International Education Studies; Vol. 9, No. 6; 2016
ISSN 1913-9020 E-ISSN 1913-9039
Published by Canadian Center of Science and Education

Mathematical Thinking Process of Autistic Students in Terms of Representational Gesture

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Received: July 16, 2015 Accepted: January 8, 2016 Online Published: May 26, 2016

doi:10.5539/ies.v9n6p93 URL: http://dx.doi.org/10.5539/ies.v9n6p93

Abstract

The aim of this study is to describe the mathematical thinking process of autistic students in terms of gesture, using a qualitative approach. Data collecting is conducted by using 3 (three) audio-visual cameras. During the learning process, both teacher and students' activity are recorded using handy cam and digital camera (full HD capacity). Once the data is collected (the recording process is complete), it will be analyzed exploratively until data triangulation is carried out. Results of this study describes the process of mathematical thinking in terms of a gesture of students with autism in three categories, namely correctly processed, partially processed, and contradictory processed. Correctly processed is a series of actions to solve the problems that are processed properly marked with a matching gesture, partially processed is a series of actions to resolve problems with partially processed properly marked with discrepancy gesture, while contradictory processed is a series of actions to solve the problems that are processed incorrectly marked with the dominance of discrepancy gesture. Matching gesture demonstrate the suitability of movement or facial expressions when observing, pointing, and uncover/calling the object being observed, while the discrepancy gesture indicates a mismatch movements or facial expressions when observing, pointing, and uncover/calling the object being observed.

Keywords: mathematical thinking process, gestures, autistic

1. Introduction

Autism Society of America (2014) defines autism as a complex developmental disorder and appears during the first three years of life as a result neurologic disorder that affects brain function. These disorders result in individuals experiencing limitations in terms of communication, social interaction and behavior. In neurological (relating to the nervous system) autistic is defined as an individual with autism has problems with brain development, especially in the aspects of language, social and fantasy/imagination (Linden Bridge School, 2014). American Psychological Association (2015) defines autism as a developmental disorder that occurs in children who are self-closing conditions. These disorders cause children to have limitations in terms of communication, social interaction and behavior. Based on this theory, it is in relation to the learning process, students with autism can be defined as students who have developmental disorders of communication, social interaction and lack of flexibility in thinking and behaving. These characteristics fit the diagnostic criteria Autism Spectrum Disorder (ASD), its characteristics can be illustrated as Figure 1.

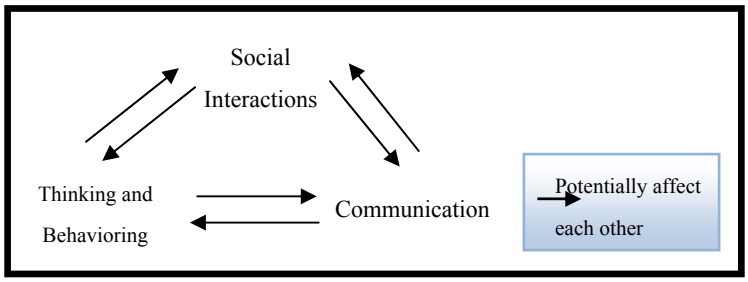

Figure 1. Illustration of autism characteristics (Modification of ASD, 2010)

Figure 1 shows the interconnections between the three characteristics. If the ability of thinking and behavior has a problem, then it will potentially affect the other two characteristics (communication and social interaction). Vice versa, if the communication does not develop, it will potentially affect the behavior and social interaction.

Sussman (1999) outlines that in learning process; students with autism are easier to learn (to understand the learning material) through visual media, so learning which use instruments as figurative media is become the chosen options for the teachers. These instruments may include images, posters, toys (balls, blocks) and others. Based on Sussman, the process of mathematic learning for students with autism can be started from the nature of concrete, using drawings or concrete objects around the students, such as learning about geometry, teachers can start the learning by introducing form of geometry with variety of concrete objects such as dice and cardboard the same shape with the shape of a cube. Students are given the opportunity to perform actions such as observing/seeing, feeling, and reveal/call geometric shapes on concrete objects that are observed, or students can be taught to identify or classify objects according to similarities in character. Action is one of the gestures (gesture), as revealed UEFAP (2015) that the gesture is an act which sends visual cues.

According to Freedman (Shein, 2012), "gesture is a facilitator of verbal expression". Supporters of this view argue that the gesture is intended to achieve a more adequate verbal expression. In addition McNeill (1992) says that "the movement of the hand and body movement can be regarded as a gesture". This was also confirmed by Hostetter and Alibali (2004), Gallagher (2005), McNeill (2005), Nunez, (2005), Gibbs (2006), Alibali and Nathan, (2007) which says that "person who uses his/her body (ie gestures) to reveal knowledge, thinking, and knowledge must be bonded/integrated with the body ". The body parts which visually most expressive are face and hands (Kumar, 2009).

Gesture can serve as a barrier symbol between the expression of words, the attitude towards other actions. Gesture explains literally the purpose of mind and reinforces the meaning of the utterance. The functions of gesture are described as Table 1 below.

Table 1. Function of gesture

Functions	Process	Behavior
Repetition	Reloading conveyed ideas	The desire to solve/answer the problem by affirming while pointing and immediately fulfill the wishes.
Substitution	Replacing symbol or verbal attribute	Without saying anything or saying something along with gaze to another object, due to misunderstanding/no idea/not interested to objects questioned
Contradiction	Contradicting verbal information by giving another meaning using nonverbal information	Agree with the answer/solutions for the problems or have to know/understand the problem (can appoint or reveal objects precisely), but cannot/do not want to do when asked, showed contradictory with the verbal information
Complementary (complement)	Complementing and enrich the nonverbal information	Facial expression shows fear/hesitated/bored/saturated/focus/serious without a sound or sounding but difficult to be understood
Accentuation	Affirming nonverbal information	Nodded his head in approval, or closed his eyes and nodded his head as if to understand penjelasa teacher or problems that will be done

Adapted from Turafanany (2012).

Gesture consists of a variety of body movements and verbal symbols which is the process of thought and ideas exchange, information submitted may be gestures, facial expressions, eyes gaze, touch, or artifacts/symbols used (Kumar, 2009; Turafanany, 2012; Sumarna, 2013). So it can be concluded that the gesture is a nonverbal communication (gestures or face expressions) that represent the mind.

It's important to identify the gesture of students with autism in mathematic learning. This is done as an attempt to understand and deepen their thinking processes. Gestures that arise can be seen as a form of manifestation of verbal communication difficult they are doing. If the gesture is performed along with a greeting, it can further clarify the representation of the mind. This is also reinforced by statements of Yoon (2011) that "the gesture that appears accompanied by speech is often regarded as a derivative of the mind". McNeill (1985) also reveals the gesture as an integral part of the speech that contributes to expressing the mind spontaneously. Gesture can be regarded as a representation of what he thinks and can serve as accents, which confirms the nonverbal information. For example, disinterest on an object can be demonstrated by looking at the other objects. For the autistic students, the ability to get a clear idea about what he thinks is often hard to do, unless there is an explanation (can be done visually). Students with autism will tend to explore an object in unstructured situations (Lord, 2001). Clarke, Goos, and Morony (in Scusa, 2008) says that "the right to develop a visual presentation of information about an issue very important to be able to solve the problem". Students need to practice, but in the present and defend their answers need to be given the opportunity to show what they think and how problems can be solved.

Autistic students' gesture in mathematics learning comes naturally and different between a student and the others. This is due to different spectrum among students, as revealed by Lord (2001) that "autism spectrums affect various aspects of thinking and learning". Gesture accompanied by remarks upon completing a math problem can arise spontaneously and simultaneously, and according to McNeill (2000) "that accompanied a greeting gesture can help shape the mind". Tots (2015) revealed that "many children with autism are visual thinkers". This statement indicates that students with autism may think or process information by using pictures, and thinking processes is termed a visual thinking. Tots (2015) added the visual thinking occurs when students think to create illustrations, drawings or play a variety of real objects in the vicinity. This process indicates that students with autism need a duration long enough to provide a response, because it is associated with cognitive ability or owned motor movement. Therefore, the main topic of the problems in this article is how the process of mathematical thinking of students with autism in terms of gesture. This formula corresponds to the objectives to be achieved, namely decrypt autistic students' mathematical thinking process by exploring their motor movements (gesture).

2. Theoretical Framework: Gesture and Mathematical Thinking Processes

Gesture is natural, and one can know what is conveyed when verbal communication is followed by nonverbal

language through body language. Gesture consists of a variety of body movements and verbal symbols which is the process of exchange of thought and ideas, information submitted may be gestures, face expressions, eye gaze, touch, or artifacts/symbols used (Kumar, 2009; Turafanany, 2012; Sumarna, 2013). So it can be concluded that the gesture is a nonverbal communication (gestures or face expressions) that can represent the mind.

Based on Shein's (2012) research, there are three (3) types of gesture that is:

1) Iconic gesture. Gesture is characterized using fingers, stationery, physical objects, places, or people. Specifically, McNeill (2000) classifies iconic gesture in reference, artifacts' and visual representations relating to tasks (e.g. spreadsheets, whiteboards or other manipulative material).
2) Representational Gesture. Gesture illustrates the ideas concrete and abstract, entity, or event that is delivered verbally and nonverbally.
3) Writing gesture. This gesture occurs when movement/gesture leave permanent scars on the new media (e.g. worksheets, chalkboard, or visual representations).

Specifically, the research of Alibali and Nathan (2007) has revealed that the representational gesture contributes to learning and help students to learn especially when teachers teach new material, introducing ideas, or respond to student questions. Becvar (2008) also found "representational gesture plays an important role in communicating the concepts and theories". Becvar (2008) believes representational gesture as an attempt instantiation (embodiment) which is very important to establish a theoretical understanding.

Representational gesture shows a simulation of the underlying motor and perceptual speech. This gesture helps nonverbal expression of ideas. McNeill (1992) interpret the gesture as an iconic representational gesture and metaphor gesture. Iconic gesture is closely related to speech, describing what was spoken through hand gestures. For example one can describe a physical object using a hand to show how big or small the object. Metaphor gesture will build a visual object or appoint an abstract object. The gesture has a relationship of form and function relatively transparent and plays an important role in communication. Representational gesture (iconic and metaphor) is very important to represent nonverbal information to be placed as verbal information.

In this review, reprentational gesture explored empirically that discrepancy was found matching gesture and discrepancy gesture. Matching gesture is the kind of gesture that marked the suitability movements or face expressions when observed, pointing, and uncover/call the object being observed. Discrepancy gesture is the kind of gesture that marked the discrepancy movements or face expressions when observed, pointing, and uncover/call the object being observed. Framework gesture can be shown as Figure 2 below.

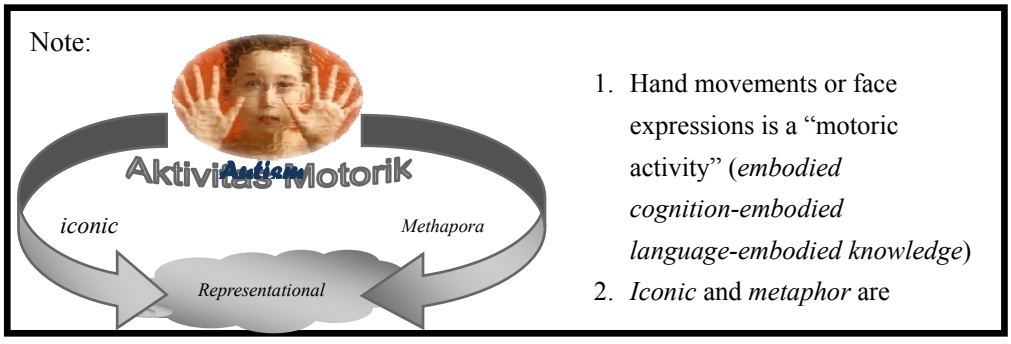

Figure 2. Framework of representational gesture (Mustafa, 2015)

In relation to the mathematical learning process Meadow et al. (2009) found "gesture teachers can assist students in learning activities". Gesture can lead students to take and understand the implied meaning of each movement of the hand or teacher facial expressions. Meadow et al. (2009) also added that "student gesture which imitated teacher during the learning process, are easier for them to understand the lessons than students who did not perform the gesture". Another theory supports the notion that the gesture helps students learn math once expressed by Meadow (1999), Alibali and Nathan (2007), Richldan (2007), Flevares (Alibali & Nathan, 2012) that "when teachers teach math, students routinely gesture gave rise along with their speech". The same statement also been disclosed Perry (1988) and reinforced by Bieda and Nathan (2009) that "when students talk about mathematical concepts, they also regularly raises gesture". Therefore, teachers' gesture when the gesture contributes to student learning. Students may mimic gesture of teacher, or spontaneously students can also bring

another gesture as accentuation/assert its ideas or ideas about mathematical concepts. Student's gesture in learning can also represent the attitudes, emotions, feelings and how to express it in certain situations. Gesture is nonverbal communication that can be delivered in the form of hand gestures, face expressions, eye gaze, touch, or artifacts (symbol/symbols used). With such a gesture can explain about the process that is going on in the minds of the students during the learning of mathematics.

This study focused on mathematical thinking process when identifying problems and described appropriate with the student's gesture performed at the time of doing the task. Form task is to identify problems of shape geometry by using concrete objects. For example; a teacher introduces geometric shapes "cube" with a picture showing the form of "cube", then shows images of concrete objects which is the same shape as a form of "cube".

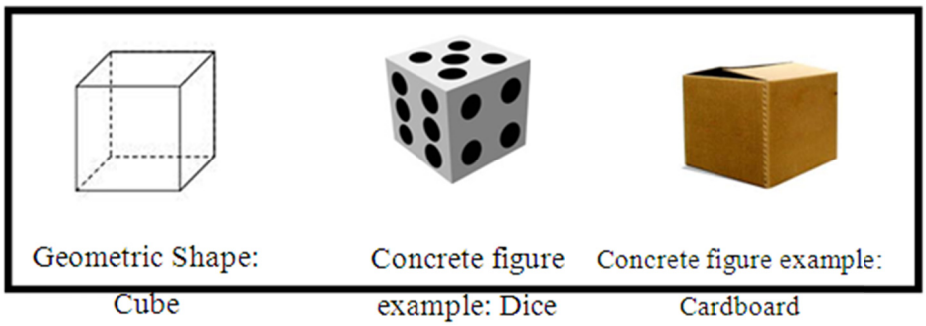

Figure 3. Example of shape geometry along concrete object

Figure 3 is the initial activity of the student before tackling the task to identify the appropriate geometry on concrete objects. In this activity the teacher introduces geometric shapes by using the drawing, further shown some examples of concrete objects shaped like the geometry. Student's activity are directed to listen, observe and recognize the image of teachers appointed, so that when the work task student can identify appropriate forms of concrete objects specified geometry.

Identify the problem (determine or establish the identity of geometric shapes in concrete objects), is the ability to find/search for, retrieve or get back information about the object being observed specifically. Identifying the problem is done through activities create the perception, analyze, and determine the identity. Perception is the act of composing, recognize, and interpret sensory information in order to provide an overview and understanding of the observed object. Empirically students with autism create the perception of how to interpret the real object is seen/ observed or holding. This is in line with the expression Solso (2008) that perception refers to the interpretation of the things seen, heard, felt, or experienced more than sensory stimulation. Further sensory events are processed/ analyzed according the knowledge of students about the observed object, then determine the identity of the object.

3. Methodology

3.1 Case Study and Data Sources

The strategy used is a qualitative case study. Subjects are autistic school students in the UM School of Autism Laboratory, Extraordinary School (SLB), and inclusions schools (autistic students in public schools). There are 13 Children with Special Needs (ABK) which "indicated" autistic by the school, so that the given task and do the recording. From the 13 crew members and associate with autistic characteristics, so it is classified, there are 9 (nine) autism, three (3) down syndrome, 1 (one) "mental retardation". In this review only describe two (2) subjects of 9 (nine) students with autism, as representative represents and already qualified enough to be explored in accordance gesture made so that it can be described the process of thinking.

Data source in this research are primary data and secondary data sources. The primary data sourced from teachers and students, while secondary data sourced from important documents related categories collected students' mathematical thinking processes, namely video footage of learning, coding of students' mathematical thinking processes, and chart/structure of students' mathematical thinking process.

3.2 Instrument

The main instrument in this study are the researchers themselves, because the researchers themselves who collect data through recording, or observation/observation (Creswell, 2012). To strengthen the research data required support, which is a tool used to collect data about the process of mathematical thinking, among others: (1) The audio-visual camera, is used as a tool to record a gesture that appeared during the learning process, and (2) are arranged Task Sheet more varied according to the materials that have been studied are familiar form concrete objects.

3.3 Data Collection and Analysis

Data collected in the form of recorded students' activity during the learning process, including when students are working on the task. Students' activity observed with its gesture, gesture explored further to describe the process of mathematical thinking. The data collected related category students' mathematical thinking processes, namely instructional video recording, coding students' mathematical thinking processes, and chart/structure of students' mathematical thinking process. To determine the accuracy of the data, using triangulation data by comparing data obtained from a video recording with a data sheet of learning task.

4. Result and Discussion

Explanation and data analysis include the description and the structure of thinking from each subject. Analysis description structured systematically as follows:

1) Choosing a collage of video footage representing alleged representative for analysis.
2) Develop a transcript of the interaction of the teacher and the subject is based on pieces of image points (1). Transcripts narrated into "Record Box" which contains conversations of teachers and the subjects in the form of speech or gesture (the expression or hand movement).
3) Analyzing "Recording Box", i.e. narrative thinking processes that appear based on points (1) and (2).
4) Make a diagram of the structure of mathematical thinking is based on points (3).

Each piece of the picture is given "squiggle line" with different colors, and each hinted meaning. A straight line with a red arrowhead indicates the subject is being observed, while yellow indicates the teacher is watching. Not straight red line shows the subject of sound whiles the yellow teacher sound/uncovering/instructed. Curved lines or a red circle indicates the student gesture (hand gestures or face expressions/view), while yellow indicates gesture teachers.

"Box Recording" is written in two different kinds of writing, the writing is printed using italic typeface (font italics) shows the interaction is done by issuing voice/speech both teachers and the subject, while writing printed with letters upright (not italic) shows interaction is done with motion compensation (hand or face expressions, no sound), if there are in the sign posts "(...)", then tells the movement cues that accompany the interaction.

At the beginning of the learning process, the teacher introduces geometric shapes such as cubes, blocks, balls, and tubes using concrete objects and sees the similarities in the pictures on sheets task that will be done. This process is the first step that teachers before students work on the task. If the student has understood the teacher's explanation, then the next step the teacher guiding students working on task.

Next is exposure data and mathematical thinking process analysis based on the results of exploration gesture learning through video recordings. Analysis was performed on two students with autism.

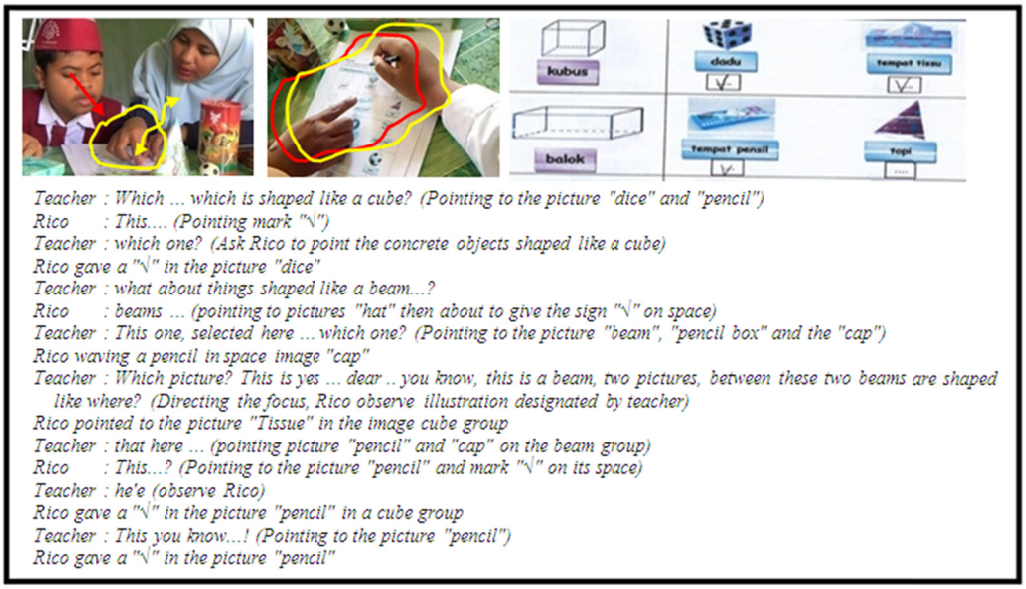

Figure 4. Interaction 1 in identifying geometric shape

Figure 4 is the interaction of teachers and Rico at the time of identifying the shape of “cube” and “beam”. Identification form “cube” made in the image concrete objects “dice” or “a tissue”, while identification form “blocks” made in the image concrete objects “pencil” or “cap”. The initial process begins with the teacher explains the task briefing. Rico asked to provide the identity of the one picture “dice” or “a tissue” that looks just like “cube”. Response from Rico listening to the explanation of teachers and observe the image on the sheet designated task. Master points to picture “dice” or “place of tissue” that looks just like a cube. Rico responds to hand gestures by pointing the symbol “√” in the task instructions, and without pointing to one picture instantly identity mark “√” in the image space “dice”. Gesture indicates Rico can perceive the form of “cube” correctly because doing matching gesture. Next comes a discrepancy gesture select images “pencil” or “cap” that looks like “beams”. Hand movements Rico was about to give the sign “√” in the picture “cap” but hesitated, so the teachers try pointing alternately directing the picture “beam”, drawing “a pencil”, and picture “cap” that Rico can easily see similarity shapes. Rico expression instead turned his attention to observe the image “Tissue” in the “cube” and direct his movements’ identity mark “√” on its space. Discrepancy gesture indicating Rico distraction on spatial relations (location/position) perceives forms “beams”. Hand movements to give the sign “√” in the picture “a tissue”, meaning that Rico can repeat ideas visually perceive “beam” as image “Tissue”, but not in accordance with the option specified image. Teacher finally asked to give personal mark “√” in the picture “pencil” as a sign that his idea was right but the wrong choice of picture.

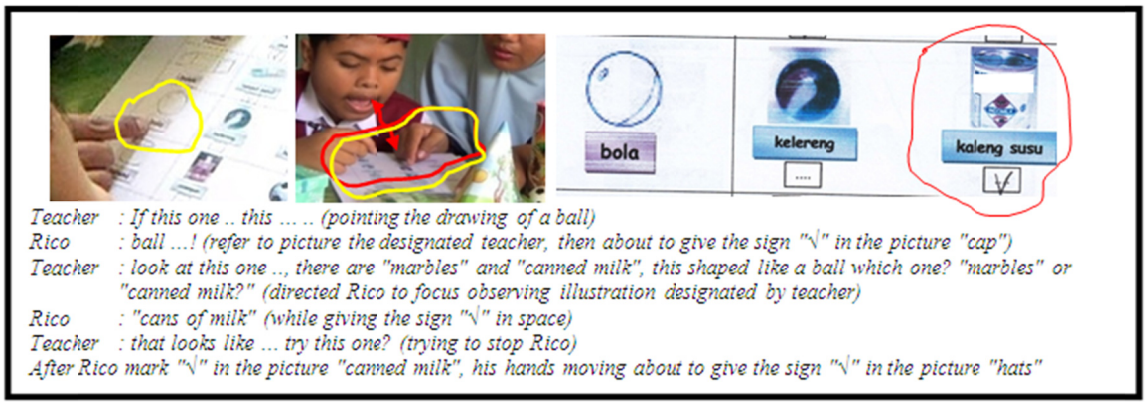

Figure 5. Interaction 2 identify shape geometry

Figure 5 is the interaction of teachers and Rico at the time of identifying the shape of the “ball” in the figure concrete objects “marbles” or “cans of milk”. Master points to pictures “ball” then Rico call picture “ball” designated teacher but accompanied by hand gestures toward an image “cap” on the “beam”. Discrepancy gesture indicating Rico still distracted on spatial relations, so the difficulty repeating ideas visually perceived forms “balls” on the choice of concrete objects specified image. A teacher distracts Rico in the picture “marbles” and “canned milk”, then asked him choose the same image with a “ball”. Discrepancies arise gesture, expression Rico responded by calling “canned milk”. At the time of his movement wanted to give a sign of identity “√” in the image space “canned milk”, the teacher tried to stop the movement of the hand and led him to back Rico observe the image. This condition indicates that the teacher's role is dominant directing Rico in order to identify the forms of concrete objects that resemble geometric shapes “ball”. Rico hand movements still give a “√” in the image space “milk cans”, and even tried to give the sign “√” in the picture “hat” again, but the teacher stops his act then giving explanation that not all the images are marked. Discrepancy gesture indicating Rico had distraction on observation to perceive the form of “canned milk”, so he ignored the image “marbles” that looks just like “ball”. Identification is then performed on geometry “tube”. Its activity is shown as Figure 6.

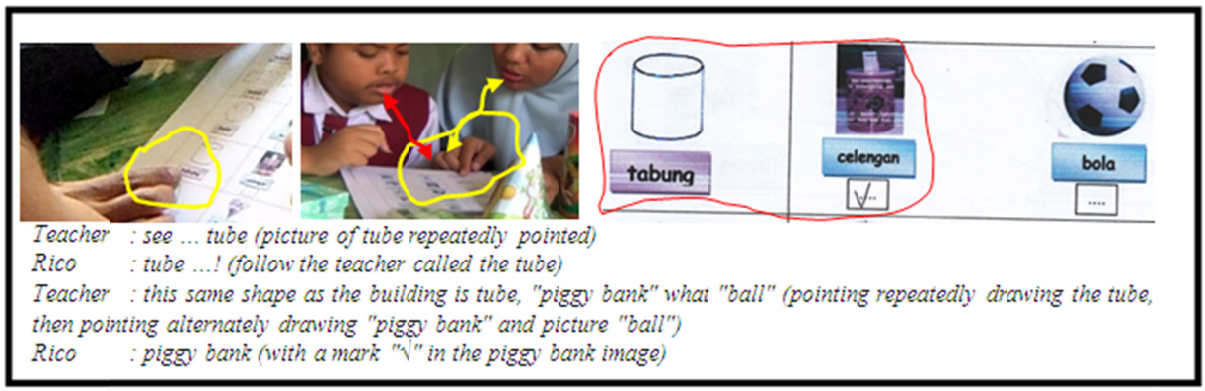

Figure 6. Interaction 3 in identifying shape geometry

Figure 6 is the interaction of teachers and Rico at the time of identifying the shape of the “tube” in the figure concrete objects “piggy bank” or “ball”. Teacher points to picture “tube”. Appears matching gesture, Rico responded by repeating the words of teachers call “tube” in the designated image repeatedly. Teachers pointed repeatedly while providing noise suppression, aims to focus Rico can observe the image. The teacher directs select images “piggy bank” or “ball” shaped like a “tube”, an expression Rico responded by calling “piggy bank” and then hand movements mark “√” in space.

The process to identify the geometric shapes by using concrete objects that done by Rico tend to experience a discrepancy gesture, meaning its happen a distraction on observation so that Rico difficult perceive, analyze and establish the identity of geometric shapes in the concrete objects image. Distraction triggered by imbalances of the motorist on observing and pointing, because the emotional (strong confidence) against his conviction can identify problems. Rico is very difficult to repeat the visual idea of the form of concrete objects. This process is termed partially processed. Partially processed empirically defined as a series of action to solve the problems those are processed with partially correct.

The structure of autistic individuals think that doing partially processed can be shown as Diagram 1 below.

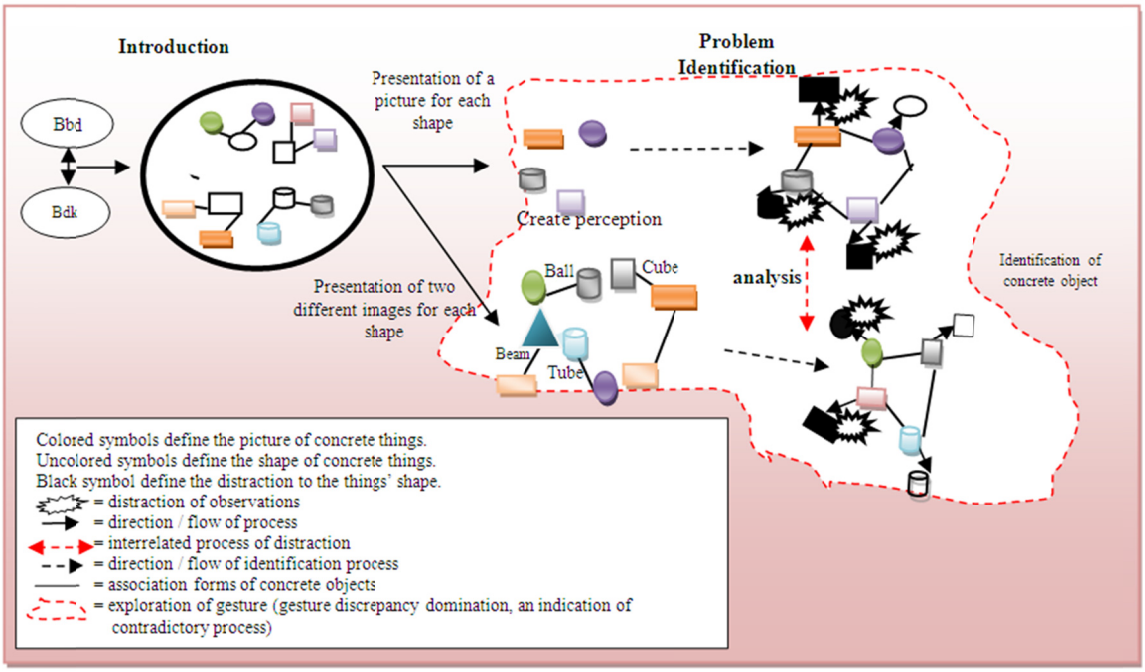

Diagram 1. Thinking structure of Rico identifying problems (Mustafa, 2015)

(There is a discrepancy gesture, an indication of the category of partially processed)

Contrary to Rico, other activities are shown Awal in identifying geometric shapes.

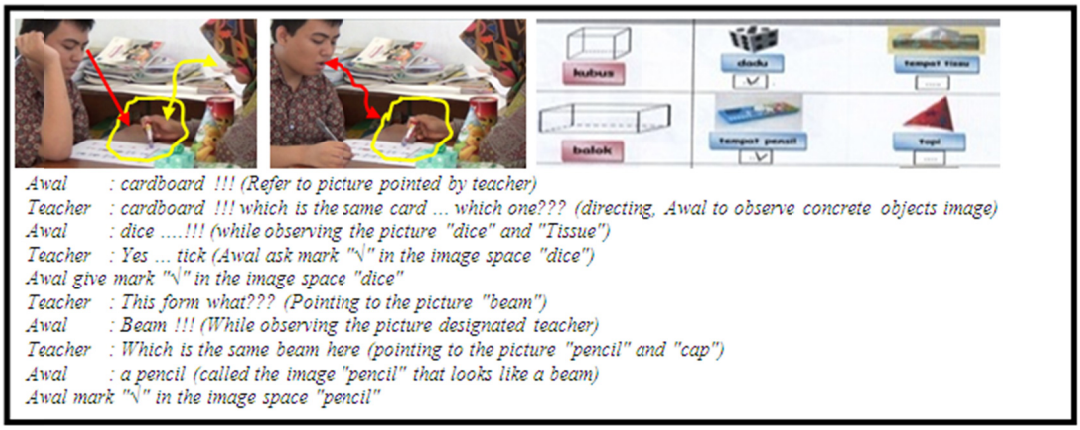

Figure 7. Interaction 1 in identifying shape geometry

Figure 7 is the interaction of teachers and Awal at the time of identifying the shape of "cube" and "beam". Identification form "cube" made in the image concrete objects "dice" or "tissue", while identification form "blocks" made in the image concrete objects "pencil "or" caps ". The teacher pointed to the first image, the image" cube ". Awal responds to call" cardboard "accompanied by hand movements pointed to" dice ". Gesture indicates, Awal can be visually perceived forms of" cardboard "together with form "dice" and both resemble the shape of "cube". Matching gesture Awal select picture "dice" which is the same shape as a form of "cube" is not an image "pencil", meaning that Awal can perception to differentiate and see the similarities with the form of "cube", i.e. picture "dice" have a common shape is a square box shape with a "cube", while images "pencil" is not the same shape with the "cube". Later in the picture "beam" appears matching gesture, expression observed Awal focus then calls the picture "beams" that appointed teachers. The teacher then asks drawing concrete objects "pencil" or "cap" that looks like "beam", Awal called the picture "a pencil". Matching gesture indicating

Awal can understand the similarity of shape image “pencil” with a picture of “a tissue” that looks like a rectangular box shape “beam”. Awal may repeat ideas visually distinguish the form of “pencil” with a “hat”. At the time of hand gestures Early select images “pencil” instead of “hat” indicates Awal understand the similarity of shape “pencil” with a “beam”. Identification is then performed on geometry “ball” and “tube”. Its activity is shown as Figure 8.

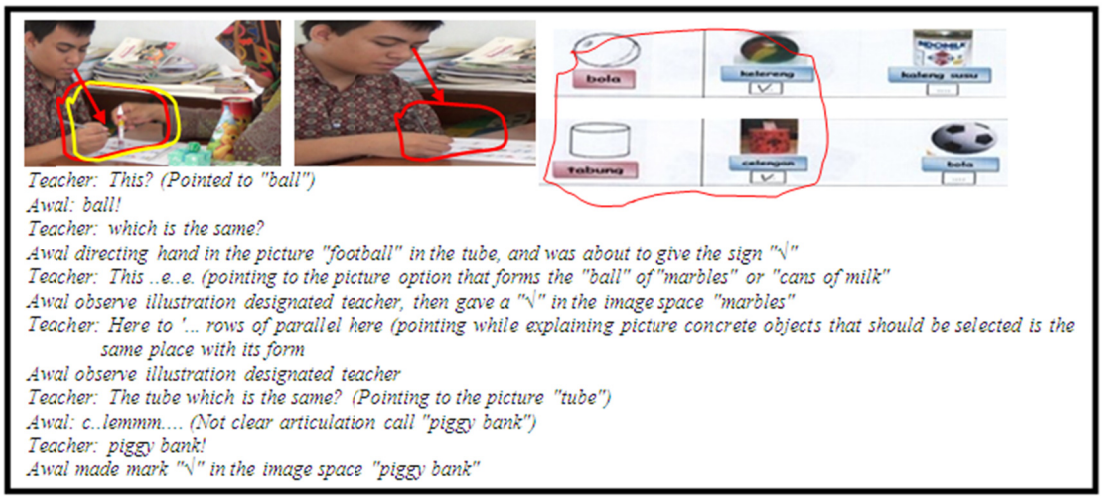

Figure 8. Interaction 2 identify shape geometry

Figure 7 is the interaction of teachers and Awal at the time of identifying the shape of the “ball” and “tube”. Identification form “balls” made in the image concrete objects “marbles” or “cans of milk”, while identification form “tube” made in the image concrete objects “piggy bank” or “football”. Awal teacher directs attention by pointing image should be chosen, namely “marbles” or “cans of milk”. Awal pointing hand gestures image “marbles” and mark “√” on its space. Matching this gesture indicates Earlier able to use his ideas visually see similarity circular shape on the “marbles” as a form of “ball”. Furthermore, in the form of “tubes” appear matching gesture, expression focus Awal observe and call the picture “tube” designated teacher, then move his hand selecting images “piggy bank” with a clear articulation while giving a “√” in the space. Matching gesture early select images “piggy bank” instead of “football” indicates Awal can understand shapes like the shape of the “tube”, because the image “football” has already revealed its shape “ball”

The process of identification of geometric shapes by using concrete objects that do tend to have matching gesture Awal, Awal means no trouble perceive, analyze and establish the identity of geometric shapes in the image concrete objects. This process is called correctly processed. Correctly processed empirically defined as a series of actions to resolve the problems properly processed.

The structure of autistic individuals think that doing correctly processed can be shown as Diagram 2 below.

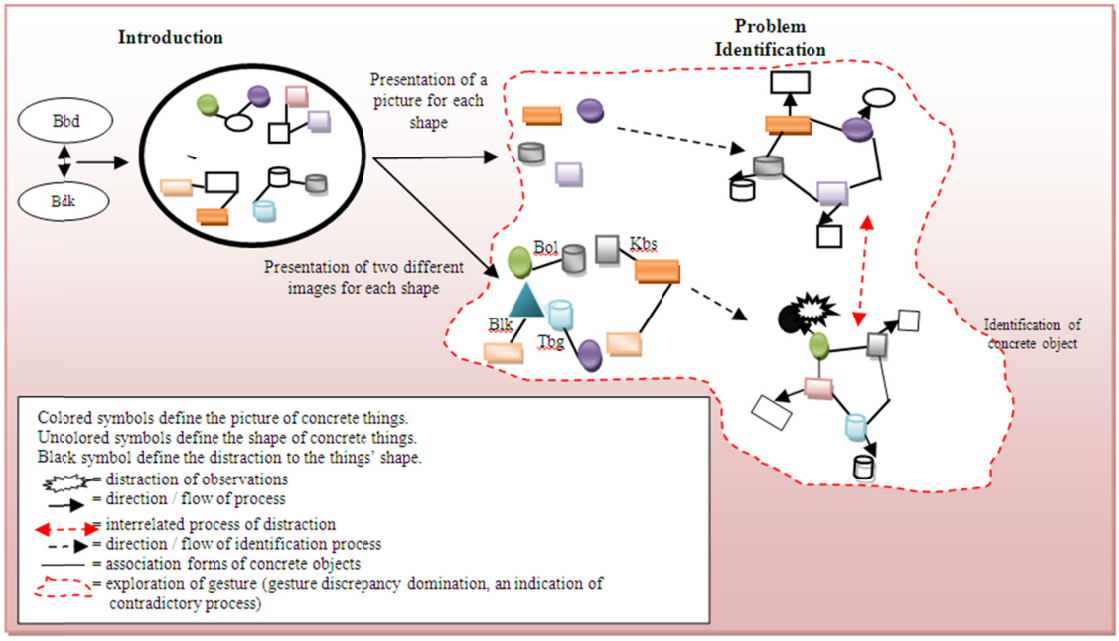

Diagram 2. Identify problems early thinking structure (Mustafa, 2015)

(Dominant matching gesture, an indication of the category correctly processed)

With the same pattern then for individuals with autism who do contradictory processed i.e. individuals with a series of measures in resolving the problem processed incorrectly characterized by the dominance of discrepancy gesture, mathematical thinking structure can described as Diagram 3 below.

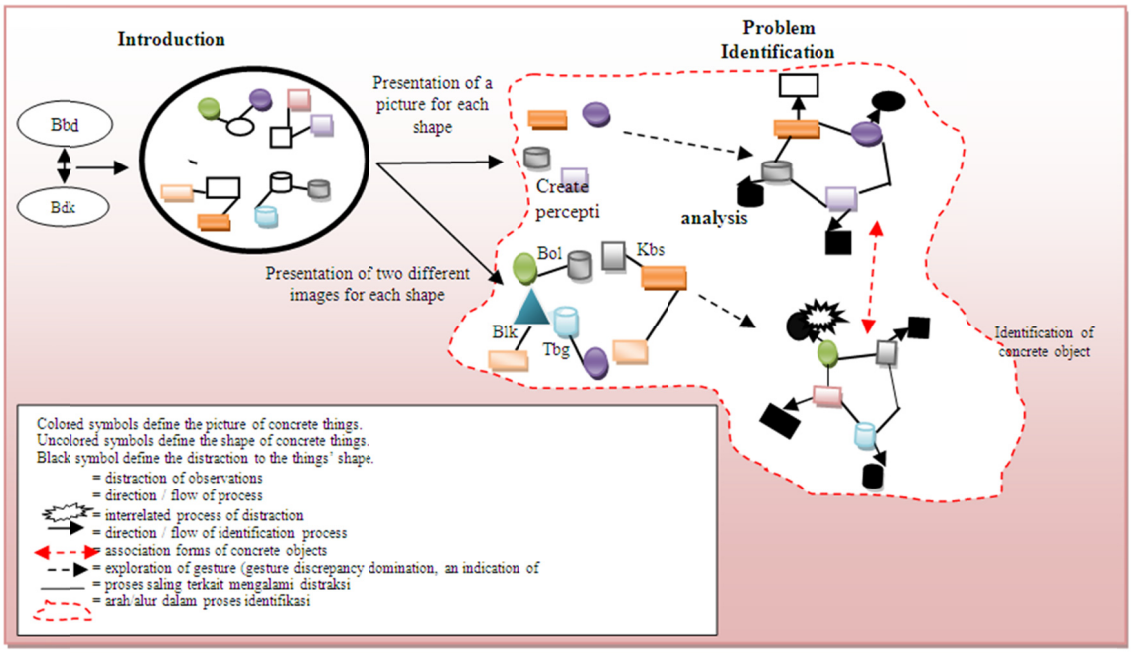

Diagram 3. Thinking structure identifying problems (Mustafa, 2015)

(Dominant discrepancy gesture, an indication of the category of contradictory processed)

Furthermore, it can be concluded that individuals perceive objects based on visual observations and tend to be

affected by the instability of mood and the circumstances surrounding it. This is in line with the statement Solso (2008) that perception refers to the interpretation of the things seen, heard, felt, or experienced more than sensory stimulation. Further sensory events are processed/analyzed according the knowledge of individuals about the object observed. Perception by individuals with autism is an interpretation of sensory information that allows people aware of the various objects and situations with meaning. Lerner (1981) reinforces this analysis by defining perception as the process of organizing raw data is achieved through a variety of senses and interpretations of meaning, while the perceptual information is improvement of sensory information.

In addition to creating the perception, individuals with autism also perform the association scheme by way of trying to repeat previous information by observing a variety of pictures or other objects that can represent the object being observed. In this way reinforced Powell (2011), which outlines that in mathematics, individual can use the scheme to organize the information by using a variety of images or diagrams that can represent the basic structure of the type of problems encountered. Association scheme by individuals simultaneously and sequentially, indicating the ability of individuals to make abstraction of the mathematical objects encountered, as Marshall (2005) reveals that the scheme contains an abstraction.

5. Findings

The findings in this study are described as follows:

1) The strength of autistic student is the focus on visual information and the real objects attractively, so that the learning process of mathematics can be meaningful using concrete objects around him.
2) Autistic students always doing repetition (repeating the idea/notion he has), but strongly influenced by mood instability. Repetition fluctuatively (not fixed/changeable though on the same topic).

Distraction occurs in the form of visual observation as follows:

1) Individuals experiencing perseveration, i.e. attention too long on one object. If the emerging interest in the object observed, then the individual will perceive visually the object is equal to another object. This condition is reinforced by Kurtz (2006) that individuals with impaired visual observation will ignore the information relative to the problems solved. Individuals experiencing difficulty recognizing, remembering, and organize visual images necessary to understand the objects used for learning. Visual perception can be considered as a cognitive component that interprets visual stimuli in a simple, because individuals with autism tend to understand the problem in accordance what he saw.
2) Individual's trouble of making abstraction, which connects knowledge based procedures, language, and mathematical symbols formal notation. "\Neurology Disability" owned by individuals with autism cause them highly susceptible to distraction on visual perception (interference when observing/see various objects/objects in relation to the set or group, resulting in discrimination of shapes and symbols).
3) Individuals difficulties to hold on a single event, if it can be controlled, the individual is still able to follow the routine, but if it cannot be controlled then it will trigger the emergence of incoherence, namely in the form of speech disorders.

6. Conclusion

6.1 Mathematical Thinking Process of Autistic Student Who Partially Processed When Identifying Problems with Representational Gesture

Facial expressions focus to hold objects observation with irregular hand movements move, taking out the words that elusive (appears echolalia), then the view slowly turns observing a variety of objects that are interrelated but difficult to maintain his observations. This gesture indicates individuals having difficulty selecting or process information so that individual processing of sensory information by partially corrects (no object designated but not in accordance with the object being observed). This gesture by the individual at the time of making the perception.

1) Furthermore, observed objects without face expressions that have been perceived, but his observations did not last long because of his active continuously. If suddenly the idea/notion of the object being observed, then the individual immediately respond very quickly move the hand pointing object, calling the identity associated with the observed object, but this movement is accompanied by accentuation echolalia. Echolalia break the concentration (being the trigger of distraction), so that the identity of the object partially done correctly. This gesture by the individual at the time to analyze and determine the identity. Individuals experiencing discrepancy gesture.

6.2 Mathematical Thinking Process of Autistic Students Who Correctly Processed When Identifying Problems with Representational Gesture

1) Facial expressions do not focus to hold objects observation regularly accompanied by hand gestures to move, and then slowly turns the view observed other objects that are interrelated. This gesture indicates the individual is selecting or process the information and then process the sensory information corresponding to the object pointed observed. This gesture by the individual at the time of making the perception.
2) Furthermore, students postponed to observe return objects that have been perceived, the hand movements are not actively moving/stationary in its position tends to be accompanied face expression focus on maintaining a view of the object being observed, and as if he did not want to be transferred to other objects in the vicinity. If people believe in the idea of the visual, then the individual immediately respond move hand, calling the identity associated with the observed object. Furthermore, the individual hand movements create identity by writing and give certain symbols on the object being observed, and these activities tend to be done right, for example, individuals can perceive the image dice cube shape with a focus at the picture, then analyzed by trying to call and appoint dice picture shape like a cube with hand movements create a symbol of identity at the dice image space. This gesture by the individual at the time to analyze and determine the identity.

6.3 Mathematical Thinking Process Autistic Students Who Contradictory Processed When Identify Problems Shown in Representational Gesture

1) Expression was not the focus of the object observed is reinforced with irregular hand movements to move. Individuals difficult to defend his views and do over movements to each object being observed. This gesture indicates the individual is very difficult to select or process information so that individuals tend to process sensory information incorrectly (does not fit with the observed object designated). This gesture by the individual at the time of making the perception.
2) Furthermore, many motor movements produced spontaneously and are not associated with the object being observed. If suddenly the idea/notion of the object observed, then the movement of the hand to respond very quickly to appoint or hold an object with an irregular utterance of the object. Dominant individuals experiencing discrepancies gesture at the time of analysis and establish identity.

References

Alibali, M., & Nathan, M. J. (2007). *Teachers' Gestures as a means of Scaffolding Students' Understanding Evidence from an Early Algebra Lesson*. Retrieved from http://www.psy.cmu.edu/edbag/alibali_nathan_vrls_inpress.pdf

Alibali, M., & Nathan, M. J. (2012). Embodiment in Mathematics Teaching and Learning: Evidence From Learners' and Teachers' Gestures. *The Journal of the Learning Sciences, 21*(1), 247-286. http://dx.doi.org/10.1080/10508406.2011.611446

American Psychological Association. (2015). *Autism*. Retrieved from http://www.apa.org/topics/autism/

Australian Advisory Board on Autism Spectrum Disorders. (2010). *Education and Autism Spectrum Disorders in Australia*. Australia.

Autism Society of America. (2014). *About Autism*. Retrieved from http://www.autism-society.org/

Barnett, V. H. (2010). *Autism*. New York: Chelsea House Publishers.

Becvar, A., Hollan, J., & Hutchins, E. (2008). *Representational Gestures as Cognitive Artifacts for Developing Theories in a Scientific Laboratory*. http://dx.doi.org/10.1007/978-1-84628-901-9_5

Bieda, K. N., & Nathan, M. J. (2009). Representational Disfluency in Algebra: Evidence from Student Gestures and Speech. *ZDM, The International Journal on Mathematics Education, 41*(5). http://dx.doi.org/10.17278/ijesim

Cermak, S. A., Coster, W., & Drake, C. (1980). Reprentational and Representational Gestures in Boys with Learning Disabilities. *The American Journal of Occupational Therapy January, 34*(1), 19-26. http://dx.doi.org/10.5014/ajot.34.1.19

Chaloux, S. (2015). *What Kind of Visual Aids Are Used to Teach Autistic Children to Count?* Retrieved from http://everydaylife.globalpost.com/kind-visual-aids-used-teach-autistic-children-count-16799.html

Creswell, J. W. (2012). *Research Desain Pendekatan Kualitatif, Kuantitatif, dan Mixed*. Yogyakarta: Pustaka Belajar.

Gallagher, S. (2005). *How the Body Shapes the Mind*. Oxford: Oxford University Press. http://dx.doi.org/10.1093/0199271941.001.0001

Gibbs, R. W., Jr. (2006). *Embodiment and Cognitive Science*. Cambridge: Cambridge University Press.

Haryanto. (2008). *Identification and Assessment Autistic*. Retrieved from http://staff.uny.ac.id/sites/default/files/Diktat_Identifikasi%20dan%20asasmen%20anak%20autis.pdf

Hostetter, A. B., & Alibali, M. W. (2004). *On the tip of the mind: Gesture as a key to conceptualization*. Retrieved from http://www.cogsci.northwestern.edu/cogsci2004/papers/paper360.pdf

Kita, Sotaro (Ed). (2000). *How Representational Gestures Help Speaking*. Language and Gesture (pp. 162-185). Chicago, IL: The University of Chicago Press.

Kumar, V. (2009). *A Little Book of Body Languange*. Tangerang: Karisma Publishing Group.

Kurtz, L. (2006). *Visual Perception Problems in Children with AD/HD, Autism and Other Learning Disabilities*. London: Jessica Kingsley Publishers.

Linden Bride School. (2014). *Autism*. Retrieved from http://www.linden-bridge.surrey.sch.uk/asdinfo_list.asp?Section=301

Lord, C. (2001). *Educating Children with Autism*. Washington, DC: National Academy PRESS.

Marshall, S. P. (2005). *Schemas in Problem Solving*. Australia: Cambridge University Press.

McNeill, D. (1985). So You Think Gestures Are Nonverbal? *Psychological (Review), 92*(3). http://dx.doi.org/10.1037/0033-295X.92.3.350

McNeill, D. (1992). *Hand and Mind: What Gestures Reveal about Thinking*. Chicago: University of Chicago Press.

McNeill, D. (2000). *Language and Gesture*. Chicago, IL: The University of Chicago Press. http://dx.doi.org/10.1017/CBO9780511620850

McNeill, D. (2005). *Gesture and Thinking*. London: Cambridge University Press.

Meadow, S. G. et al. (2009). Gesturing Gives Children New Ideas About Math. *Journal Psychological Science, 20*(3). http://dx.doi.org/10.12785/jeps

Mustafa, S. (2015). *Proses Berpikir Matematis dalam Representational Gesture Anak Berkebutuhan Khusus (Studi Kasus pada Siswa Autis)* (Unpublished doctoral dissertation). Universitas Negeri Malang (UM), Malang.

Nunez, R. (2005). *Do Real Numbers Really Move? Language, Thinking, and Gesture: The Embodied Cognitive Foundations of Mathematics*. Retrieved from http://www.cogsci.ucsd.edu/~nunez/COGS200/nunez%2Bpdf.pdf

Perry, M., Church. R. B., & Meadow, S. G. (1988). Transitional Knowledge in the Acquisition of Concepts. *Cognitive Development, 3*, 359-400. http://dx.doi.org/10.1016/0885-2014(88)90021-4

Powell, S. R. (2011). *Solving Word Problems using Schemas: A Review of the Literature*. *Learn Disabil Res Pract, 26*(2), 94-108. http://dx.doi.org/10.1111/j.1540-5826.2011.00329.x

Scusa, T. (2008). *Five Processes of Mathematical Thinking*. Retrieved from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1030&context=mathmidsummative

Shein, P. P. (2012). Seeing With Two Eyes: A Teacher's Use of Gestures in Questioning and Revoicing to Engage English Language Learners in the Repair of Mathematical Errors. *Journal for Research in Mathematics Education, 2*(43).

Solso, R. L. (2007). *Psikologi Kognitif*. Jakarta: Erlangga.

Stacey, K. (2009). *What is Mathematical Thinking and Why is It Important*? Retrieved from http://www.apecknowledgebank.org/resources/files/12_3-4_06_1_Stacey.pdf

Sumarna, S. H. (2013). *Jago Membaca Pikiran dan Perasaan Orang Lain Lewat Bahasa Tubuh*. Klaten: Galmas Publisher.

Sussman, F. (1999). *More Than Words*. Canada: A Hanen Centre Publication.

Tots, B. (2015). *Children Living with Autism are Visual Thinkers*. Retrieved from http://www.brighttots.com/Autism/Visual_thinkers_autism.html

Turafanany, L. (2012). *Trik Jitu Membaca Pikiran Orang Lain Lewat Bahasa Tubuh*. Yogyakarta: Pinang Merah Publisher.

Yoon, C. (2011). Gestures and Insight in Advanced Mathematical Thinking. *International Journal of Mathematical Education in Science and Technology, 42*(7), 891-901. http://dx.doi.org/10.1080/0020739X.2011.608861