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Autistic gesture in the Problem-based learning model; Matching or contradiction?

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Abstract

Mathematics learning is not only for students in regular schools but also for special needs children. Related to this, various learning models can be used in Mathematics learning, one of them being the Problem-Based Learning model. This study aims to identify and describe autistic gestures. This research uses a qualitative approach with a descriptive type of research. The research subjects were students in the autistic category at the elementary school level in Makassar, Indonesia. The technique of determining the subject is purposive sampling. The data collected were analyzed qualitatively using the Miles and Huberman model. The results showed that many autistic gestures were produced during the learning process. Two components indicated gestures: matching gestures and contradiction gestures. A matching gesture is produced to indicate that the dominant autism can complete the given tasks correctly. This gesture is mostly produced in the first and the third phases. Contradiction gestures suggest that the dominant autism is distracted, so the tasks given had obstacles, Tthis gesture is mostly produced in the second and the fifth phases. Problem-based learning model involves students solving problems through several stages of the scientific method.

Introduction

Learning (instruction) is an accumulation of the concept of teaching and the idea of learning. Learning aims to guide the students to behave well. The behavior shown must be by the concepts formulated in the learning objectives as a result of learning. Learning outcomes will be obtained maximally when the learning is meaningful to students. Therefore, teacher creativity in learning is necessary (Mustafa et al., 2021). Specifically, in learning mathematics, teachers teaching mathematics to students should know and understand the object to be introduced, namely, mathematics.

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The aspects of mathematics learning management include planning, organizing, implementing, and evaluating learning outcomes (Sutama et al., 2012). Mathematics learning needs to be well-designed to achieve the learning objectives. It is not only taught to students in regular schools but also to special needs children. The National Council of Teachers of Mathematics (NCTM) has recommended that all students, including Children with Special Needs (CSN), should learn mathematics. All students should have the opportunity and support needed to know and understand mathematics (National Council of Teachers of Mathematics [NCTM], 2000). Farrell (2008) noted that there are 14 categories of children with special needs, including autism. In this study, the case of students with special needs focused on the autism category.

In managing learning, teachers are expected to have good classroom management activities, create conducive conditions, and be student-oriented. In this regard, various learning models can be used in mathematics learning, one of which is the Problem-Based Learning (PBL) model. Many studies recommend that PBL be implemented in teaching various subjects, including Mathematics. Mathematics is a compulsory subject at every level of education, from elementary to university level, but some students find it challenging to learn because it is an abstract subject (Amin et al., 2021), if PBL is applied to mathematics learning, it is expected to improve students' mathematics competence. The Problem-Based Learning (PBL) model is an innovative learning model that can provide active learning (Mustafa et al., 2019). The Problem-Based Learning (PBL) model changes students' assumptions as subjects who have nothing into objects that can be used as partners and contributors and provide inspiration for the continuity of learning (Syamsidah & Suryani, 2018). This learning model is expected to foster a spirit of self-regulated learning that is accustomed to solving problems and has a strong competitive mentality. Barret and Mac Labhrainn (2005) and Mustafa et al. (2019) explain the Problem-Based Learning (PBL) syntax as follows:

Figure 1 shows the syntax of the Problem-Based Learning Model. The learning process of each step is explained as follows: (1) Problem-oriented. Students are given problems by the teacher (or problems are revealed from the experience of students). In this stage, the teacher explains the learning objectives and logistics needed, motivates students to be involved in problem-solving activities, and poses problems; (2) They are organizing the students. In this stage, the teacher divides students into groups and helps students to define and organize learning tasks related to the problem; (3) They guide individual and group investigation. In this stage, the teacher encourages students to collect the necessary information and conduct experiments and investigations to get explanations and problem-solving; (4) They are developing and presenting the result. In this stage, the teacher assists students in planning and preparing reports, documentation, or models and helps them share tasks with their friends; (5) They analyze and evaluate the process and result of problem-solving. In this stage, the teacher helps students reflect on or evaluate the process and results of their investigations.

Literature Review

The application of the PBL model in mathematics learning with autistic students is unique and interesting because it has challenges for teachers in delivering students to understand the meaning contained in each mathematical concept. There is still little research on PBL with autistic students because it is generally conducted on normal students. The efforts in applying the PBL model, in this case, continue to follow each phase in PBL, although special assistance is needed for students due to different learning needs. Teachers must be able to understand the learning needs of autistic students and understand the characteristics and learning patterns, as well as obstacles that may be experienced during the learning process. One of the strategies teachers can use in understanding student behavior is gestures.

It is interesting to associate mathematics learning with language and gestures. Gestures in learning mathematics have a very important role in conveying material and focusing students' attention (Mustafa et al., 2021). Gestures of teachers and students that appear during the learning process prove that the body is involved in the learning interaction.

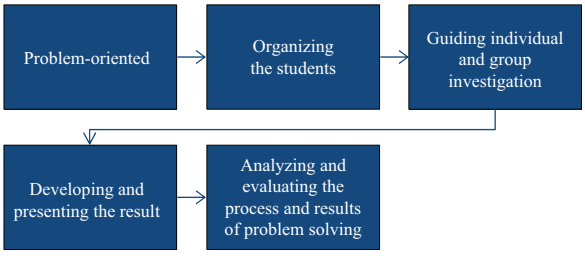

Figure 1 Syntax of problem-based learning model

This is reinforced by Alibali and Nathan (2012), who revealed that to convey ideas in learning, the body's members are involved in it. Applying the PBL model in mathematics learning is an effort to improve the quality of mathematics learning. The interactions between teachers and students in the PBL model are interesting to analyze, especially regarding the gestures produced during mathematics learning. The main focus is on students, but the teacher also plays an important role as a facilitator.

Mustafa's research (2015) defines gesture as a form of nonverbal behavior that communicates through body movements. Gestures are produced spontaneously and cannot be manipulated (Mustafa, 2021). This is reinforced by Escalera et al. (2016), who revealed that gestures are made as part of deliberate actions, signs or signals, or subconsciously showing intentions or attitudes. The gesture is not a translation of speech or irrelevant to speech. Gestures and speech are different communicative manifestations of one mental representation (Cassell et al., 2019), but what they convey to adults is always complimentary.

Research on gestures in the domain of mathematics education research has been conducted by Reynolds and Reeve (2002), Rasmussen et al. (2004), Arzarello and Robutti (2004), Arzarello et al. (2005), Edwards (2005), Williams et al. (2004). Their research claims that gestures play an important role in interpreting students' learning processes. Gestures help emphasize difficult concepts, especially if special language is needed to explain mathematical concepts. In this condition, if the utterance is sufficient to convey the speaker's meaning, then the gesture only acts as a supporter. Still, if the gesture means different information from the information provided by the utterance, then the interpretation of the gesture is very important. The teacher's gestures can help direct students to take and understand the implied meaning of every hand movement or facial expression made by the teacher (Mustafa et al., 2017). Meadow and Mitchell (2009) even emphasized that the gestures of students who imitated the gestures of the teacher during the learning process made it easier for them to understand the lesson. Therefore, gestures not only indicate that students are ready to learn, but gestures can help students in learning (Mustafa, 2015). A gesture is a specific bodily movement that reinforces a verbal message or conveys a particular thought or emotion. Although gestures may be made with the head, shoulders, or even the legs and feet, most are made with the hands and arms (Sugiarmin, 2011).

Problem-based learning is one of the learning models that can activate students in their learning activities. This study aims to identify the gestures that appear during applying the PBL model in mathematics learning. This is important and interesting to study because gestures can strengthen understanding of mathematical concepts. Gesture assumptions that emerged in this study were identified in two categories: gestures that indicated the dominant autism could correctly complete the given tasks, and gestures that indicated prevalent autism were distracted so that the given functions experienced obstacles. Mustafa (2015) provides the terms matching gesture and contradiction gesture. The two types of gestures were identified through the PBL model.

The PBL model is generally applied to learning with normal students so that they can easily identify the gestures produced. However, in this study, the PBL model was applied to students with special needs in the autism category with the consideration that the PBL model had the advantage of being problem-oriented, able to activate students' learning, and the teacher's role as a facilitator so that learning could provide a learning experience doing scientific work/activities. Learning for autism is generally based on the principles of (1) structured; (2) patterned; (3) programmed; and (4) consistent (P4TKTKPLB, 2019). Structured learning strategies for autistic children at a practical level mean providing teaching materials starting from the material/root material that is the easiest and can be done by students. After the ability of stage one is mastered, it proceeds to the next stage but is an inseparable series from the previous step. As an illustration, if the competency that students must master to understand the meaning of the instruction "take a ball-shaped object" in a series of self-help learning (self-help), the first material that must be introduced to students is the meaning of the word "take", then "shape", and "ball". After students know and understand word by word, the next step is translating the "take a ball-shaped object" instruction into concrete actions. Thus, the learning structure for autistic children includes the structure of time, the structure of space, and the structure of activities.

Gestures are natural and spontaneously produced. Therefore, a person can understand what is delivered when verbal communication is followed by non-verbal language through body language (Mustafa, 2023). Gestures are one effective medium of delivering a message in a way that speech normally cannot do. The involvement of gestures in mathematics learning has been proven to influence perception,

learning comprehension, and students' development (Damayanti & Sa, 2019). Therefore, understanding students' gestures when learning can determine students' comprehension of the material taught. Specifically, the learning process of Mathematics for autistic students can be started from the concrete. The learning process can be conducted by considering gestures and using visual strategies, for instance, using concrete objects or tasks presented visually using colourful images that attract students' attention (Mustafa et al., 2017). Autistic students tend to perceive objects based on their visual observation and are influenced by mood instabilities and surrounding situations. The condition's impact on the probabilities of the gestures produced are matching or contradictory. This research focuses on teachers' and students' gestures in the learning process. The researcher observed in depth each gesture produced and ensured that each application of the problem-based learning model could be implemented according to the phases.

Methodology

This study uses a qualitative approach with a descriptive research type. The research process is conducted in the classroom by recording learning activities by teachers and students. The teacher and students' activities were audio-visually recorded during the learning process to obtain accurate data. The recordings were processed according to this study's qualitative data analysis stages.

Sample

The research subjects were students in the autism category at the elementary school level in Makassar, South Sulawesi, Indonesia. The technique of determining the subject is purposive sampling, considering that students are included in the autism category, can follow the learning process, and the learning model used during the mathematics learning process is problem-based. The determination process of the research subject was conducted by testing several students categorized as autistic, interviewing teachers related to students' ability, and asking for agreement from the school and subjects' parents whether the students were allowed as a subject if fulfilling the category. After conducting some testing in the classroom, it was determined that the research subjects in this study were students who qualified for the medium category and the teacher (mathematics subject). The teacher would assist and conduct the learning process by applying a problem-based learning model.

This research only focused on one case with a limited number of subjects. It was conducted due to the limited number of subjects who fulfilled the category. The advantage is that analysis can be in-depth, although comparisons with other cases are required. However, the researcher would develop the follow-up research in the next stage.

Data Collection

Creswell (2012), in the book Research Design, explains that qualitative research is a method to describe, explore, and comprehend the significance that several individuals or groups consider from social or humanity problems. Sugiyono (2019) also emphasizes that qualitative research is based on philosophy, used to research the scientific conditions (experiments) where the researcher is an instrument, data collection techniques, and is analyzed qualitatively to emphasize the meaning.

The main instrument in this study was the researcher, while the supporting instrument used documentation in the form of audio-visual recording equipment, Instrument tasks which contain mathematical tasks about geometric shapes, namely, cubes, blocks, cones, tubes, and spheres, as well as props for concrete objects are also provided. The tasks and concrete objects used were validated by experts and declared valid to be tested. Data were collected by recording and observing the activities of teachers and students during the learning process.

Data Analysis

The collected data were then analyzed qualitatively using the Miles and Huberman (1984) model. The data analysis in this qualitative research was conducted during data collection and after completing the data collection within a certain period. The qualitative data analysis was conducted interactively and continuously until complete, so the data were saturated.

Figure 2 shows the cycle of the data analysis technique. Data reduction is the stage of simplifying

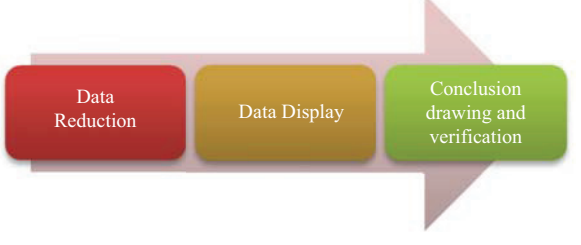

Figure 2 The cycle of data analysis

the data according to the need to get information easily. The data that has been collected will be categorized or grouped into very important, less important, and unimportant data. Furthermore, the researcher saves the necessary data and discards unnecessary data for research. The data will be simpler and clearer, making it easier to continue to the next stage. The data presentation is taken to display data that has been reduced into graphs, charts, and others. It aims to make it easier to convey and understand by others. It will also make it easier for the reader to absorb the information in the data. The presentation of the data in this article is done in the form of images and graphs. The conclusion drawn is the information obtained from data that have been compiled and grouped and then presented using certain techniques. The findings can be placed at the end or closing, so the reader can find conclusions from the entire research.

The data reduction

Sugiyono (2019) explains that data reduction is summarizing, selecting essential points, focusing on important points that are appropriate to the research topic, looking for themes and patterns, and ultimately providing a clearer overview and facilitating it easier to do further data collection. Reducing data would be guided by the objective determined. Data reduction also is a critical thinking process that requires high intelligence and insight.

Data display

After reducing data, the next stage is displaying data. The data displayed in this research was conducted in image form or recorded documentation. By displaying data, the data can be organized and arranged in a relational pattern to be easily understood. In addition, the data displayed in this research was conducted in a brief description, the relationships between categories complemented by narratives. The data can be organized and arranged to be easily understood by displaying data.

Conclusion

The last stage in qualitative data analysis is the conclusion. Conclusion in qualitative research can answer the problem statements formulated initially, although it may not because problem and problem statements are still temporary and will develop after the research is conducted in the field. Conclusion in qualitative research are new findings that have not previously existed. Findings in this research describe an object that was previously unclear so that it becomes clear after research.

Furthermore, the data validity checks in this research are achieved using the data collection with the data triangulation technique. Data triangulation is a data collection technique that combines various existing data and sources. The triangulation techniques used are (1) source triangulation, (2) data collection techniques triangulation, and (3) time triangulation. The source triangulation is conducted to check the credibility of data obtained from various data sources such as interviews, archives, or other documents. Technical triangulation is conducted to check the credibility of data by checking on the data obtained from the same sources but using different techniques. For instance, the data obtained from observation was then checked with interviews. Time triangulation is conducted through checking by interviews, observations, or other techniques in different times and situations. It is repeatedly checked until the certainty of the data is found.

Results

The mathematics learning process in this study was conducted directly and recorded using an audio-visual camera. The learning model used is problem-based by applying five phases. The research subjects were students in the autism category.

The Phase of Problem Orientation to the Students

In this stage, the teacher conveys the problem to be solved. The problem given is recognizing geometric shapes and various concrete objects whose shapes resemble geometric shapes. The teacher introduces geometric shapes, such as cubes, blocks, cones, tubes, and spheres. In addition to displaying geometric shapes, the teacher also shows various examples of concrete objects in everyday life that resemble geometric shapes. In this stage, the student's activity is listening and observing the teacher's geometrical media and examples of concrete objects.

Figure 3 shows the subject's gesture when observing the media shown by the teacher indicating a focus on seriously paying attention to the object he is observing. This gesture lasts only 6 seconds but is assumed to be sufficient to represent the subject's ability to orientate in recognizing the shape of the cube. The subject has distractions because he diverts his attention to other objects in front of him.

Figure 3 The phase of problem orientation

This condition is commonly experienced by autism due to obstacles in eye gaze, understanding of meaning, and sensory processing (Mustafa, 2015). The problem orientation phase is not only intended to explain the problem but is also intended to motivate the subject in their learning activities. The dominant gesture that appears in this phase is the regulator. The function of this gesture is directing, supervising, and coordinating interactions with others. The teacher uses eye contact in paying attention to the subject. The regulator is the main interactive sign, iconic and intrinsic (Mustafa et al., 2022). This type of gesture is a collection of expressions and gestures that help to control and understand better communication because it includes a combination of many aspects of body language such as eye contact, touch, hand movements, head nodding, or shaking of the head, facial expressions, and vocal cues. This gesture plays an important role in this phase because it builds an emotional bond between the teacher and students, thus having a positive impact on the next phase.

The Phase of Organizing Students to Learn

In this stage, the teacher ensures that the subject understands the task. The subject's gesture is listening to the teacher's explanation, even though his attention is more dominant on the object of the picture in front of him. The substance of this stage directs the subject to conduct the data collection/investigation process so that he can complete the given instrument task.

Figure 4 shows the teacher's activities when organizing the subject with the problem that will be solved. When the teacher took the display media (the ball), the subject quickly responded by taking the ball he held while he said "ball". This condition is different when the teacher shows the cube. The subject is more interested in the ball, the response is fast, and the gesture of taking the ball in the teacher's hand indicates a strong interest in the object he sees. This gesture lasts up to 16 seconds, which is quite long compared to the gestures on the cube box. The subject holds and plays with the ball in his hand. After that, the teacher takes the ball again and then directs the subject's attention to observing and investigating the ball picture in front of him. The gesture subject looks focused, fiddling with many image objects in front of him. The object is in the form of pieces of concrete objects that exist in everyday life, and the shape resembles the geometric shapes of cubes, blocks, cubes, cones, and spheres. The object attracts the subject's attention because it is visually close to his daily life, easy to recognize and the presentation of the picture is colorful so that it is interesting. This situation is relevant to Higbee (2016).

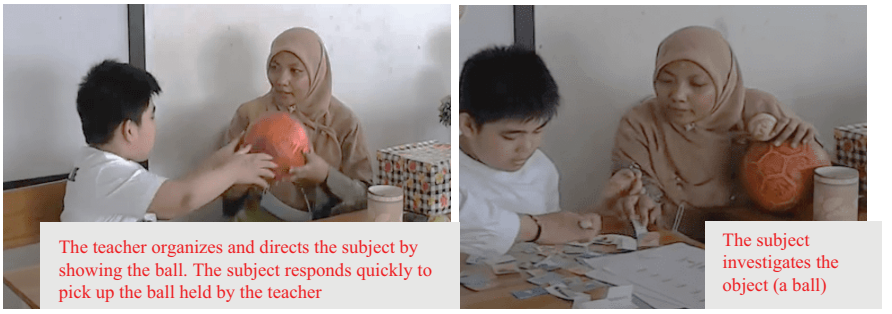

Figure 4 The phase of organizing the Subject

They explain that the student touched a picture of a specific object if physically prompted toward the location of that object. This strategy is quite helpful for the subject to identify geometric shapes. This condition has been revealed by Mustafa (2015) that in the autism learning process, it is easier to learn (understand learning material) through visual media, so learning that uses aids as learning media is the main choice for teachers. Aids can be in the form of pictures, posters, balls, toy blocks, and other items.

The Phase of Guiding Phase of the Individual Investigation

In this stage, the teacher monitors the subject's involvement in collecting data/materials while investigating geometric shapes.

Figure 5 shows that the teacher helps the subject conduct an investigation, identifying/grouping the image objects according to their geometric shape and then filling out the given task sheet. In helping the subject, the teacher continues to use the media as a concrete object. This strategy continues to be used to ensure the subject has understood the task given. However, a different situation was shown when the teacher took a cone-shaped hat and placed it on the subject's head. The real purpose was for the subject to feel the educative elements of each visual medium and understand that the birthday celebration hat identically looks like a cone. But spontaneously, the subject played with the hat, observing its shape while flipping it from top to bottom. This gesture lasts for 8 seconds because the teacher can quickly divert the subject's attention to the pieces of the picture in front of him to continue the investigation. This indicates that the subject communicates with others through complex, fluid, and rapid coordination between speech, altering facial expression, changing eyebrows or head position, and gestures (Iverson, 2010). The subject's reactions indicate an interest in the object. Autism will perceive objects based on their visual observations and tend to be influenced by mood instability and the surrounding situation (Mustafa, 2015). In general, students with autism spectrum disorders will show atypical development of gesture production, and gesture disorder is one of the determining factors in the diagnosis of autism spectrum disorders (Mastrogiuseppe et al., 2014).

The Phase of Developing and Presenting the Work

In this stage, the teacher monitors and guides the subject to get the work results.

Figure 6 shows that the subject is still fiddling with several pictures in front of him. This activity can distract the subject. Sometimes the subject mentions the introduced image, and when completing the task correctly,

Figure 5 The phase of guiding investigation

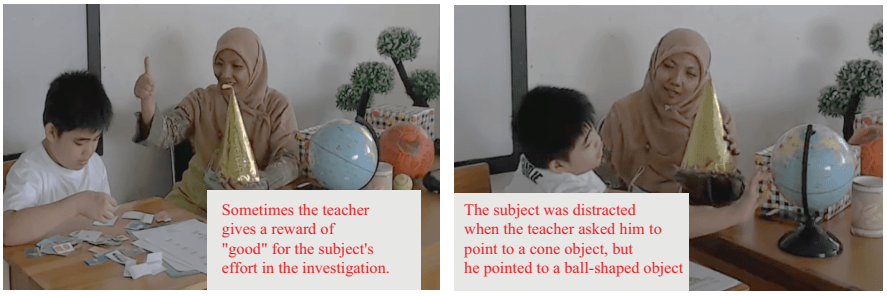

Figure 6 The phase of developing and presenting the work

the teacher gives a reward by giving the thumbs up sign while saying "good". Rewards are given as the teacher's appreciation for the subject's efforts in completing their tasks well, which could motivate the subject to continue the activities. The reward is a pleasant consequence that students get as a result of the expected response. Giving rewards for autism is expected to increase the correct response when listening to instructions. Rewards profoundly impact human motivation, cognition, affect, and behavior. The study of reward processing and the effects of incentives thus occupies a central place in psychology and cognitive neuroscience (Veselic et al., 2021).

The Phase of Analyzing and Evaluating the Problem-Solving Process

In this stage, the teacher gives appreciation and input, and the subject concludes the material.

Figure 7 explains the analysis and evaluation of problem-solving that are conducted in this stage. Analysis and evaluation are activities to analyze the subject's task and obtain a conclusion. Evaluation is intended as the subject's decision-making process on the problems that have been solved. The teacher helps the subject reflect or evaluate the investigation and the processes used. The reflection process is individual. In this stage, the subject is asked to express his feelings and experiences while completing the task. The teacher and the subject develop the discussions to improve performance during the learning process, so there will be a new inquiry to answer the problems posed in the first stage of learning. In general, the subject can follow this process well. The teacher's guidance is also supported by visual media that is attractive to the subject. The role of the teacher is quite important in assisting students during the learning process. Meadow and Mitchell (2009) once revealed that teacher gestures could help students in their learning activities. Gestures can direct students to get and understand the implied meaning of every movement or facial expression (Mustafa, 2015). Mood instability which generally refers to autism is a unique characteristic that can affect gestures. To maintain stability, the teacher can provide a stimulus as a reward/praise.

Discussion

Overall, the autism learning process by applying PBL lasted for 00:50:47 (50 minutes, 47 seconds), although it was not optimal because there were a lot of distraction. The learning process indicates that autism has executive function deficits or difficulty solving mathematical problems. The test proves this by organizing the problem and must be supported by visual media. Each phase of PBL can be passed, although there are many distractions. The following figure shows the intensity of distraction in each passing phase.

Based on Figure 8, it can be concluded that distraction is one of the learning obstacles for autism. Phase 2 and Phase 5 have a lot of distractions. The rate of distraction is quite high compared with other phases. This is because, in phase 2, some of the objects/visual media used can distract students' attention from the given task. Visual media are generally easy to find in everyday life, so it is very easy to attract students' attention, while in phase 5, students have difficulty constructing problems.

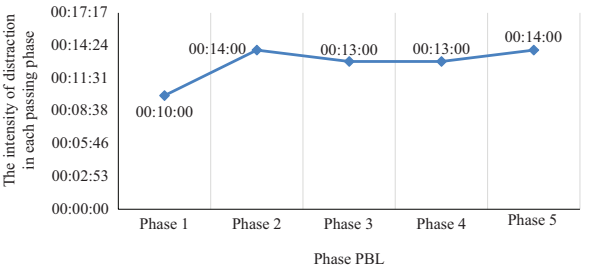

Figure 8 The rate of distraction

Figure 7 The phase of analyzing and evaluating the problem

In this case, learning obstacles are seen in the process dimension (Sugiarmin, 2011), which refers to the inability, difficulty, or failure to capture and interpret information. The obstacles of autism have problems in receiving information and analyzing it. The barriers in social interaction and focusing attention on learning objects cause them to be unable to absorb and respond appropriately and correctly to various stimuli or commands in participating in the learning activities. In helping students in their learning activities, the teacher produces a lot of prompting gestures, such as gestures used to help generate the desired response from students. For example, the teacher has thumbs up, claps, or takes certain actions to increase student response (Mustafa et al., 2021). Prompting gestures are very important, especially as a call to action, because they help direct people and encourage them to do what's next. In this case, the gestural prompt gives autism information about the cue to use behavior or skill through gestures. The research by Maes et al. (2021) shows that children with autism exhibit different patterns of attention to intentional compared to unintentional pointing cues. This may indicate variations in social information processing and communication.

Another finding that causes Phase 2 and Phase 5 to have a fairly high-rate distraction compared to other phases is because in this phase the learning focus is on the chosen problem, so students not only learn concepts through visual aids but are also required to use task instruments to solve problems. This means that students are faced with two concerns, which allows the focus of attention to be divided. The main activity of the teacher in phase 2 is helping students to learn (organizing students to know related to the given problem). If students are difficult to control, the learning process will have obstacles affecting the next phase. However, if the teacher can organize students well, the problem investigation process can run well. Furthermore, the main activity of the teacher in phase 5 is guiding/facilitating students to analyze and evaluate the problem-solving process they have obtained. Teachers help students to reflect on or assess their investigations and the strategies they use.

Problem-based learning begins with a problem that triggers a cognitive imbalance in students. This condition encourages curiosity and raises various student reactions when organizing issues. The problem-based learning model involves students trying to solve problems with several stages of the scientific method so that students can learn related knowledge and, at the same time have skills in solving problems (Ibrahim & Mohamad Nur, 2010; Yackel et al., 1993). The Problem-Based Learning model will be a learning approach that seeks to apply issues that occur in the real world as a context for students to practice problem-solving (Syamsidah & Suryani, 2018). The dominant distractions of Phase 2 and Phase 5 cause a lot of contradiction gestures that appear in that phase.

Figure 9 shows how gesture dominance is produced by autistic students during mathematics learning through a problem-based learning model. Learning includes not only cognitive processes but also mental processes and the role of the environment. Understanding autism gestures during the learning process impacts their behavior and mentality. Autism has the characteristics of concrete visual thinking. In addition, autism also has limitations in divergent thinking. Psychologically they are easily anxious when faced with new and changing situations. Because of the weakness in imagination, conducting an activity or completing a task tends to be used one way. In limited conditions, structured learning with the PBL model provides a solution to direct and guide autistic students to grow and develop in life like other normal children. Structured learning will make it easier for them to understand their environment and learn to conduct activities according to their consistent stages.

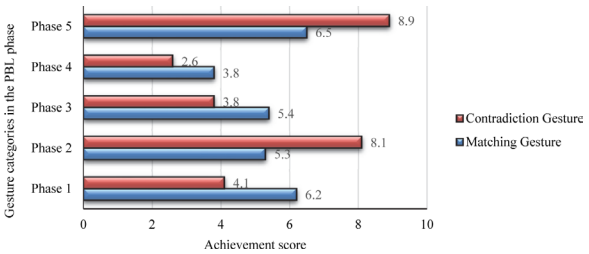

Figure 9 The dominance of the gestures

Based on the results of the analysis of the gestures produced by autistic students during the learning process, it can be explained that in learning activities, autistic students find it easier to accept information or knowledge conveyed through pictures (visual learners). This is supported by Lucking (2021) indicating that gestures function as a complement or substitute for verbal expression, and how gestures can reinforce the meaning conveyed in spoken language. Otherwise, they will have obstacles in understanding information through long sentences or solving arithmetic problems using sentences. During the learning process, gesture production indicates that the dominant autism can correctly complete the given tasks.

In contrast, contradiction gestures suggest that the prevalent autism is distracted, so the assigned tasks experience obstacles. During the process of learning mathematics, students' responses were quite good, although sometimes they experienced distractions that caused a lack of attention. According to Kamid et al. (2021), student responses to the learning model will greatly affect the learning process; if the response is positive then the learning process will also be good, which will have an impact on student process skills. Student responses and incorrect skills are related to learning outcomes. Student responses and good process skills will have a positive influence on learning outcomes. Good learning outcomes will be obtained from the learning process that allows students to build their knowledge. By building their knowledge, the learning process will be more meaningful.

The problem-based learning model is specifically aimed at enhancing and optimizing the educational outcomes of learner-centered, collaborative, contextual, integrated, self-directed, and reflective learning. Although it is assumed that they have limitations in participating in mathematics learning, the results of the study show that autism has a good response and can follow every phase of learning. The application of PBL helps them follow every process of learning mathematics and understanding mathematical concepts by using concrete teaching aids. This model is characterized by the use of real-life problems as something that students must learn to train and improve critical thinking and problem-solving skills, as well as gain knowledge of important concepts, where the teacher's task must focus on helping students achieve self-direction skills. PBL models provide opportunities for children to get real experiences during the learning process so that children can discover, construct, and develop their insights and skills in various aspects of development independently. There are many benefits that we can take from this problem-based learning, including (1) a Practice Mindset. Students will think and work together when asked to solve problems supervised by the teacher. If this learning is familiar to students, their thinking will always develop and form a critical personality; (2) Easier to Remember. Cooperation can also make students remember the lessons they have experienced. Although not all, at least students have an image of it in their memory; (3) Students are more active. The activeness of students in class is certainly really liked by the teacher because they feel that their students look more active when studying even though they sometimes experience distraction.

Conclusion and Recommendation

The application of the problem-based learning model in autism is according to the phases specified in it. In general, autism can follow the learning process using visual media. The use of visual media helps the autistic understand the tasks given. Various disorders can occur and are experienced by autism potentially, so it has a high risk of the emergence of obstacles in various aspects of development. This condition creates problems that will result in autism having obstructions or interference in learning. Many autism gestures are produced during the learning process. Two components indicated the gestures: (1) matching gestures, and (2) contradiction gestures.

The matching gesture means the dominant autism can correctly complete the given tasks, which occurs in the phase of problem orientation, guidance, and work presentation. In contrast, the contradiction gesture indicates that the dominant autism is distracted, so the tasks given have obstacles. It occurs in the phase of organizing students and analyzing/evaluating the problem-solving process.

In this research, the teacher applied a problem-based learning model following the phases, which are (1) orienting students to the problem, (2) Organizing students to learn, (3) Guiding individual investigations, (4) Developing and demonstrating products, and (5) Analyzing and evaluating. The teacher has an essential role in assisting students' learning activities. Each gesture produced by the teacher contributed to students' activities. It can be imitated and helps to understand mathematical concepts.

This research does not examine the cognitive ability (IQ level) of autism but only identifies the gesture produced during the learning process, so other researchers can follow up by developing or expanding problems in the cognitive aspect or students' mathematical thinking process, also applying problem-based learning model in other learning.

Conflict of Interest

The authors declare that there is no conflict of interest.

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