathematical problems. This is supported by the results of research Moschkovich (2015) which shows that although cultural background affects communication style, it does not necessarily affect mathematical reasoning ability.

According to respondents, the ability of students to solve problems depends on the depth of understanding of the material provided. Cultural differences that exist in the classroom, show no difference in approach in solving problems. Cultural differences are more visible in the discussion process than in the results of problem-solving. The differences that occur in this multicultural class occur more in the discussion process (Esmonde, 2016). The findings in this aspect are supported by the results of Esmonde's research. In the process of delivering material and question and answer in class, cultural differences are visible. This difference occurs in terms of how to explain the material some groups explain too complicated but some groups explain directly and simply. Intercultural learning refers to the learning process in a multicultural environment where students become aware of the subjective cultural context and become more competent to interact sensitively in that cultural contex (Sorge et al., 2023). The results showed that in the interaction of learning activities, students did not find it difficult to interact with fellow students who had different cultural backgrounds.

2. Group Dynamics in Geometry Problem Solving

This aspect explores some of the challenges found in group dynamics that come from different cultures. From the 16 respondents, it was found that the main challenges of this multicultural class were the differences in language and thinking styles as well as problem-solving strategies. Students in multicultural schools effectively overcome challenges stemming from cultural differences and demonstrate positive collaborative behaviors when applying cooperative discussion learning methods (Pitaloka & Neolaka, 2023). Language differences lead to different ways of communication. This sometimes becomes an obstacle in the discussion process. Language should not be a barrier to math participation; discourse-rich classrooms support multilingual students (Moschkovich, 2015). Differences in thinking styles that occur can be caused by habits that come from culture. These stylistic differences can result in different ways students find and solve given problems, this is shown in Figure 2. Research results explain that increasing cultural

diversity in classrooms presents challenges and opportunities for educators to provide effective teaching (Sabir et al., 2024).



2. Apa tantangan utama dalam bekerja sama dengan mahasiswa dari budaya yang berbeda dalam pemecahan masalah matematika? *(pilih lebih dari satu jika perlu)*

1. ( ) Perbedaan bahasa dan istilah matematika
2. (✓) Perbedaan gaya berpikir dan strategi pemecahan masalah
3. ( ) Kurangnya pemahaman terhadap konteks budaya lain
4. ( ) Hambatan komunikasi non-verbal
5. ( ) Lainnya: _____

Jelaskan pendapat Anda:
Perbedaan gaya berpikir dan strategi pemecahan masalah adalah tantangan utama dalam bekerja sama baik dengan mahasiswa multikultural ataupun yang tidak.

Figure 2. Example of Questionnaire Results on Group Dynamics Aspects in Mathematics Problem Solving

The results reveal that the group dynamics involved in the solving of Geometry problems were affected by language practices, accents, means of communication, and diverse thinking styles. These aspects emerged in interpreting figures, identifying what is known, explaining the properties of Geometry, and explaining the reasoning behind a particular step in the solution. Figure 2 illustrates this result as it demonstrates how the students faced difficulties concerning group dynamics in mathematical problem-solving activities. Thus, the difficulty faced by the students in multicultural Geometry education is not just communication but the creation of meaning (Fatmanissa et al., 2022; Jimenez-Silva et al., 2025; Langer-Osuna et al., 2020).

Moreover, the results of the observation also revealed that the students employed diagrams, symbols, arrows, labels, and written steps in their solutions to explain their logic in situations where oral explanations alone did not suffice. Thus, it is clear that mathematical communication in the observed Geometry class was multimodal since students not only used verbal language for communicating mathematically but also used non-verbal forms of communication such as visual and symbolic communication (Jimenez-Silva et al., 2025; Sharma, 2023).

3. Collaborative Activities in Geometry Learning

In this aspect, respondents explained that different cultural backgrounds do not influence improving their mathematical understanding. In multicultural classrooms, students mostly focus on their performance, which results in poor collaboration among

classmates (Tielman et al., 2012). The multicultural classroom is not an aspect related to students' mathematical.

Understanding. Students' mathematical understanding still depends on their cognitive understanding. Teachers have an important role in the teaching and learning process. In a multicultural classroom, for example, teachers must be good at putting themselves in any situation among different students (Anggraini & Lubis, 2022). Respondents explained that increasing the effectiveness of learning in this multicultural class requires the use of a good Indonesian language so that it will facilitate the process of interaction and discussion that occurs. In addition, in the process of group discussion, group members should also consist of different cultural backgrounds to respect each other. Cultural diversity is a valuable resource, not a barrier to teaching (Qin, 2024).

These results explain that the majority of students (8 out of 16 respondents) interacted frequently with friends from different cultures, indicating an openness to cross-cultural collaboration; however, there was one respondent who interacted infrequently, indicating the need for a specialized approach to increase engagement. The findings of this study confirm that fundamentally, cultural background does not play a significant role in implementing solutions in mathematics, which depend more on the depth of understanding of the subject matter and less on any cultural factors. Nevertheless, the evidence suggests that real cultural differences emerge more in communication patterns (e.g., convoluted versus straightforward explanations) than in consequences, where language and thinking styles are the biggest hurdles in group dynamics. The findings of this study are also relevant to the results of a study Wachira & Mburu (2019) which found an increasingly diverse student population coming from various ethnic, cultural, and linguistic backgrounds. There is a need for more aligned practices that can utilize students' cultural capital in the learning process. This finding explains that contemporary practices, especially in mathematics teaching, do not meet the educational needs of the majority of heterogeneous students, impacting their overall achievement. Although cultural differences do not automatically lead to improved mathematical understanding, cross-cultural collaboration can provide an alternative viewpoint where teachers play an important role in mediating interactions and creating an inclusive environment. The values of mathematics education most highly rated by students were those identified as practice, family ties, respect, and perseverance. In contrast, the principles of accuracy and practicality were rated the lowest. The results showed a convergence between the mathematics cultural values of Pacific Islanders and educational philosophy (Hunter, 2021).

It can be seen from the results that working together with other students belonging to diverse cultures or regions allowed the students to receive different explanations of the

problem and solutions as well as comprehend the geometry task from different angles. At the same time, it was found out that heterogeneous groups do not provide equal participation by default. There were some students who dominated in explaining diagrams and solution procedures, whereas others were more passive and listened, wrote down something or asked brief questions (Pitaloka & Neolaka, 2023).

The findings of this study should be interpreted carefully because the study did not measure students' mathematical ability, mathematical reasoning, achievement, or conceptual understanding through formal tests. Therefore, this study does not claim that cultural diversity directly affects students' mathematical achievement. Instead, the contribution of this study lies in explaining how cultural diversity shapes the process of learning mathematics, especially communication, participation, representation, and argumentation during collaborative geometry problem solving. This position is consistent with studies showing that culture influences lesson interaction, classroom participation, and students' access to meaningful mathematical engagement (Abdulrahim & Orosco, 2020; Clivaz & Miyakawa, 2020).

There are various weaknesses that can be highlighted in this study. Firstly, the number of participants used for this study was only 16 undergraduate students of mathematics education in one particular private university in Metro City, Indonesia. Secondly, the study was carried out in just the geometry subject only and involved four meetings. Thirdly, this study did not involve any test in measuring the mathematical abilities and achievements of the participants. Such weaknesses can be found in qualitative case study research. This research not only confirms previous findings on cultural neutrality in mathematics problem-solving but also provides practical innovations for collaborative learning in multicultural classrooms. Its benefits include theoretical, pedagogical, and social aspects, making it relevant for educators, researchers, and policymakers.

However, despite all of this, the results have some implications for multicultural mathematics education. The lecturer is supposed to create Geometry learning through collaboration that will incorporate both inclusive communication and mathematics communication. This is done through making heterogenous groups, role assignment in group discussion, using proper Indonesian language, explaining the diagrams by the students, justifying the steps of solution, and comparing solutions among other strategies. In such cases, the multicultural classroom becomes a place where students engage both socially and mathematically through communication, representation, reasoning, and proof.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that this study shows that cultural diversity in multicultural classes does not directly affect students' mathematical problem-solving skills, but rather affects the communication process and discussion dynamics. Despite challenges such as differences in language and thinking styles, most students tried to interact and collaborate with friends from different cultural backgrounds well. The ability to understand the material remains the main factor in solving math problems, while cultural differences are more visible in the way opinions are expressed in discussions. Teachers have an important role in facilitating cross-cultural interaction by creating an inclusive environment and designing heterogeneous learning groups. Good Indonesian language use and grouping plans based on cultural diversity can Strengthen the effectiveness of collaborative learning. This research not only confirms that culture influences the interaction process, but also makes a practical and methodological contribution to designing learning responsive to multicultural contexts.

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