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Inclusive Mathematics Learning Based on Visuals and Gestures for Students with Autism: A Focused Video Study

Sriyanti Mustafa[1*]

[1] *Universitas Muhammadiyah Parepare, South Sulawesi, Indonesia, Email: sriyanti_mustafa@yahoo.co.id*

*__Corresponding Author:__ sriyanti_mustafa@yahoo.co.id

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ABSTRACT

Students with autism often face challenges in understanding mathematical concepts due to limited verbal communication and difficulty interpreting abstract symbols. In inclusive classrooms, this issue calls for adaptive, multisensory strategies aligned with the visual and kinesthetic learning styles common among these students. This study examines the effectiveness of mathematics instruction integrating visual media and gestures to improve engagement and understanding in students with autism. A descriptive qualitative approach was employed, using a 2400-second classroom video, from which a focused 63.83-second segment was purposively selected for detailed analysis. This selection followed the principles of focused video analysis, emphasizing intensive observation within a representative timeframe. Data were analyzed qualitatively to explore teacher strategies, communication types, and student responses, and quantitatively through time-based segmentation to examine interaction frequency, communication forms, response types, and average response duration. The results show that visual-gestural strategies fostered adaptive, two-way communication, with active responses dominating and consistent response times. Teachers used a mix of verbal and nonverbal cues to make abstract concepts more concrete. These findings suggest that integrating gestures and visual media holds strong potential as a practical strategy for designing inclusive, effective mathematics instruction for students with autism.

Keywords: Autism; Gesture; Inclusive Learning; Mathematics; Visual Media.

INTRODUCTION

Understanding math concepts for students with autism remains a serious challenge in inclusive education practices. Therefore, this research is expected to identify learning approaches that suit their needs.

Education is a human right that must be accessed by all individuals, including children with special needs. Within the framework of inclusive education, efforts to provide a learning environment that is responsive to the needs of each student are becoming increasingly important. However, children with autism often face great challenges in learning, especially in math subjects that tend to be abstract (Mustafa & Sari, 2024). Mathematics is considered one of the essential fields of science to train logical and analytical thinking skills. However, its abstract nature becomes an obstacle for students with autism. Difficulty understanding mathematical symbols, concepts, and procedures is a common problem that requires a more adaptive learning approach.

Children with autism have unique characteristics that affect how they learn. They tend to think visually and need concrete representations to understand abstract concepts (Mustafa et al., 2024; Watrina Anindita et al., 2024). This statement is also supported by Shurr et al. (2021) that concrete manipulatives are more effective in helping students understand abstract mathematical concepts compared to virtual manipulatives, and the statement (Zheng et al.,

2022) emphasizing the importance of concrete visual representations in facilitating the understanding of abstract concepts, which is relevant to the learning needs of children with autism. Therefore, a visual-based learning approach becomes relevant to help them connect new information with the experiences they already have. As revealed by (Nugrahani et al., 2024) visual approaches can help individuals with autism connect new information with previous experiences, and (Kaya & Yildiz, 2023) that visual-based learning is effective in helping students understand and retain mathematical skills, as well as generalize them to other environments by connecting new concepts to existing experiences. Furthermore, gesture as a nonverbal communication tool has an important role in helping students understand abstract concepts (Mustafa et al, 2015). Gesture provides a physical representation that can connect abstract ideas with concrete reality. This is in line with the *Embodied Cognition* theory which states that body movements can strengthen cognitive understanding through sensorimotor experiences (Lakoff & Johnson, 1999). In the context of mathematics learning, gestures can be used to explain concepts such as geometric shapes, addition, and subtraction (Mustafa et al., 2024). For example, pointing gestures can help students focus on certain elements in a diagram, while iconic gestures can be used to illustrate the relationship between numbers and mathematical operations. In addition to gestures, using visual media also has a very important role in learning mathematics, for example, pictures, diagrams, and concrete manipulatives provide representations that are more easily understood by students with autism. These media help students to see, feel, and manipulate objects related to math concepts.

The integrated use of visual media and gestures provides multiple benefits. On the one hand, visual media provides a concrete framework that students can follow. On the other hand, gesture helps strengthen the connection between visual representations and abstract concepts (Mustafa et al., 2015). This is supported by Hannah Guo et al. (2025) who stated that gesture plays an important role in connecting visual representations with abstract concepts through attention and memory mechanisms. This combination creates a more holistic learning experience. The importance of this approach is also supported by various previous studies. According to Goldin-Meadow et al. (2009), gestures can improve students' understanding of abstract concepts by providing relevant physical cues. Another study by Alibali and Nathan (2019) showed that the use of gestures in mathematics teaching can improve knowledge retention and transfer. However, despite evidence showing the effectiveness of visual media and gestures, the implementation of these strategies in inclusive education is still limited. Many teachers have not been trained to use these approaches systematically. In addition, the lack of resources, such as appropriate visual aids, is an obstacle to the implementation of these strategies.

In particular, inclusive education in Indonesia continues to address these challenges through various policies and teacher training programs. One of the main focuses is ensuring that every student, including those with disabilities, has access to relevant and effective learning. In this context, the integration of visual and gesture media is a promising strategy. Inclusive education aims to provide equal access to education for all students, including children with special needs. In mathematics learning, students with autism often face challenges in understanding abstract concepts, due to verbal, cognitive, or sensory communication limitations (Goldin-Meadow et al., 2009) Innovative approaches that integrate visual and gesture media can help bridge this gap.

Visual media helps convey information in a more concrete format, while gesture as a nonverbal communication tool provides a physical representation of mathematical concepts (Hostetter, 2011). The combination of these two methods allows students with autism to understand concepts visually and kinesthetically by their learning style. Therefore, this research aims to design a mathematics learning model that is responsive to the needs of children with autism by integrating visual and gesture media.

Innovative learning designs that are responsive to the needs of students with autism not only help them understand math but also improve their communication skills. Students who previously had difficulty communicating can begin to express themselves through gestures guided by the teacher. In addition, this approach also helps to create an inclusive learning environment. Non-Disabled students in inclusive classes can learn to appreciate diversity by interacting and working together with their peers who have special needs. This is in line with the principle of inclusive education which aims to create a fair and equal learning community, as UNICEF (2023) asserts that emphasizes that inclusive education focuses on creating a fair and equal learning community, Ainscow (2020) also emphasizes the importance of creating a fair and equal learning environment as part of the principle of inclusive education.

In recent years, technological advances have also opened up new opportunities to support visual media and gesture-based learning (AP News, 2024; Weston, 2025). Interactive educational applications allow teachers to deliver material more engagingly and understandably. This technology can be used to reinforce traditional methods and provide a richer learning experience. However, the use of technology must be tailored to the needs of students.

Technology that is not designed with the special needs of students with autism in mind can be counterproductive (Villamin & Luppicini, 2024; Wang & Jeon, 2023). Therefore, the design of learning media should involve experts who understand the learning characteristics of students with autism.

It is important to remember that each child with autism is unique (Mustafa et al., 2024). An approach that works for one student may not be effective for another. Therefore, learning design should be flexible and responsive to students' individual needs. Through the integration of visual and gesture media, math learning for students with autism can become more inclusive and effective. This approach allows students to learn in a way that suits their learning style, thus increasing their motivation and engagement in learning. Innovative designs that incorporate visual media and gesture are not just an option, but a necessity in inclusive education. With these strategies, we can help students with autism reach their full potential in math and everyday life.

Several previous studies have shown that visual and gesture-based learning approaches are highly effective in supporting the understanding of math concepts in children with autism. According to Shurr et al. (2021), concrete manipulatives help students understand abstract ideas better than virtual manipulatives. Goldin-Meadow and Cook (2022) also confirmed that gestures can strengthen conceptual understanding by activating sensorimotor pathways in the learning process. Kaya & Yildiz (2023) found that visual-based learning improves knowledge retention and transfer ability. In addition, Guo et al. (2025) highlighted that gesture has an important function in improving students' visual attention and memory. These findings reinforce the belief that the combination of visual media and gesture can be an effective solution in adaptive mathematics learning for students with autism.

However, most of these studies are still limited to the context of laboratory experiments or have not been systematically applied in inclusive classrooms at the primary school level in Indonesia. There is not much empirical data that directly records how teachers use gestures and visual media in real learning practices and how students respond to these strategies. This gap is important to answer so that learning strategies based on visual-gestural approaches do not stop as theories or limited experiments, but can be adopted as good practices in inclusive education in the field.

Based on this background, this study aims to analyze the effectiveness of visual media integration and gesture in mathematics learning for students with autism in inclusive classrooms. The research was conducted through observation of real learning videos documenting teacher and student interactions, both in terms of learning strategies, types of communication, and student responses. This research is expected to contribute to the development of inclusive learning models that are more adaptive, applicable, and based on the real needs of students with autism.

RESEARCH METHODS

This study uses a descriptive qualitative approach with video-based observational analysis to examine the effectiveness of visual media and gesture-based mathematics learning strategies in the context of inclusive education. This research was conducted in an inclusive primary school in Makassar City, South Sulawesi, Indonesia that has implemented adaptive learning for students with special needs, especially children with autism. This school was purposively selected because it has a strong track record of visual-based learning practices and adequate documentation of learning activities for video analysis.

The main data for this study was obtained through video documentation of mathematics lessons recorded naturally without direct intervention by the researcher. From the total recording duration of 2400 seconds (40 minutes), the researcher purposively selected a 63.83-second segment for in-depth analysis. This segment was selected based on the consideration that the duration covers one complete cycle of learning, starting from the provision of instructions, the use of visual media and gestures, to the emergence of student responses. Besides being pedagogically representative, this duration is also by the principle of *focused video analysis*, which advocates intensive observation of short but meaningful snippets (Derry et al., 2010). Meanwhile, other parts of the video were used for the development of observation rubrics, observer training, and instrument design validation.

Data analysis was conducted by combining narrative qualitative and descriptive quantitative analysis techniques. Qualitatively, the researcher examined the type of learning strategy, the form of teacher communication (verbal and nonverbal), and the pattern of student responses that emerged in the interaction. Quantitatively, the video was divided into six time intervals (every 10 seconds), and in each interval, the frequency of teacher-to-student interaction, the dominant type of communication, the number of active and passive student responses, and the

estimated average student response time were calculated. The data were then organized into tables and graphs to see trends in interaction patterns that emerged throughout the analysis.

The discussion of the results of the analysis is directed at understanding the relationship between the strategies used by teachers and students' involvement in learning mathematics. The researcher reflects on observations of inclusive learning theories, multisensory and visual-gestural approaches, and compares them with the findings of previous studies. The main focus of the discussion is how the integration of visual media and gesture can create a learning space that is responsive to the characteristics of students with autism, and how nonverbal communication supports the effectiveness of understanding basic mathematics concepts.

Conclusions were drawn thematically, based on observational data and synthesizing the theory underpinning the research. The conclusions not only summarize the main findings but also provide directions for learning practices in inclusive classrooms and the development of teacher competencies in the use of adaptive learning strategies. The researcher also formulated recommendations for further research, including the use of other video segments for comparative studies or quasi-experiments involving control classes. Thus, this methodology supports the research objective of producing an in-depth analysis that has a direct impact on developing evidence-based inclusive education practices.

RESEARCH RESULTS

Qualitative Analysis

To better understand the effectiveness of the learning approach applied in this study, the researcher analyzed video documentation that directly recorded the learning process in the inclusive classroom. This video is the main source of data in identifying how teachers integrate visual media and gestures in delivering math materials to students with autism. Through systematic observation of the recordings, detailed information was obtained about the pattern of teacher interaction, the dominant types of communication, and the responses shown by students during the learning process.

The 63.83-second video depicts a real-life inclusive classroom situation where teachers are actively involved in guiding students using a multisensory approach. The recorded learning includes the use of visual aids and gestures to reinforce the understanding of abstract math concepts. Students with autism appear to be directly involved through physical activities such as pointing, picking up cards, or mimicking movements made by the teacher. With this approach, learning is not a one-way street, but rather a two-way interaction that is responsive to students' individual needs.

The video was analyzed by dividing the duration of the recording into specific time intervals, and at each interval, the key activities that emerged were recorded, such as the number of teacher interactions, the type of communication (verbal or nonverbal), and the form of student responses. This way, the researcher gets both a quantitative and qualitative picture of the effectiveness of the ongoing learning. The findings from the video will be described through snapshots at specific points in time, accompanied by narrative explanations to interpret the meaning of each recorded interaction.

The snapshots shown in the following section visually demonstrate how inclusive learning strategies are implemented and how students respond enthusiastically to the visual and gestural approaches. This visualization reinforces the numerical data previously presented in tables and graphs, as well as provides a real context for good practices in learning mathematics for children with special needs in inclusive classrooms.

Figure 1. Learning video footage

Based on the initial observation of the visuals of each frame, the following is a detailed analysis based on the three main aspects of inclusive learning:

Learning Strategy

a. The teacher is seen actively using visual media (such as cards/pictures).

b. Students are allowed to interact directly with tools, signaling a concrete- representational-based learning strategy.

c. Students manipulate objects or point with the help of the teacher, indicating a direct participatory method.

d. Learning is done individually and in small groups, an effective strategy for autistic children as it reduces distractions.

e. A multisensory approach (through visuals, movement, and sound) is dominant, in line with the principle of embodied learning.

Teacher Communication

f. The teacher uses a combination of clear gestures (pointing, hand pointing) and friendly visual contact.

g. Verbal language appears simple and structured, supporting the understanding of children with communication barriers.

h. The teacher gives pause before the student responds, showing an understanding of the processing time needs of children with autism.

i. Two-way communication is active, with the teacher confirming students' understanding through gestures, not just verbal responses.

Student Response

j. Most students appear to be motorically and attentionally active, for example by pointing, picking up objects, or answering.

k. Students' facial expressions show concentration and interest, especially when visual media are used.

l. There were varied responses between students, with some responding immediately, and some requiring additional cueing assistance.

m. The activities provided seem to be structured and easy to follow, allowing all students to participate according to their abilities.

Qualitatively, the video shows that the teacher has effectively implemented an inclusive approach, using concrete visual media such as picture cards and iconic gestures to clarify mathematical concepts. The teacher was

responsive to students' needs by providing pauses after instructions, using gestures as the main tool, and demonstrating purposeful and empathic communication. Students with autism responded actively through physical actions such as pointing, picking up objects, or following the teacher's movements. Although there are some passive responses, the majority of students show positive participation, focus, and high engagement throughout the learning process.

Quantitative Analysis

After conducting a qualitative analysis of the content of the learning videos that directly record the interaction process between teachers and students in inclusive classrooms, the next step is to present quantitative data obtained from systematic observations. This quantitative analysis aims to provide an objective picture of the frequency of teacher interactions, the types of communication used, and the form of student responses to visual media and gesture-based learning strategies. Data was collected by dividing the duration of the video into six 10-second intervals, and at each interval recording the learning activities that emerged.

The information analyzed includes the number of teacher-to-student interactions, the dominance of verbal or nonverbal communication, the number of students who respond actively or passively, and the estimated duration of time it takes for students to respond to instructions. The presentation of data in tabular form aims to make it easier for readers to understand the learning patterns that occur numerically. This analysis is also useful to strengthen the interpretation of the qualitative observation results described earlier. By juxtaposing this quantitative data with the qualitative data that has been discussed, this research seeks to present a comprehensive picture of the effectiveness of visual and gesture approaches in learning mathematics for students with autism. Table 1 below summarizes these observations.

Table 1. Video Quantitative Analysis

Time (seconds)	Number of Teachers to Student Interactions	Dominant Communication Type	Number of Students Active Responses	Number of Students' Passive Responses	Average Duration of Response (seconds)
10	3	Nonverbal	2	1	4
20	4	Verbal	3	1	3
30	3	Nonverbal	2	2	5
40	5	Verbal	3	0	2
50	4	Nonverbal	2	2	5
60	3	Verbal	2	1	4

Teacher to Student Interaction totals 22 times. The dominance of Communication is 50% verbal, and 50% nonverbal. Total Student Responses, namely Active 14 times, and Passive 7 times. The average duration of student responses is 3.83 seconds. Table 1 presents the results of observations of learning videos with a duration of about one minute, which were analyzed every 10 seconds to observe the dynamics of interaction between teachers and students in inclusive classrooms. The first column shows the time of observations made at the 10th, 20th, 30th, 40th, 50th, and 60th seconds, to provide a temporal overview of the learning process. At each of these time points, the number of teacher-to-student interactions, which included giving instructions, reinforcement, or inviting dialogue through verbal and nonverbal communication, was recorded.

The dominant type of communication from the teacher at each interval is also recorded in a separate column. This communication can be divided into two main categories, namely verbal communication (such as speaking directly to the student) and nonverbal communication (such as pointing, using gestures, or facial expressions). The use of nonverbal communication significantly plays an important role in the learning of children with autism who tend to have stronger visual information processing. Furthermore, the column regarding the number of student responses is divided into two parts, namely active responses and passive responses. Active responses reflect students' direct involvement in learning activities, such as answering questions, pointing at media, or physically performing teacher instructions. Meanwhile, passive responses refer to students who do not show a direct response, either because they have not understood the instructions, or because they are still in the process of adapting to the stimulus given. In addition to frequency, the duration of time it takes for students to respond is also a major concern in this table. Therefore, a column is provided that shows the average time (in seconds) it takes students to respond after the teacher gives instructions. This duration is an important indicator in measuring the affordability of teacher

communication to the thinking process of students with special needs, where providing sufficient waiting time is an important principle in inclusive learning.

Overall, this narrative reinforces the meaning of each numerical data in the table, which not only describes the quantity but also reflects the quality of students' interaction and engagement in learning. The visual and gesture-based approach applied by the teacher is proven to be able to create positive responses from students, both in terms of frequency of interaction and timeliness in responding.

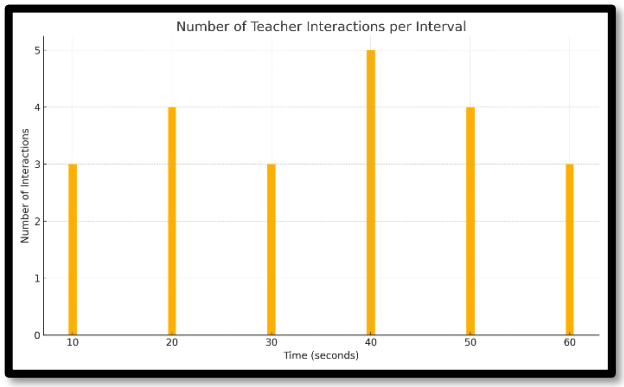

Figure 2. Teacher and Student Interaction

Figure 2 shows the number of interactions the teacher had with the students in each 10-second time interval throughout the video. It appears that the peak of interactions occurs at the 40th second with a total of five interactions, while the lowest point is at the 10, 30, and 60-second intervals with three interactions. These fluctuations reflect the dynamics of classroom activities, which depend on the learning phase. The high number of interactions at the 40th second most likely occurred when the teacher was providing active instruction, managing tasks, or responding to individual student responses. This pattern shows that the teacher is consistently present in the learning process, but the intensity of teacher involvement also depends on the stage of the activity.

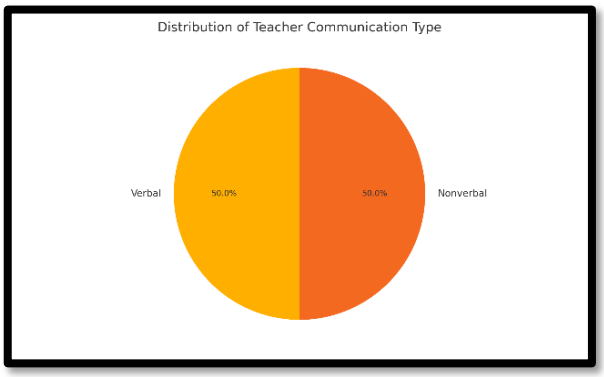

Figure 3. Distribution of Teacher Communication Type

Figure 3 illustrates the proportion of communication types used by teachers in the learning process, namely verbal and nonverbal. Verbal and nonverbal communication each dominates at 50%. This balance indicates that teachers do not only rely on spoken language in conveying material but also use gestures or body expressions to reinforce the delivery of messages. The use of nonverbal communication is very relevant in the learning context of students with autism, as they tend to be more responsive to visual or gestural instructions than verbal instructions. This shows that the teacher has implemented the multisensory principle which is important in the inclusive approach.

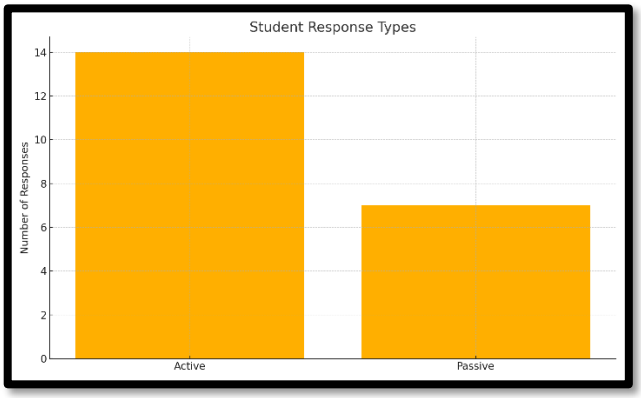

Figure 4. Student Response Types

Figure 4 compares the number of student responses categorized into active and passive. The results show that active responses (14 times) are much more dominant than passive responses (7 times), with a ratio of 2:1. This indicates that most students are actively involved in the learning process. Active responses include actions such as pointing, answering, or following instructions through movement. The existence of a number of passive responses is also reasonable given the diversity of student profiles, especially in children with autism who take longer to adjust to learning situations. In general, the dominance of active responses reflects the effectiveness of the visual and gesture approach in facilitating students' understanding.

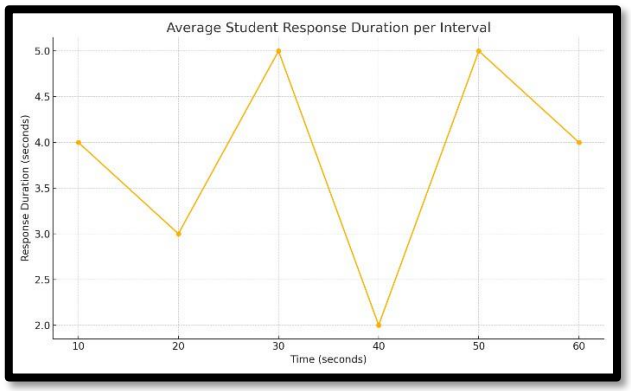

Figure 5. Average Student Response Duration

Figure 5 shows the average duration of time taken by students to respond to teacher instructions in each time interval. The duration ranged from 2 to 5 seconds, with a median value of 4 seconds. This variation shows that while some students can respond quickly (e.g. by the 40th second), others take longer to process the information. This is an important indicator of inclusive learning - that teachers should allow enough waiting time for students to understand and respond comfortably. This stability of response duration indicates that the learning strategy used has been able to accommodate students' learning pace fairly.

Figure 2, Figure 3, Figure 4, and Figure 5 together show that learning with the integration of visual media and gesture creates an inclusive and responsive atmosphere. Teachers show a high intensity of interaction, relying on verbal and nonverbal communication in a balanced way, and encouraging active involvement from the majority of students. The duration of students' responses within a reasonable range also reflects the existence of a safe and adaptive space in the learning process. The implication of this finding is the importance of teacher training to use multisensory strategies in a consistent and structured manner, as well as providing concrete visual learning media to support the understanding of mathematics concepts in students with autism.

Quantitatively, the results of the analysis of the 63.83-second video show that the teacher conducted 22 interactions with students in six-time intervals (every 10 seconds). The communication used was equally divided between verbal (3 times) and nonverbal (3 times), reflecting the proportional use of multisensory strategies. In terms of student responses, there were 14 active responses and 7 passive responses, indicating the dominance of students' active engagement in learning. The average duration of time students took to respond was 3.83 seconds, with a

median value of 4 seconds, indicating a reasonable period and suggesting that students were given sufficient space to process the information.

The overall findings from this video reinforce that the integration of visual media and gestures can create an inclusive, responsive, and participatory learning environment, especially for students with special needs such as autism. This strategy not only supports the understanding of abstract math concepts but also builds positive social interactions in an inclusive classroom. The combination of numerical data and narrative observations provides an overall picture that this approach is worth recommending as a good practice in inclusive education at the primary school level.

DISCUSSION

The following discussion integrates the observations with theory and findings from previous studies to provide an in-depth understanding of the effectiveness of visual and gesture approaches.

The results showed that learning mathematics with the integration of visual media and gestures had a positive impact on the engagement and understanding of students with autism in inclusive classrooms. Quantitative data revealed a high frequency of teacher interaction (22 times) and the dominance of students' active responses (14 times) over passive responses (7 times). The average duration of students' responses, which were in the range of 2-5 seconds, indicated that students needed reasonable thinking time and could adjust to the multisensory approach. Qualitatively, teachers seem to consistently use gestures, facial expressions, and concrete visual aids such as picture cards, which make it easier for students to understand abstract concepts. This approach builds inclusive two-way communication while strengthening cognitive processes through sensorimotor experiences, as supported by the theory of embodied cognition (Goldin-Meadow et al., 2009).

This finding is in line with previous studies that emphasize the effectiveness of using gesture and visual media in learning mathematics for children with autism. Shurr et al. (2021) found that the use of concrete manipulatives helped students with autism understand abstract concepts better than virtual manipulatives. Kaya and Yildiz (2023) also showed that visual-based learning significantly improved the retention and transfer of mathematical understanding in students with autism. In addition, Guo et al. (2025) emphasized that gesture plays an important role in strengthening students' visual attention and memory. Thus, the results of this study not only strengthen previous findings but also provide new empirical evidence in the local context of inclusive education in Indonesia.

The implications of the results of this study indicate that teaching strategies that integrate visual media and gestures can be an effective and adaptive learning model in inclusive classrooms. The success of this approach is likely due to the suitability of the learning strategy with the learning characteristics of students with autism who tend to be visual and sensorimotor. The use of gestures and concrete tools allows students to not only hear the teacher's explanation but also see and perform movement representations, thus strengthening concept understanding through multisensory pathways (Hostetter, 2020). Another implication is the need for special teacher training in the proper and systematic use of gestures as part of learning communication, as well as the provision of visual media that are relevant and cognitively interesting for students.

However, this study has some limitations that need to be considered in further studies. First, the duration of the video analyzed is limited to 63.83 seconds, so although the data obtained is quite informative, the scope of observation is still a snapshot of the entire learning process. Secondly, this study has not compared learning outcomes with other classes or different approaches longitudinally. Therefore, further research is recommended to use longer observation data and involve various mathematics topics. In addition, a quasi-experiment involving a control group can be conducted to strengthen the evidence of causality of the effectiveness of using visual media and gestures in learning mathematics for students with autism (Villamin & Luppicini, 2024).

CONCLUSION

Based on the results of the analysis and discussion, conclusions can be drawn regarding the relevance and effectiveness of learning strategies applied to students with autism in the context of inclusive classrooms. This study found that the use of visual media and gestures in learning mathematics in an inclusive classroom can significantly increase the engagement and understanding of students with autism. Through observation of the 63.83-second learning video, it was found that the teacher consistently conducted intensive interactions with students using verbal and nonverbal communication in a balanced manner. Students' responses are dominated by active

engagement, with a stable and reasonable average response time, indicating that the learning approach has accommodated students' thinking process needs well. In addition, the use of gestures proved effective in bridging abstract concepts into more concrete and easily understood representations. This finding directly answers the research objective, which is to examine the effectiveness of the integration of visual media and gesture in learning mathematics for students with special needs, especially children with autism. Based on the qualitative and quantitative data obtained, it can be concluded that this approach not only strengthens the understanding of mathematics concepts but also improves communication and teacher-student interaction. The applied learning model succeeded in creating an inclusive, adaptive, and fun learning atmosphere, in line with the principles of inclusive education which emphasizes accessibility and fairness of learning for all students.

RECOMMENDATION

As a practical recommendation, teachers in inclusive classrooms are advised to use concrete visual media and gesture systematically in every stage of mathematics learning, especially when explaining abstract concepts. Teacher training in nonverbal communication and the use of visual aids needs to be improved so that this strategy can be implemented more widely. For further research, it is recommended to conduct experimental studies with comparison groups and longer observation duration, as well as explore the application of similar approaches to other mathematics topics and different special needs groups.

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Conflict of Interest

Authors state no conflict of interest.

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