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# Student Gestures in Solving Mathematics Problems in Group Discussion Activities

**Masniladevi[1*]**

[1] Pendidikan Guru Sekolah Dasar, Universitas Negeri Padang, Padang, Indonesia

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***ABSTRAK***

*Matematika sebagai salah satu mata pelajaran dalam kurikulum pendidikan nasional memiliki peranan penting dalam kehidupan manusia. Matematika tidak hanya digunakan sebagai acuan melanjutkan pendidikan yang lebih tinggi tetapi juga digunakan dalam mendukung karir seseorang. Namun, kenyataannya siswa masih sulit dalam memahami materi yang dipelajari termasuk memahami masalah yang terdapat dalam matematika. Penelitian ini bertujuan untuk menganalisis penggunaan gesture dalam menyelesaikan masalah matematika pada diskusi kelompok. Penelitian ini menggunakan penelitian kualitatif dan menggunakan jenis penelitian deskriptif eksploratif. Subjek penelitian yang dipilih terdiri atas 2 siswa pada kelompok rendah, 2 siswa pada kelompok sedang, dan 2 siswa pada kelompok tinggi berdasarkan diskusi dengan guru mata pelajaran. Gesture yang diamati adalah ketika siswa memecahkan masalah secara berkelompok. Hasil analisis data menunjukkan bahwa gesture yang dilakukan siswa ada beberapa variasi. siswa pada kelompok tinggi lebih banyak melakukan macam-macam gesture seperti pointing gesture, writing gesture, dan representasional gesture serta mereka lebih memahami masalah. Representational gesture yang digunakan oleh siswa yang berkemampuan tinggi dapat memberikan pemahaman konsep kepada teman kelompoknya sedangkan yang berkemampuan sedang dan rendah dalam proses diskusi pemecahan masalah matematika masih bingung dalam merepresentasikan maksud dari pemecahan masalah mereka.*

**ABSTRACT**

As one of the subjects in the national education curriculum, mathematics has an important role in human life. Mathematics is not only used as a reference for continuing higher education but is also used to support one's career. However, in reality, students still find it difficult to understand the material being studied, including understanding the problems in mathematics. This study aims to analyze the use of gestures in solving mathematical problems in group discussions. This research uses qualitative research and uses exploratory, descriptive research. The research subjects selected consisted of 2 students in the low group, two in the medium group, and two in the high group based on discussions with the subject teacher. The observed gesture is when students solve problems in groups. The results of data analysis show that the gestures made by students have several variations. Students in the high group performed more gestures such as pointing, writing, and representational gestures, and they understood the problem better. Representational gestures used by high-ability students can provide conceptual understanding to their groupmates, while those with moderate and low abilities in the discussion process of solving mathematical problems are still confused in representing the intent of their problem-s.

## 1. INTRODUCTION

As one of the subjects in the national education curriculum, mathematics has an important role in human life. Mathematics is always inseparable from all kinds of dimensions of life (Ambussaidi & Yang, 2019; Setiyani et al., 2020). The importance of mathematics can be seen from studying mathematics from elementary, secondary, to tertiary education levels. In addition, mathematics is considered to train and improve logical, critical, and creative thinking skills (Hobri et al., 2021; Lin et al., 2020; Nenotaek et al., 2019; Yemi, 2018). It underlies one of the main goals of education: a continuous human process to overcome problems faced throughout life, so students must be skilled in solving problems (Nathalia et al., 2015; Setiawan, 2020; Tere et al., 2020). Mathematics is often considered a science that only emphasizes thinking

Corresponding author
*E-mail addresses: Masniladevi187@gmail.com (Masniladevi1)

logically with a single and definite solution (Fitriyah et al., 2017; Hasibuan et al., 2020; Ujianti, 2019). It caused mathematics to be a subject feared and disliked by students (Wardani & Setyadi, 2020; Yuniawardani & Mawardi, 2018). Mathematics is studied at every level of education and becomes one of the indicators (indicators) of student success in taking a level of education and being a test material for the selection of admissions to certain fields of work. Seeing this condition means that mathematics is not only used as a reference for continuing higher education but is also used to support one's career (Wulandari & Agustika, 2018). However, in reality, it students are still difficult to understand the material being studied, including understanding the problems contained in mathematics (Anggreni et al., 2020; Kurnia et al., 2019; Vivitri & Sunardi, 2018; Widiasih, 2019).

Problem-solving is a characteristic of mathematical activity and a great means of developing mathematical knowledge. It is a way to find achieving goals that are not immediately possible (Khairunnisa & Ilmi, 2020; Kurnia et al., 2019). Mathematics as a compulsory subject in both primary and secondary schools has a strategic role in building the character of formal knowledge for students (Kurnia et al., 2019; Wulandari & Agustika, 2018). The problem-solving process is a complex cognitive process. Problem-solving is symbolized as an activity that involves a variety of thinking actions. Problem-solving includes coordination between previous experience in solving problems, knowledge, familiar representations, patterns in concluding, and intuition to produce new representations and connecting patterns. Conclusions have been resolved in solving the problem (Hidayat & Sariningsih, 2018; Safithri et al., 2021; Utomo et al., 2021). The overall effect of problem-solving is that teaching and learning mathematics intervention is positive and meaningful. Students in the formal thinking level can plan problem-solving by linking the information obtained with the information requested logically (Pucangan et al., 2018; Winata & Friantini, 2018). Students who have high metacognitive abilities can solve the given problems. Students must have a good ability to perform mathematical operations, be skillful in solving problems, and be critical in interpreting non-routine problems are general prerequisites for having good formal reasoning (Baswendro et al., 2015; Zuhaida, 2018). *Mathematical problem solving* is a process that involves several dynamic activities such as understanding the problem, making plans, implementing plans, and reviewing the definitions that were last applied to the discussions in this review (Chabibah et al., 2019; Taqiyyah et al., 2017). One of the things that can be seen to solve the problem is gestures.

The gesture is a person's natural behavior so that he can know what is conveyed when verbal communication is followed by nonverbal language through gestures (Closser et al., 2021; Okumus & Hollebrands, 2019). Gestures play a central role in cognition, with recent studies emphasizing that gestures are not just thoughts but are active and genuine elements of thought. Gestures consist of various body movements and verbal symbols, which are thought processes and exchange ideas. The information conveyed can be in the form of gestures, facial expressions, eye gaze, touch, or artifacts/symbols used (Ashwin & Guddeti, 2020; Parrill et al., 2019). Gestures can be used as a window to see if students in the class are thinking (Keene et al., 2012; Majlesi, 2015). Based on the research, there are three types of signs: First, iconic signs. Attitudes are characterized by using fingers, writing tools, physical objects, places, or people (Dargue et al., 2021; Shein, 2012). In particular, classifying iconic cues in references, artifacts, and visual representations is related to the task (e.g., spreadsheets, whiteboards, or other manipulative materials). Second, representational attitude. Attitudes illustrate concrete and abstract ideas, entities, or events conveyed verbally and nonverbally (Flood, 2021; Shein, 2012). Third, write cues. This movement occurs when the gesture/gesture leaves a permanent mark on a new medium (e.g., worksheets, whiteboards, or visual representations (Shein, 2012).

Representational gestures to instantiate (embodiment) are very important to build theoretical understanding (Fonger, 2019; Okumus & Hollebrands, 2019). Representational attitudes exhibit motor simulations and underlying perceptual perceptions. This gesture helps the nonverbal expression of ideas. Gestures can evoke manipulative abilities, and gestures are very precise about structural details (Pier et al., 2019; Walkington, Chelule, et al., 2019). Student gestures form mathematical understanding (Freitas & Sinclair, 2012). According to research, gestures provide evidence that the body is involved in thinking and talking about ideas expressed through gestures (Alibali & Nathan, 2011). a person will appear to produce a gesture when someone is looking at them and talking to other people. In this way, researchers assume that students will produce many gestures when communicating with their friends in solving math problems. Other studies have shown strong evidence regarding the interrelationship between gestures and problem solving (Francaviglia & Servidio, 2011). This relationship is shown that gestures can provide a good communication strategy in investigating students' mathematical thinking processes in solving problems. Mathematical understanding is formed from students' gestures to represent mathematical thinking through gestures and speech. This study aims to analyze the use of gestures in solving mathematical problems in group discussions.

## 2. METHOD

This study uses a qualitative approach with a descriptive-exploratory type of research. The research was conducted in class VI SD Plus Marhamah Padang. The selected subjects were three groups in one class. Data is taken by recording all student activities when solving math problems. In addition, an interview process was also carried out as additional data to know better the role of gestures made by students when discussing mathematical solving problems. The main instruments in this study are the researchers themselves because they collect data through recordings or observations (Creswell, 2012). Support is needed to strengthen research data, namely tools used to collect data about the mathematical thought process, including an Audio-visual camera, used to record signals that appear during the learning process, and several task questions that have been prepared according to the material that has been prepared. Studied. The group assignment sheet is handed over to each group formed to solve the problem by discussing it in groups. During the discussion process, the researcher observed the discussion conducted by the research subjects to describe student gestures. Recording tools are used to avoid loss or loss of information during the discussion process. The recording device in this study is a video recorder that functions to record student activities as research subjects when they begin to discuss the given assignment sheet. Recordings are used to avoid or miss information during the group discussion process. The recording results will be used as a source of observational data and in the interview process as an additional and complementary question from the interview guide. Interviews will be conducted on all students who have been selected as research subjects. In the interview process, students who were selected as subjects were allowed to reflect on what they had done by showing a video of the recorded discussion process, and then the researchers discussed what they had done based on the interview guidelines. Interviews were conducted to collect incomplete information or data in the observed discussion process. Six students were formed into three groups, with details of two high-ability students, two moderately capable students, and two low-ability students taking into account the students' communication skills when expressing opinions or ideas orally or in writing based on interviews with mathematics teachers. The group then discusses the given math problem. The technique used to analyze the data is descriptive qualitative analysis.

## 3. RESULT AND DISCUSSION

### Result

First is the low group (S1). The gestures made by S1 in solving the problem in problem 1, namely determining the area of a plot of land: include: pointing gestures and writing gestures but do not perform representational gestures. One of the pointing gestures used by S1 is when S1 points to a rectangle and a question. So that S1 understands that to answer question 1. The concept of the area and perimeter of a rectangle must be connected. S1 points using the finger at the problem as an object to be understood. The gesture made by S1 is said to be a pointing gesture because S1 makes a pointing gesture using his finger at the problem as an object to be understood. By the opinion of research, gestures provide evidence that the body is involved in thinking and speaking about ideas expressed through gestures (Alibali & Nathan, 2011). One of the writing gestures performed by S1 when discussing question 1 was by writing 44 m – ( 8 + 8) on the answer sheet. Although S1 tries to write down what S1 knows, this does not seem right. It indicates that S1 does not understand the meaning of the problem and is confused about finding a solution. That way, S1 cannot calculate the requested answer. This movement can be seen in Figure 1.

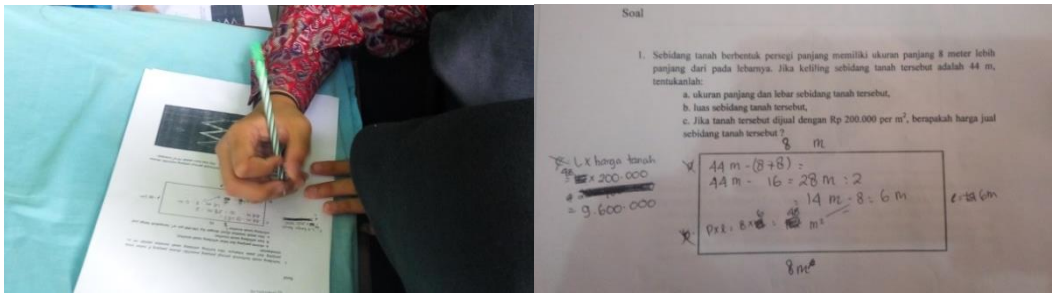


Figure **1.** Errors made by S1 when working on question number 1

The results of S1's work above show that the error made by S1 is a conceptual error because S1 does not understand how to change the shape of a rectangle's length and width, and S1 writes 44 - ( 8 + 8 ) so that the results obtained by S1 are wrong. Moreover, S1 does not make a representational gesture because he does not understand whether this answer is right or wrong. The second is the

medium group (S2). Gestures used by Master to solve problem 1, namely determining the area of a plot of land: include pointing gesture, writing gesture, and representational gesture. One of the pointing gestures used by S2 is when S2 points to a rectangle and a question. So that S2 understands that to answer question 1. The concept of the area and perimeter of a rectangle must be connected. S2 points to using a pencil on the problem as an object to be understood. The movement made by S2 is said to be a pointing gesture because S2 makes a pointing gesture using his finger at the problem as an object to be understood. By the opinion of research by Alibali & Nathan (2011), gesture provides evidence that the body is involved in thinking and talking about ideas expressed through gesture. People will appear to produce gestures when someone is looking at them and when they are talking to other people (Becvar et al., 2008). One of the writing movements performed by S2 during the break for question 1 was by writing 44 = 2 x ( ( l+8 ) + l ) on the answer sheet. S2 had tried to write down what S2 had stopped but could continue with the next step. No, S2 has been able to understand the meaning of the problem and its solution. In this group, the students have understood the desired concept. That way, S2 can calculate the requested answer. The movement can be seen in Figure 2.

**Figure 2.** S2 performs a writing gesture by writing down the answer

The results of S2's work above show that the solution made by S2 is conceptually correct because S2 understands how to change the shape of a rectangle's length and width, and S2 writes 44 = 2 x ( ( l+8 ) + l ) correctly so that the results obtained S2 is correct. Moreover, S2 made a representational gesture when explaining the question's meaning to his group friends, but he was not sure whether this answer was right or wrong. The attitude of representation carried out by S2 is to explain problem 1. This activity is to calculate the length and width of a rectangle. The answer result is 105 m2 on the answer sheet. In addition, S2 explained that land prices would be sought from the results of the area. S2 does it to help group friends understand in detail to get the right answer. The third is the high group. The gestures used by Doctorate in solving the problem in problem one are determining the area of a plot of land: including pointing and writing gestures and representational gestures. S3 performs all the gestures. one of which is the pointing gesture used by S3. When pointing to a rectangle and a question for S3 to understand that in order to answer question 1, the concepts of area and perimeter of a rectangle must be linked. S3 points the finger at the problem as an object to be understood. The movement made by S3 is said to be a pointing gesture because S3 makes a pointing gesture using his finger at the problem as an object to be understood and can design a solution. One of the writing gestures done by S3 when discussing question 1, was by writing 2 x ( ( l+8 ) + l ) = 44 until he got the length and width so that the area and price of the land were obtained on the answer sheet. S3 can write down what S3 knows and continue with the next step to get the correct result. It indicates that S3 can understand the meaning of the problem and find a solution. In this group, students already understand the desired concept. That way, S3 can calculate the requested answer. The movement can be seen in Figure 3

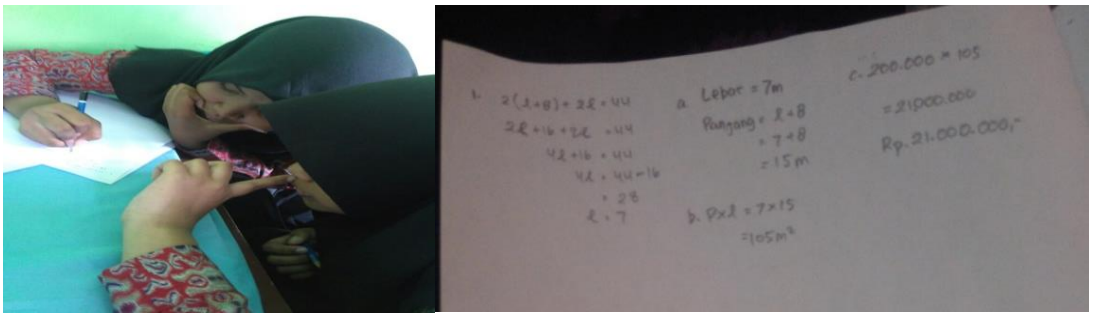

**Figure 3.** S3 performs a writing gesture by writing down an understood answer

The results of S3's work above show that the solution made by S3 is conceptually correct because S3 understands how to change the shape of a rectangle's length and width, and S3 writes 2 x ( ( l+8 ) + l ) = 44 correctly and gets the length, and the width and the process are correct so that the results obtained by S3 are correct. Moreover, S3 performs a representational gesture when explaining the question's meaning to her group friends, and S3 believes that this answer is correct. The representational gesture performed by S3 was when S3 explained question 1, which was calculating the length and width of a rectangle and producing an answer of 105 m2 and Rp. 21,000,000 on the answer sheet while explaining that from the area's results, the land price was obtained. S3 does it to help group friends understand in detail to get the right answer. Previous research believes that representational gestures are very important in building a theoretical understanding (Becvar et al., 2008). Representational attitudes exhibit motor simulations and underlying perceptual perceptions. This representational gesture is useful for strengthening understanding of the questions and answers so that answers are obtained that are by the objectives. Gestures used by S3 in the discussion process can help their group mates. After getting help from their friends who used gestures, students who initially had difficulty were able to solve the problem and get the right answer. It happens because the gestures used by S3 can make friends. They help better understand the language being conveyed. Listeners are often better able to understand the message conveyed by the speaker in words accompanied by gestures (Alibali & Nathan, 2011). People will appear to produce gestures when someone is looking at them and when they are talking to other people

**Discussion**

During the group discussion process, gestures used by research subjects can help their group mates when working on individual test questions. It is consistent with previous research, which stated that gesture is an important source of information, because gesture supports oral communication, reduces language ambiguity, and increases conceptual understanding (Francaviglia & Servidio, 2011; Walkington, Woods, et al., 2019). Mathematical understanding is formed from students' gestures to represent mathematical thinking through gestures and speech (Dubé & McEwen, 2015; Herbert & Pierce, 2013). Gestures are needed in learning and teaching mathematics. It is consistent with other studies which state that gesture provides evidence that the body is involved in thinking and speaking about ideas expressed through gestures (Alibali & Nathan, 2011; Walkington, Chelule, et al., 2019). People will appear to produce gestures when someone is looking at them and talking to other people. Hand gestures can lay the foundation of new knowledge for learning and understanding math in children.

The pointing gesture used by high-ability students can help them understand the problems of their group mates. Meanwhile, those with moderate and low abilities in the discussion process of solving mathematical problems have not understood the problem. Writing gestures used by high-ability students can solve problems properly and correctly compared to moderate and low-ability students in the discussion process and when solving math problems (Burkhardt-Reed et al., 2021; Walkington, Chelule, et al., 2019). Representational gestures used by high-ability students can provide conceptual understanding to their groupmates, while those with moderate and low abilities in the discussion process of solving math problems are still confused in representing the intent of their problem solving (Costini et al., 2017; Putri et al., 2020). Gestures are an additional, spontaneous modality, which can serve as a bridge between personal images that are difficult to pronounce verbally and mathematical ideas that are formally symbolic (Okumus & Hollebrands, 2019; Parrill et al., 2019). Gestures are a form of communication that can understand students' thoughts which are sometimes difficult to express in written form (Shein, 2012; Walkington, Chelule, et al., 2019). It causes gestures to be indispensable in learning mathematics. Learning mathematics must be carried out continuously from understanding basic concepts to higher levels because mathematics is not only in material but also in application to everyday life and the face of advances in science and technology. The findings of previous studies also state that gestures are a form of communication that can understand students' thinking because successful teaching is being able to determine what students think and then use that information as a basis for learning instruction (Francaviglia & Servidio, 2011; Herbert & Pierce, 2013).

## 4. CONCLUSION

The results showed that students in the high-ability group could solve problems better than those with medium and low abilities. In the discussion process of solving math problems, students in the high ability group used gestures, including pointing gestures, writing gestures, and representational gestures. Second, students in the moderate ability group were able to solve problems, but they were not sure whether their answers were correct or not and looked a bit hesitant in representing their group friends. In the discussion process of solving math problems, students in the moderate ability group also used gestures, including pointing gestures, writing gestures, and representational gestures. Third, students in the low

ability group could not solve the problem, and in the low group discussion process, they only made several pointing and writing gestures but did not perform representational gestures.

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