International Conference on Islam, Law, and Society (INCOILS)
Conference Proceedings 2024

Students' Mathematical Gestures in Solving Operations Problems on Whole Numbers Class XI at SLB-B Negeri Tulungagung

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ABSTRACT :
Mathematical gestures are movements that a person makes with their hands and arms when speaking and are intended to be intentionally related to mathematics. Gestures are part of non-verbal communication. With cues, students can solve math problems. When solving math problems, the signals given by students are very diverse. According to Mc Neill, gestures are divided into 3 types, namely iconic gestures, metaphoric gestures, and deictic gestures. The purpose of this research is to describe the mathematical gestures of students with mild, moderate and severe hearing impairments in solving operation problems on integers in class XI at SLB-B Negeri Tulungagung. So it is hoped that it can provide a brief overview of the mathematical gestures made by students. This research uses a qualitative approach with a case study type of research. The research location is SLB-B Negeri Tulungagung. The selection of subjects was based on the level of hearing impairment, namely 2 students with mild hearing impairment, 2 students with moderate hearing impairment, 2 students with severe hearing impairment. Data collection methods use observation, tests and interviews. The data analysis techniques used are data reduction, data presentation, and drawing conclusions. Checking the validity of the data is carried out by observation, triangulation and peer checking. The results of this research obtained an overview of gestures, namely (1) Mildly deaf students can demonstrate the use of iconic gestures, metaphoric gestures and deictic gestures in solving operation problems on integers and the gesture indicators are met in solving the questions. (2) Students with moderate hearing impairment can show that they use fewer metaphorical signs than deictic signs and use the most iconic signs in solving operational problems on integers and the signal indicators are fulfilled in solving the problems. (3) Students with severe abilities show the least use of deictic cues. Meanwhile, there are fewer metaphorical gestures than iconic gestures when solving operations problems on integers and the gesture indicators are fulfilled in solving the problems.

Keywords: *Mathematical Gestures, Solving Operation Problems on Integers*

INTRODUCTION

Education is an effort carried out by the government through several activities such as teaching, guidance and training that take place at school and outside school throughout life.[1] Apart from that, education can also be interpreted as the formation of the main personality which is carried out with conscious guidance by the teacher towards the physical and spiritual development of students.[2] Education has an important role in the life of the nation and state. One of them is to improve the quality of human resources both in the fields of knowledge and morals in life.

Mathematics is a tool in solving problems and developing other knowledge. Equipping

[1] Saifullah Maysa, *Epistimologi Reward dan Punishment dalam Pendidikan,* Jurnal Mudarrisunah, Vol. 11, No. 4, 2021, p. 5

[2] J Amelia, *Peran Keteladanan Guru PAI dalam Pembentukan Karakter Religius Siswa*, Jurnal Penelitian Pendidikan Islam, Vol. 6, No. 1, 2021, p. 9

students to be able to use mathematics and mathematical thinking patterns in life is the goal of mathematics education.[3] By studying mathematics, students can build a systematic, logical and conceptual way of thinking. Learning mathematics is not just memorizing concepts, but how to teach students to think through mathematics.[4] Education is also a necessity for individuals who want to progress and mathematics education is not only provided for normal students, but is also provided for students with special needs.

Government Regulation Number 157 of 2014, concerning the special education curriculum, states that learning for students with disabilities or special needs refers to regular learning principles and approaches that are adapted to student learning, characterized by the uniqueness of each student.[5] Children with Special Needs (ABK) include the blind, deaf, speech impaired, moderate and mild mental impairment, mild and moderate physical impairment, hearing impairment, HIV, AIDS, drug sufferers, autism, Asperger's syndrome, multiple disabilities, learning difficulties, slow learner, gifted and talented and indigo.[6] One of those who are called people with special needs (disabled) are deaf students. Deaf students are students who have lost some or all of their hearing, so they have difficulty communicating. These communication difficulties often become obstacles in adapting and learning. Therefore, deaf students need social guidance or special treatment. The deaf are divided into several groups, including group I with a loss of 15-30 dB or mild hearing loss with the ability to perceive normal human speech sounds, group II with a loss of 31-60 dB or moderate hearing impairment with only partial apprehension of human speech sounds, and group III loss of 61-90 dB or severe hearing loss with no ability to perceive human speech.[7]

Difficulties in the process of conveying information experienced by deaf students often become problems in learning at school.[8] This applies to all subjects, including mathematics subjects. Due to limitations in hearing, gestures are one of the efforts made to transfer knowledge so that the meaning can be understood by deaf students.[9] Therefore, in learning mathematics, deaf students use gestures as a means of communication and interaction with both the teacher and their peers. Gesture acts as a facilitator in solving mathematical problems.

Gesture basically has a role as an intermediary between gesture users and observers because of the limitations that deaf students have, so gesture is the core key in discussing and communicating. Gestures are divided into 3 (three) types, namely iconic gestures, metaphoric gestures and deictic gestures.[10] Movements in iconic gestures coincide with parts of speech that convey the same meaning. Metaphoric gesture, a gesture that presents an image of an image that does not look like an abstraction. Deictic gestures are pointing movements. This movement is not shown in the physical place where the interlocutor was before, but in the

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[3] Kurniasih, *Penerapan Metode Inkuri untuk Kemampuan Berpikir Kritis Matematis Mahasiswa Calon Gury*, Vol. 4, no. 2, 2018, p. 751-760

[4] Nurhayati & Marlianai, *Implementasi Model Pembelajaran Kooperatif Tipe Course Review Horay (CRH) Terhadap Kemampuan Pemecahan Masalah Matematika*, JKPM (Jurnal Kajian Pendidikan Matematika), Vol. 5, no. 1, 2019, p. 30

[5] BNSP, *Peraturan Mentri Pendidikan dan Kebudayaan Nomor 21 Tahun 2016 tantang Standar Isi Pendidikan Dasar dan Menengah*, Kemendikbud, 2016

[6] Ginintasari, *Proses Pembelajaran Anak Berkebutuhan Khusus*, Bandung: Psikologi Fakultas ilmu pendidikan UPI, 2019

[7] Murni Winarsih, *Kemampuan membaca Permulaan Anak Tunarungu Usia Dini*, Jurnal ilmiah Pendidik dan Tenaga Kependidikan Pendidik Non Formal, Vol. 13 No. 2, 2018, p. 4

[8] Pujiwati, *Meningkatkan Kosakata Benda Anak Tunarungu melalui Metode Maternal Reflektif di Kelas D II B di SDLBN Tarantang Lima Puluh Kota*, E-Juphekku, 2020, p. 142-151

[9] Kurniasih dkk, *Gesture Siswa Tunarungu dalam Belajar Matematika di Tinjau dari Gender*, JKPM (Jurnal Kajian Pendidikan Matematika), Vol. 5, No. 2, 2020, p. 6

[10] David McNeill, *Gesture and language dialectic*, Acta Linguistica Hafniensia, Vol. 34, no. 1, 2002, p. 7-37

abstract concept of where he was before.[11]

One of the materials that students must learn is operations on integers. Because the material consists of addition, subtraction, multiplication and division of integers.[12] So this material becomes an important part of mathematics lessons that must be mastered by students, especially deaf students.[13] As well as the material on operations on integers in solving the problem, it is possible to bring out these three mathematical gestures.

Analysis of the gestures of deaf students was carried out to obtain information on how to solve operations problems on integers for deaf students so as to achieve maximum results. Gestures are natural, and someone can know what is being conveyed if verbal communication is followed by non-verbal language through body language.[14] Previous research stated that mentally retarded students use gestures in solving problems in order to communicate students' thoughts about mathematics, scaffolding for mentally retarded students, and focusing the attention of mentally retarded students.[15]

Based on the results of an interview with the Principal at SLB-B Negeri Tulungagung, he stated that there were class XI students who had mathematical gestures in solving mathematics problems. Where this can be seen from the level of students' mathematical abilities.

Based on this, researchers are interested in conducting research to describe students' mathematical gestures in solving operation problems on integers for class XI at SLB-B Negeri Tulungagung. So the researcher will conduct research with the title: "Students' Mathematical Gestures in Solving Operations Problems on Whole Numbers Class XI at SLB-B Negeri Tulungagung ".

Methods

This research uses a qualitative approach which is a case study type. The research was conducted at SLB-B Negeri Tulungagung. The data collected in this research are the results of observations, test results and interview results. Meanwhile, the data source in this research was class XI students at SLB-B Negeri Tulungagung with a total of 7 students. From the research subjects, 6 students were selected as interview subjects, namely 2 students who were mildly deaf, 2 students who were moderately deaf, and 2 students who were severely deaf. Apart from that, there is also documentation of test results in research, photos and videos. In this research, the data techniques used were observation, tests and interviews. Meanwhile, the data analysis process in this research involves data reduction, data presentation, and drawing conclusions.

Result

1. Analysis of mathematical gestures of mildly deaf students in solving problems of operations on integers

Iconic gestures

[11] Mah Ruhamah, *Peran Gesture Guru SMP dalam Pembelajaran Maatematika Berdasarkan Gender*, Jurnal Unkhair, Vol. 11, No. 1, 2022, p. 7

[12] Muhammad Arif Tiro dkk, *Pengenalan Teori Bilangan*, (Makassar; Andira Publisher, 2018), p. 111

[13] Neon B. Brooks dkk, *The Role of Gesture in Supporting Mental Representation: The Case of Mental Abacus Arithmetics*, 2018, p. 6

[14] Yoon, Thomas, & Dreyfus, *Grounded blends and mathematical gesture spaces: Developing mathematical understandings via gestures*, Educational Studies in Mathematics, 2020, Vol. 78, no. 3, pl. 371–393

[15] Rivatul Ridho Elvierayani & Abdul Kholiq, *Gesture Siswa Tunagrahita dalam Menyelesaikan Masalah Matematika*, Lintang Songo: Jurnal Pendidikan, Vol. 2, No. 2, 2019, p. 1

Figure 1.1 Iconic gesture for question number 1

In Figure 1.1, the iconic gesture that occurs shows the addition done by S1 using his fingers (S1.GI.SN1). This gesture occurs when S1 solves a problem to add 7 marbles owned by Anton with 3 marbles owned by Rudi (S1.SN1). This is done by S1 to find the final result (the number of marbles owned by Anton now) (S1.SN1). S1 calculates the addition result using his fingers. This is supported by the following interview results:

P : Why do you use your fingers when solving the problem (S1.GI.SN1)?
S1 : I use my fingers to make it easier to count and to show that the problem is solved by addition (S1.GI.SN1).
P : What were you thinking at that time?
S1 : At that time what I was thinking was adding 7 Anton marbles with 3 Rudi marbles (S1.SN1).
Q : Do you use your fingers to help you solve the problem (S1.GI.SN1)?
S1 : Of course, ma'am

Based on the interview, S1 used an iconic gesture by showing addition using his fingers. This gesture was done by S1 to solve the problem.

The following are the results of S1's answers in completing the addition in question number 1:

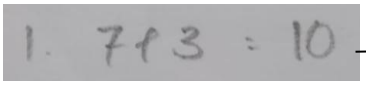

Figure 1.2 S1 answer results for question number 1

2. Analysis of mathematical gestures of deaf students in solving problems of operations on integers

Metaphoric gestures

Figure 1.3 Metaphorical gesture for question number 2

In figure 1.3, the metaphorical gesture performed by S3 to describe what is happening abstractly by supporting his head with 1 finger (S3.GM.SN2). This gesture is shown by S3 because he is hesitant in answering the question. This is supported by the following interview results:

P : Why are you supporting your head with 1 finger (S3.GM.SN2).?

S3 : I am confused and hesitant, ma'am.
P : What makes you hesitant?
S3 : Is the solution I worked on correct or not, ma'am.
P : What were you thinking at that time?
S3 : I thought by checking my answer again to make it right, ma'am.

Based on the interview, the metaphorical gesture performed by S3 by supporting his head using 1 finger was because he was hesitant about the answer that had been completed. So the gesture performed by S3 can help him to complete the question correctly (S3.SN2). The following are the results of S3's answers in completing the division in question number 2:

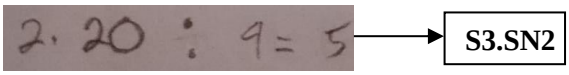

Figure 1.4 Results of S3's answer to question number 2

3. Analysis of mathematical gestures of severely deaf students in solving operations on integers

Deictic gestures

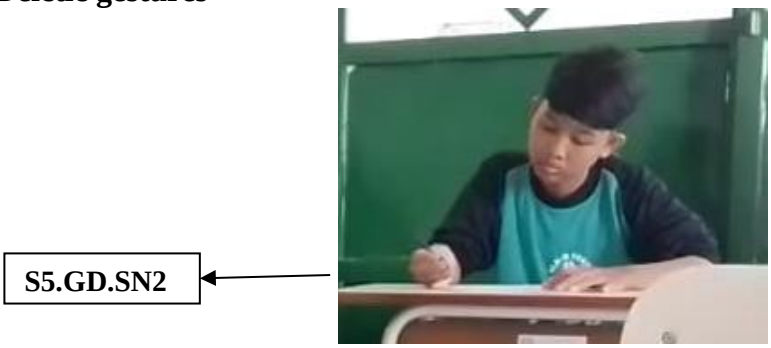

Figure 1.5 Deictic gesture for question number 2

In figure 1.5, this deictic gesture is performed by S5 with a gesture pointing at the question (S5.GD.SN2). Deictic gesture by pointing at the question is used by S5 to understand the question. S5 uses a pencil to point at the question (S5.GD.SN2). This is supported by the following interview results:

P : What are you pointing at using the pencil (S5.GD.SN2)?
S5 : I am pointing at the question, ma'am.
P : Why did you do that?
S5 : I am trying to understand what the question means.
P : Does that help you?
S5 : Yes, ma'am.

Based on the interview, S5 points at the question using a pencil (S5.GD.SN2). This is done by S5 to make it easier for him to understand the meaning of the question.

The following are S5's answers in completing the division on question number 2:

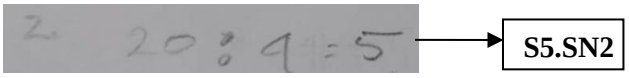

Figure 1.6 S5 answer results for question number 2

Discussion

A. Mathematical gestures of mildly deaf students in solving integer operation problems in grade XI at SLB-B Negeri Tulungagung.

1. Iconic Gestures

Iconic gestures that appear in mildly deaf students are 36 times in both questions in S1 and S2. The iconic movements performed by the subjects are done using fingers to solve the

problems. This is similar to the findings of Alibali and Nathan's research that this gesture can be done using fingers that are actually done in the air.[16] In addition, the iconic gestures shown by the subjects are included in the problem solving indicators at the stage of understanding the problem, making or compiling a problem solving plan, and implementing the plan used to describe the symbols intended by the subjects to solve the problems. This is in line with the research of Herdiman, et al., that in learning this gesture is the most involved in solving problems.[17]

2. Metaphoric Gestures

   Metaphoric gestures that appear in mildly deaf students are 16 times in S1 and S2 when solving both problems. Metaphoric gestures are done on the table and on paper. This is similar to the findings in Rivatul Ridho's research that the way to use gestures is done on paper, on the table and in the air.[18] Metaphoric gestures in mildly deaf students are included in the problem solving indicators at the stage of understanding the problem, making or compiling a plan to solve the problem, implementing the plan, and reviewing the answers. This metaphoric gesture is used to focus on understanding the problem and rechecking the answers to avoid mistakes. This was revealed in Nur Laili's research that this gesture can be aimed at oneself, others or both to solve problems that lead to attention.[19]

3. Deictic Gestures

   Deictic gestures in mildly deaf students appeared 73 times in S1 and S2 when solving both problems. Deictic gestures were done using a pencil and index finger. This is in accordance with research conducted by Tiwi Nur Masita, et al. stating that deictic gestures (pointing) are done using their own fingers or using aids such as pens to point to objects in the problem visualization.[20] Deictic gestures shown by S1 and S2 at the stage of understanding the problem, making or compiling a plan to solve the problem, implementing the plan, and reviewing the answer. This gesture is used to indicate an object that is already clear. This deictic gesture also functions to focus on information.[21]

B. Mathematical gestures of deaf students in solving problems of operations on integers in grade XI at SLB-B Negeri Tulungagung.

1. Iconic Gestures

   The iconic gestures of deaf students appeared in S3 and S4 24 times when solving both problems. These iconic gestures were performed on the table and floating in the air. As found in Rivatul Ridho's research, the way to use gestures is done on paper, on the table, and in the air.[22] Iconic gestures performed by deaf students in the problem solving indicator at the stage of understanding the problem, making or compiling a plan to solve the problem, and implementing the plan. Iconic gestures here are used to describe the symbols intended by the subject to solve the problem. This is in accordance with research conducted by Tiwi

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[16] Alibali, & Nathan, *Embodiment in Mathematics Teaching and Leaning: Evidence from Learner's and Teahcer's Gestures*. The Journal of The Learning Sciences, Vol. 5. No. 2, 2022, p. 43-47

[17] Hendriana, B., Waluya, B., Rochmad, R., & Mulyono, M, *Kemampuan Komunikasi Matematis Siswa Berdasarkan Gaya Belajar Honey dan Mumford*, Vol. 2, 2021, 147–152

[18] Rivatul Ridho Elvierayani, *Gesture Matematis Siswa dalam Menyelesaikan Masalah Fungsi* , dalam Jurnal Reforma 4, no.1, 2021, p. 16

[19]Nur Laili Achadiyah dan Abdussakir, *Penggunaan Gesture Representasional oleh Sisiswa dalam Memecahkan Masalah Matematis secara Berkelompok*, dalam Suska Journal of Mathematics Education, 3. no. 1, 2022, p. 138

[20] Tiwi Nur Masita, Edy. B Irawan, dan Sisworo, *Gesture Siswa dalam Memecahkan Masalah Secara Berkelompok Sesuai dengan Tahapan Berpikir Van Hiele*, dalam Prosiding Strategi Pengembangan Kualitas Pembelajaran Matematika dalam Kurikulum Nasional, 2023, p. 339

[21] Nur Laili Achadiyah dan Abdussakir, *Penggunaan Gesture Representasional oleh Si siswa dalam Memecahkan Masalah Matematis secara Berkelompok*, dalam Suska Journal of Mathematics Education, 3. no. 1, 2022, p. 139

[22]Rivatul Ridho Elvierayani, *Gesture Matematis Siswa dalam Menyelesaikan Masalah Fungsi* , dalam Jurnal Reforma 4, no.1, 2021, p. 16

Nur Masita stating that gestures are used by speakers when thinking and talking about mathematical ideas and to facilitate the process of thinking about ideas.[23]

2. Metaphoric Gestures
   Metaphoric gestures shown by deaf students appear 13 times in both questions. Metaphoric gestures are done on the table and floating in the air. As in the findings of Rivatul Ridho's research that the use of gestures is done on paper, on the table and in the air. Metaphoric gestures in S3 and S4 when solving problems at the stage of understanding the problem, making or compiling a plan to solve the problem, implementing the plan, and reviewing the answers. Metaphoric gestures are used to understand the problem, plan the solution, answer the question or recheck the solution to the problem. This is in accordance with the research of Achadiyah and Abdussakir that this gesture has a role as a facilitator in solving mathematical problems.[24]
3. Deictic Gesture
   The deictic gestures of moderately deaf students in S3 and S4 appeared 18 times when solving both problems. Deictic gestures were performed by moderately deaf students using their index fingers. This is in accordance with research by Mustafa A.H. Ruhama, et al. that deictic gestures can be performed with hand/finger movements or objects carried (eg pencils, markers or chalk) to point to something (people, events, locations, or materials).[25] Deictic gestures in both subjects in problem solving entered the stage of understanding the problem, making or compiling a plan to solve the problem, implementing the plan, and reviewing the answer. This gesture is used to indicate an object that is already clear. This is like the research of Susan Goldin, et al., that this deictic gesture is a signal used to point to objects, people, and locations in the real world.[26]

C. Mathematical gestures of severely deaf students in solving operations problems on integers in class XI at SLB-B Negeri Tulungagung.

1. Iconic Gestures
   Iconic gestures that appear in severely deaf students 14 times when completing both questions in S5 and S6. The iconic gestures shown are also done on the table. Research conducted by Rivatul Ridho states that the use of gestures can be done on the table.[27] Iconic gestures shown by subjects when solving questions at the stage of understanding the problem, making or compiling a plan to solve the problem, and implementing the plan. Iconic gestures here are used to describe a symbol by the subject. This is in line with the opinion of Nur Laili and Abdussakir about the function of gestures in solving questions to concretize something that is being thought about.[28]
2. Metaphoric Gestures
   Metaphoric gestures appear 9 times in S5 and S6 when completing questions. Metaphoric gestures are done by subjects on the table, and floating in the air. As in the findings of research conducted by Rivatul Ridho that the use of gestures is done on paper, on the table

[23] Tiwi Nur Masita, Edy. B Irawan, dan Sisworo, *Gesture Siswa dalam Memecahkan Masalah Secara Berkelompok Sesuai dengan Tahapan Berpikir Van Hiele*, dalam Prosiding Strategi Pengembangan Kualitas Pembelajaran Matematika dalam Kurikulum Nasional, 2023, p. 272

[24] Nur Laili Achadiyah dan Abdussakir, *Penggunaan Gesture Representasional oleh Si siswa dalam Memecahkan Masalah Matematis secara Berkelompok*, dalam Suska Journal of Mathematics Education, 3. no. 1, 2022, p. 139

[25] Mustofa A. H Ruhama, dkk, *Penggunaan Deictic Gesture dalam Pembelajaran Matematika*, dalam Prosiding Seminar Nasional Pendidikan Matematika, 2021, p. 122

[26] Susan Goldin-Meadow, *Hearing Gesture: How Our Hand Help Us Think*. America: Harvard University Press, p. 10

[27] Rivatul Ridho Elvierayani, *Gesture Matematis Siswa dalam Menyelesaikan Masalah Fungsi* , dalam Jurnal Reforma 4, no.1, 2021, p. 16

[28] Nur Laili Achadiyah dan Abdussakir, *Penggunaan Gesture Representasional oleh Si siswa dalam Memecahkan Masalah Matematis secara Berkelompok*, dalam Suska Journal of Mathematics Education, 3. no. 1, 2022, p. 139

and in the air.[29] Metaphoric gestures in subjects are done when solving problems at the stage of understanding the problem, making a problem-solving plan, implementing the problem-solving plan, and rechecking the answers. This gesture is used to convince themselves in solving the problem. This is in accordance with the function of gestures according to Nur Laili and Abdussakir in solving problems using metaphoric gestures.[30]

3. Deictic Gestures

   Deictic gestures in severely deaf students appear 7 times in S5 and S6 when solving problems. Deictic gestures are done by subjects using their index fingers and using the pencils they are carrying. This is in accordance with the research of Mustafa A.H. Ruhama, et al. that deictic gestures can be done with hand/finger movements or objects carried (eg pencils, markers or chalk) to point to something (people, events, locations, or materials).[31] Deictic gestures in both subjects during the problem-solving process enter the stage of understanding the problem, making a problem-solving plan, implementing the problem-solving plan, and reviewing the answers obtained. This deictic gesture is used to indicate the intended object written on paper. This is like research from Susan Goldin that this deictic gesture is a signal used to indicate objects, people, and locations in the real world.[32]

   Based on the findings and discussion, it can be taken as an outline (1) iconic gestures are shown by the subject in the form of images in the form of symbols (2) variations of gestures can be accompanied by speech or without speech (3) gestures can be done on the table, on paper, or floating in the air (4) the most frequently used gesture is the iconic gesture, which is 74 gestures out of 158 gestures (5) iconic gestures are done using the subject's fingers (6) in solving problems, gestures as facilitators in communicating (7) the function of gestures as solving problems of operations on integers, to help students indicate thinking, and help students solve problems correctly.

Conclusion

1. Students with mild hearing impairment can demonstrate the use of iconic gestures, metaphoric gestures, and deictic gestures in solving problems with integer operations and the gesture indicators are met in solving the problems.
2. Students with moderate hearing impairment can demonstrate the use of metaphoric gestures less than deictic gestures and use the most iconic gestures in solving problems with integer operations and the gesture indicators are met in solving the problems.
3. Students with severe hearing impairments show the least use of deictic gestures. While metaphoric gestures are less than and iconic gestures when solving problems with integer operations and the gesture indicators are met in solving the problems.

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[29] Rivatul Ridho Elvierayani, *Gesture Matematis Siswa dalam Menyelesaikan Masalah Fungsi* , dalam Jurnal Reforma 4, no.1, 2021, p. 16

[30] Nur Laili Achadiyah dan Abdussakir, *Penggunaan Gesture Representasional oleh Si siswa dalam Memecahkan Masalah Matematis secara Berkelompok*, dalam Suska Journal of Mathematics Education, 3. no. 1, 2022, p. 139-141

[31] Mustofa A. H Ruhama, dkk, *Penggunaan Deictic Gesture dalam Pembelajaran Matematika*, dalam Prosiding Seminar Nasional Pendidikan Matematika, 2021, p. 122

[32] Susan Goldin-Meadow, *Hearing Gesture: How Our Hand Help Us Think*. America: Harvard University Press, 2022, p. 10

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