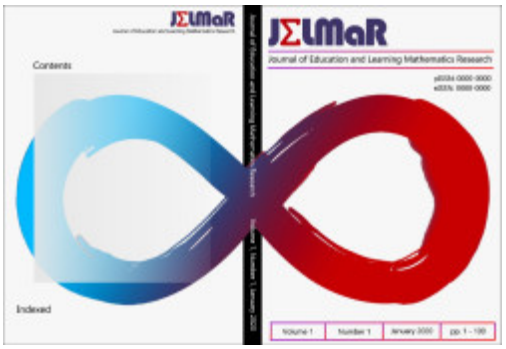

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Nonny Zakiyanita Heldiana Ferly, [2]Eric Dwi Putra, Marsidi

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Identify Mathematical Gestures of Deaf Students in Solving Math Problems

[1]Nonny Zakiyanita Heldiana Ferly, [2] Eric Dwi Putra, [3] Marsidi
Mathematics Education Study Program, PGRI Argopuro Jember University, Jember, Indonesia
Email: dwieric454@gmail.com

***Abstract**: Gestures that can help students communicate mathematically can be called gestures. This study aims to find out gestures that can help deaf students when solving math problems. This research uses a descriptive approach with a qualitative research type. The data sources used are test questions, observations, and interviews. This research was conducted at SLB ABC Balung with the subject of research as many as 2 SMALB students. The results of this study show that both subjects have their own characteristics when working on the problem. The first student prefers to count using movements assisted by scribbles, while the second student prefers to use hand gestures. In the first student, gestures occurred 38 times, consisting of iconic gestures 17 times, metaphorical gestures 10 times, and deictic gestures 11 times. In the second student, gestures occurred 40 times, consisting of iconic gestures 13 times, metaphorical gestures 5 times, and deictic gestures 22 times. Based on the results of this study, the gesture most often used when deaf students solve the problem is the deictic gesture, which occurs 33 times, and the gesture that appears the least is the metaphorical gesture, which occurs 15 times.*
Keywords: gesture, deaf, mathematical

INTRODUCTION

Learning is an interaction between teachers and students where there is an intense and directed communication process with the aim of achieving predetermined learner indicators. (Lestari & Putra, 2020) In studying mathematics, there are prerequisite concepts commonly called "primitive concepts" as a basis for understanding the next concept. Students can learn math better by using *mathematical gestures, especially when talking about complex concepts or problems. Mathematical* gestures are all spontaneous actions of students in solving mathematical problems (Nisa, R. K. 2020). Furthermore, Nisa's research (2020) explained that *mathematical gestures are body movements or gestures used to communicate or describe mathematical concepts or operations.*

Alibali & Nathan (2012) explained in their research that gestures can help students organize thoughts and strengthen their understanding of mathematical concepts to contribute to solving mathematical problems and strengthen their understanding of concepts. The relationship between gestures and math involves understanding the way we use gestures to help understand, model, and communicate mathematical concepts. Gestures can be hand gestures, body positions, facial expressions, or a combination of these.

Mathematics often involves complex concepts and is difficult to explain with words or writing alone. Gestures can be used to illustrate mathematical processes, illustrate relationships between concepts, or visualize solutions to mathematical problems. In many situations, hand (Cook & Goldin-Meadow, 2009). In many situations, hand gestures become an additional way to communicate and understand mathematics. This can help overcome spoken language barriers and assist students and teachers in understanding and teaching math concepts.

Becvar et al., (2008) Gestures are all body movements, especially arms and hands, that are integrated with speech or not and used as a tool to communicate something. For example, the use of fingers to calculate or demonstrate basic mathematical operations such as addition or multiplication, shows that gestures can improve students' visual

understanding of geometry concepts explained through diagrams. Chen & Herbst (2013) Gestures can also serve as mathematical communication tools.

Children with special needs (ABK) have been in the spotlight of society and the government for almost a decade. This is realized by the government in the form of inclusive education and the tightening of public buildings and facilities that must meet ABK accessibility standards. (Nisa, K, et al, 2018) *Gesture* basically has a role as an intermediary between *gesture* users and observers because of the limitations of deaf students, so *gestures* become the core key in discussing and communicating. David Mc Naill divides *gestures* into 3 (three) types, namely *iconic gestures,* metaphorical gestures and *deictic gestures The movement in the* iconic gesture *coincides with the part of the speech that is presented the same meaning*. (Mc Neill, 1992) *Metaphor gesture*, *a gesture* that presents an image of an image that does not look abstraction. And finally, the deictic gesture is a pointing gesture. This gesture is not shown in the physical place where the interlocutor was before, but in the abstract concept where he was before (Kurniasih et al., 2020).

Mc Neill distinguishes gestures into two, namely propositional gestures and non-propositional gestures. Propositional gestures are gestures that have a main image component, while non-propositional gestures are conversational gestures. Propositional gestures are divided into three, namely (a) iconic gestures, (b) metaphorical gestures, and (c) deictic gestures. Non-propositional gestures are divided into two, namely (a) beat gestures, and (b) cohesive gestures (Achadiyah & Abdussakir, 2015).

Based on observations made by researchers on November 2, 2023, at SLB – ABC Balung, students at the SMALB level, especially deaf students who have difficulty understanding mathematics lessons. This is obtained during interviews with students. Students are quite difficult to count if not coupled with sign language gestures. Students are only able to operate the numbers 1 – 100. Reinforced from the results of interviews with teachers at SLB-ABC Balung, if students have quite it difficult to learn to count. To count, students need hand movements and write numbers in a way that is arranged repeatedly both in operating addition, subtraction, multiplication and division. When teaching, teachers also use hand gestures in the form of sign language so that students can understand what is being learned.

Sign language is also a communication tool for deaf people to identify themselves and obtain information. The fundamental difference between sign language and spoken language lies in its modality or means of production and perception. Spoken language is produced through speech (oral) and perceived through auditory (auditory), while sign language is produced through hand gestures (gestures) and perceived through visual devices (Ulfah &; Ubaidah, 2023).

Learning styles for deaf people are visual and kinesthetic learning styles. Deaf people really like visuals or images that appear to be seen by sight, where indeed, for these senses, students do not experience obstacles or limitations. As for the kinesthetic learning style, students show, because gross motor skills using props and illustration media are very helpful and preferred (Panglipur, 2023). Based on the explanation above, there is a relationship between gestures with sign language and learning styles of deaf students that makes researchers interested in researching deaf students with the title "**Identification of Mathematical Gestures in Deaf Students in Solving Math Problems**". With this study, researchers expect to pay more attention to mathematical gestures in students.

METHOD

In this study, researchers used a descriptive approach with a type of qualitative research. Qualitative research is one of the research methods that aims to gain an understanding of reality through an inductive thinking process Descriptive qualitative is

a research method that moves on a simple qualitative approach with an inductive flow (Aldini et al., 2022) (Yuliani, 2018).

Researchers tried to explain how deaf students do math. The type of gesture used refers to the classification of gestures made by David McNeill. The gesture studied is the type that students use when solving math problems. These gestures are divided into three categories: iconic, metaphoric, and deictic. This research is focused on Yayasan SLB – ABC Balung. The address is Kebonsari, Balung Lor, Balung Sub-district, Jember Regency. The subjects of this study were 2 students who were grade 2 SMALB students at SLB – ABC Balung. The process of collecting data in this study is that researchers provide test questions, make observations and interviews with selected students.

RESULT AND DISCUSSION

Based on the results of research and observations that have been carried out by researchers for SMALB ABC, Balung students were selected based on the highest score, there were 78 gestures from the two students, including iconic gestures, metaphorical gestures and domestic gestures. Researchers observed student gestures based on the gesture classification of David Mc Naill.

David Mc Naill (1992) divides gestures into 3 parts, namely iconic gestures, which are actions that show movements according to what is being said, metaphorical gestures, which are abstraction movements that arise spontaneously, and, deictic gestures, which are pointing movements. The following will explain examples of gestures that students do when answer questions that researchers have prepared for two selected students.

1. The first student with the R initial, question number 1

a. Iconic Gesture

Figure 1. Iconic Gesture

Iconic: R moves 6 fingers followed by lip movements (oral) saying the number 6

Based on figure 1, R is solving question number 1, R is doing the summation calculation operation on the problem in order assisted by iconic gestures such as hand movements with fingers number 6 and followed also by lip movements called 6. This activity is an iconic gesture because it is in accordance with the understanding of iconic gestures, namely actions that describe movements according to what is being said.

b. Metaphoric Gesture

Figure 2. Metaphoric Gesture

Metaphoric*: R lowers the finger indicating that he is counting the problem.*

Based on figure 2, it can be seen a metaphorical movement when R completes the stacking calculation operation that was written earlier. Next, R made an iconic gesture by showing his six fingers, followed by a metaphorical gesture in the form of putting his finger back to sleep as a sign that R was collecting stacks using gestures.

c. Deictic Gesture

Figure 3. Deitic Gesture

Deictic: R moves *the finger pointing at the problem in order to understand the meaning of the problem.*

Based on figure 3, there is a domestic gesture or pointing gesture. R points to question number 1 to understand the meaning of the problem before starting to work. This pointing motion is done repeatedly until R understands the meaning of the problem.

2. Gesture the second student with initial A, question number 1

a. Iconic gestures

Figure 4. Iconic Gesture

Iconic: student A moves his hand to show 9 fingers and followed by a lip movement (oral) saying the number 9.

Based on figure 4, A moves the finger followed by the movement of the lips to show the number 9, the movement performed by A is an iconic gesture because it is in accordance with the meaning of the iconic gesture which is a hand movement indicating something followed by lip movement.

b. Metaphoric Gesture

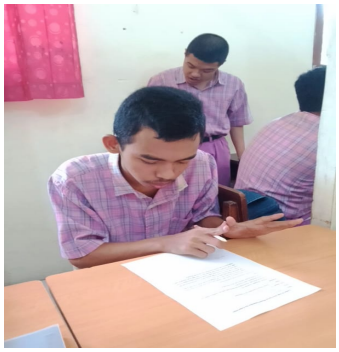

Figure 5. Metaphoric Gesture

Metaphoric: student A begins to count, it can be seen from the movement of folding fingers indicating that the finger has been counted.

Based on figure 5, it can be seen that A is counting. A starts moving the hand, showing 9 fingers later, with the finger folding movement indicating it has been counted. Movement A is in accordance with the definition of metaphorical gestures, namely movements that are carried out abstractly and spontaneously.

c. Deictic Gesture

Figure 6. Deictic Gesture

Deictic: student A seems to scratch his finger to point to the problem the student is working on.

Figure 6 shows that A uses his finger to point at the problem with the aim of making it easier to understand the problem. This is a characteristic of the deictic gesture is the movement of a person pointing at the intended object. A tends to issue more pointing gestures.

3. The first student with the initials R, question number 2

a. Iconic Gestures

Figure 7. Iconic Gesture

Iconic: R starts moving the finger number 7 followed by lip movement (oral) mentioning the number 7.

Based on figure 7, R solves in the same way as before, namely using the stacking calculation method assisted by manual counting by hand. R indicates 7 fingers followed by lip movement mentioning the number 7. The R gesture fits the definition of an iconic gesture.

b. Metaphor Gesture

Figure 8. Metaphoric Gesture

Metaphoric: R begins counting by folding fingers as a sign has been counted.

Based on figure 8, R starts problem number 2 by collecting numbers to count. Then, R performs his signature movement, showing a number of numbers and then folding his fingers, indicating that he is counting. This is characteristic of metaphorical movements, which have already been explained earlier that they are carried out spontaneously.

c. Deictic Gesture

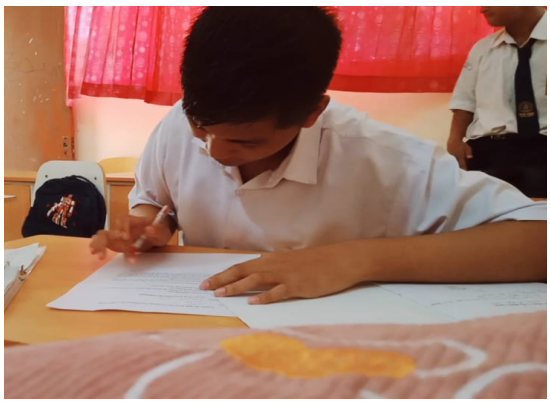

Figure 9. Deictic Gesture

Deictic: R seems to move his finger with the aim of pointing to the problem that R is reading and understanding.

Based on figure 9, it can be seen that R is starting to solve question number 2. R starts by reading the question first. When R reads, there is a hand movement from R pointing at the problem repeatedly, this movement is done to make it easier to understand the problem being solved. This pointing gesture is a characteristic of deictic gestures.

4. The second student initials A, question number 2

a. Iconic Gestures

Figure 10. Iconic Gesture

Iconic: A starts moving the finger number 8 followed by lip movement (oral) mentioning the number 8.

Based on figure 10, A is solving question number 2, in the same way that A solves question number 1 using the help of fingers. A's finger movement is the same as the iconic movement, it looks like A is removing 8 fingers followed by lip movement (oral) mentioning the number 8 as well.

b. Metaphoric Gesture

Figure 11. Metaphoric Gesture

Metaphoric: After removing the previous finger, student A begins to fold it spontaneously.

Based on figure 11, after A pulls out a finger which is an iconic gesture. Then, A begins to fold several fingers when counting the problem, the A movement is characteristic of metaphorical gestures because it is done spontaneously.

c. Deictic Gesture

Figure 12. Deictic Gesture

Deictic: A is counting the problem, one of A's fingers points to the problem to re-understand.

Based on figure 12, A is calculating the problem. How to do A is quite unique, namely understanding one sentence, continuing to count and re-reading the problem so that during the process of doing quite a lot of deictic gestures. As in picture A pointing to the problem, the gesture fits the definition of a deictic gesture.

From the results of the explanation above, the mathematical gestures of deaf students in solving math problems, researchers found from both subjects, namely R and A. The gestures they used were iconic gestures 30 times, metaphorical gestures 17 times and deictic gestures 33 times. This shows that the gesture most used by deaf students in solving math problems is the domestic gesture. The following is the result of all the gestures that R and A use; 78

Table 1. The Result of All The Gestures

Student	Type of Gesture	Question 1	Question 2	Amount
1	Iconic Gesture	7	10	17
	Metaphoric Gesture	5	5	10
	Deictic Gesture	6	5	11
2	Iconic Gesture	5	8	13
	Metaphoric Gesture	1	4	5
	Deictic Gesture	10	12	22
Amount		34	44	78

From table 1, it can be seen the difference in gestures between R and A in solving mathematical problems with the material of addition and subtraction calculation operations. From the following table the researcher will provide a description of each type of gesture from both subjects;

1. Iconic Gestures

From the results of data analysis obtained on iconic gestures, both subjects performed many movements, which were iconic gestures. The difference in the number of iconic gestures between R and A is also quite, thin, from the iconic R gesture as many as 17 times, while in student A, as many as 13 times. Each student has their own characteristics for solving problems. R students often use iconic gestures because the way to solve them is to use stacking calculations which are then continued by counting one by one using fingers. During the interview, R explained that he prefers to use hand gestures and scribbles because he can solve problems faster. Unlike R, which is assisted by scribbles, A only uses the hands to calculate and keep the results of the count in mind. The observations he made while working on the questions given by the researcher showed that A was able to answer the questions correctly, quickly and silently. When interviewed by researchers, A said he was used to relying on his ten fingers to count and focusing on counting from 1 to 100.

2. Metaphoric Gesture

Metaphoric gestures are rarely used by deaf students to solve math problems. During the interview, R and A explained that they have their own movements in solving math problems. This is in accordance with research by Hord et al. (2016) that explains that visual gestures look more expressive, namely the face and hands. While spontaneous cues are only as additional information. In this study, there were 15 metaphorical gestures that emerged from the two students. On R, as many as 10 times with the same movement, namely spontaneous movements when counting, and 5 times on A.

3. Deictic Gesture

Deictic gestures are the most common gestures that appear during student work on problems. In R, the deictic gesture appears 11 times, judging from the way R solves the problem, the gesture pointing to R occurs before doing it, because the deictic gesture occurs when R tries to understand the problem. While in a domestic gesture, it appears 22 times. This is because, A, in solving math problems, prefers to use the help of his hands, to understand the problem is also different, like R, who understands first and then starts counting. A tends to read per verse of the question marked by deictic gestures, then continue with iconic and metaphorical gestures and return to the initial step of reading the questions in the next stanza so that many deictic gestures appear when A completes both questions.

CONCLUSION

Based on the results of the analysis and discussion above, it can be concluded that gestures in deaf students when solving math problems 78 times, which include iconic gestures, metaphorical gestures and domestic gestures. Each gesture has its own position in helping deaf students solve math problems. The gesture that students often use in solving math problems is the domestic gesture 33 times, because the gesture can help students with hearing and speech disabilities in understanding a lesson, one of which is mathematics.

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