The Van Hiele Geometry Thinking Level of Autism Students

Fadhilah Rahmawati[1], Megita Dwi Pamungkas[2], Rizki Sariningtias[3]

[1, 2, 3] Universitas Tidar

[1] fadhilahrahmawati@untidar.ac.id, [2] megitadwip@untidar.ac.id, [3] riskisariningtiias@gmail.com

Abstract: This research aims to investigate the geometry thinking level of autism students. This research focused on the thinking level based on Van Hiele theory. This research uses a qualitative method with a study case strategy. The data obtained from the test result and interview. The subjects in this research are 10 autism students. The results of this study show that the ability of autism students with another is different but have the same thinking level of geometry. The geometry thinking level of autism students identified in level 0, level 1 and level 2 based on Van Hiele theory. Based on the geometry thinking level of autism students, the teacher should modify the material with the ability of autism students, shadow teachers should communicate with mathematics teacher about how to explain the material to autism students.

Keywords: autism, geometry thinking level, Van Hiele

INTRODUCTION

Geometry is one of the most essential topics in mathematics, as important as fractions, decimals, percentages, functions, and calculus (Chew and Lim, 2013). Geometry learns about points, lines, the relation between line, area, volume and others (Bieber, Tuna, and Korkmaz, 2013) (Shomad, Kusmayadi, and Riyadi, 2017). Autism Spectrum disorder (ASD) is a behaviorally defined neurodevelopmental disorder associated with the presence of social-communication deficits and restricted and repetitive behaviors (Ousley & Cermak, 2014). Based on the Diagnostic and Statistical Manual of Mental Disorders, Six Edition (DSM-5; American Psychiatric Association, 2013), people with ASD have communication deficits, such as responding inappropriately in conversations, misreading non-verbal interactions, or having difficulty objects relation appropriate to their age. Besides, people with ASD may be overly dependent on routines, highly sensitive to changes in their environment, or intensely focused on inappropriate items. Again, the symptoms of people with ASD will fall on a continuum, with some individuals showing mild symptoms and others having much more severe symptoms. This Spectrum will allow clinicians to account for the variations in symptoms and behaviors from person to person.

Based on American Psychiatric Association (2013), three criteria of ASD are, (1) qualitative impairment in social interaction, (2) in Communication, and (3) restricted repetitive and stereotyped patterns of behaviors, interest, and activities have been reconstructed two domains; (1) Persistent deficits in social communication and social interaction, (2) restricted, repetitive patterns of behavior, interests, or activities. Students with ASD are increasingly held accountable to academic standards comparable to normally students (Schaefer-Whitby, 2013).

Based on the intelligence level, autistic students are divided into three levels, namely 1) low functioning (low IQ), 2) medium functioning (medium IQ), and 3) high functioning (high IQ) (Pusponegoro and Purboyo, 2007). Based on the Ministry of Education in British Columbia (2000), individuals with autism have a psycho-educational profile that is different from normally developing individuals.

One of the theories about the geometry thinking level is theory from Van Hiele. The theory of Geometry thinking levels from the Van Hiele advanced by mathematician Dina Van Hiele and his wife Marie Van Hiele Pierce in 1957. Based on the theory of Geometry thinking Van Hiele There are five levels, namely 1) Level 0 (visualization), 2) Level 1 (Analysis), 3) Level 2 (Informal deduction), 4) Level 3 (deduction), and 5) Level 4 (Rigor). Elementary school students are at level 1-2 (Sayin and Orbay. 2015), whereas average students with high scores are on level 2-3 (Yilmaz and Koparan, 2015). Geometry Thinking Level by Van Hiele is equally suitable for both genders (Haviger and Vojkuvkova, 2014).

METHOD

This method of study uses qualitative research methods with case study strategies. Qualitative research is a research procedure that generates descriptive data of written or spoken words from persons and observable behaviors (Moleong, 2013) (Creswell, 2012:15). The case study strategy is an empirical strategy aimed at studying in detail the present phenomenon in a real-life context (Zaidah, 2007) (Given, 2008).

The subject of this study was ten autistic students at the school of inclusion in Surakarta. The technique of taking a subject with purposive sampling is the choice of subjects aiming to obtain the description of geometric thought levels based on Van Hiele's theory. The number of research subjects in this study was ten students with four autistic students at low IQ levels, 4 autistic students at moderate IQ, and two autistic students with high IQ levels.

Data were analyzed by steps Miles and Huberman of analyzing involve data reduction, data display, and verification (Sugiyono, 2013). The Data obtained from the test result of the geometry thinking level is further analyzed to determine the level of geometry thinking students are autistic based on Van Hiele theory. The validity of the data in this study uses triangulation, triangulation, i.e. data validity inspection technique utilizing something else outside the data to check or as a comparison to the data (Moleong, 2013). This research discusses the level of the students ' geometry of autistic thinking with low, moderate, and high intelligence levels.

RESULTS AND DISCUSSION

The categorizing of autistic students based on IQ levels in this study can be seen in Table 1 below.

Table 1. The Categorizing of Autistic Students Based on IQ Levels

Subject	IQ Level
A.01	Low
A.02	Low
A.03	Low
A.04	Low
A.05	Medium
A.06	Medium
A.07	Medium
A.08	Medium
A.09	High
A.10	High

The categorizing is based on data obtained from the school researchers who perform the assessment periodically. These subjects were in the first Grade 7 junior high school and had

obtained previous quadrivalent materials. After categorizing the subject's autistic level, the test was conducted, i.e., the geometry-thinking test based on Van Hiele's theory.

Based on the results of the study, data obtained in the form of the subject geometry thought level can be seen in Table 2 as follows.

Table 2. The Van Hiele Geometry Thinking Level

Subject	IQ Level	Geometry Thinking Level
A.01	Low	0
A.02	Low	0
A.03	Low	1
A.04	Low	0
A.05	Medium	1
A.06	Medium	1
A.07	Medium	1
A.08	Medium	1
A.09	High	2
A.10	High	2

Based on the results of the above research, there is information that there are three subjects with a level of 0 geometry thought, five subjects with level 1 thinking, and two students with geometry level 2 thinking. There is no one subject to the level of thinking geometry 3 and 4, namely the deduction and rigor.

Autistic Students with Geometry Thinking Level 0

Subjects belonging to the categories of 0 geometry thought levels are subjects A. 01, A. 02, and A. 04. The subject is a subject with a low IQ category. The subject was entered into that level because the subject was unable to categorize the objects onto the rectangle. Subjects with category level think geometry 0 can only mention the name of a 2 dimension (2D) objects. Subjects have not been able to identify the attributes or properties of various geometry objects. At this level, the subject has been able to learn the vocabulary geometry objects, able to identify a particular object from its visual appearance, and show the shape of the object and redraw it (Usiskin, 1982).
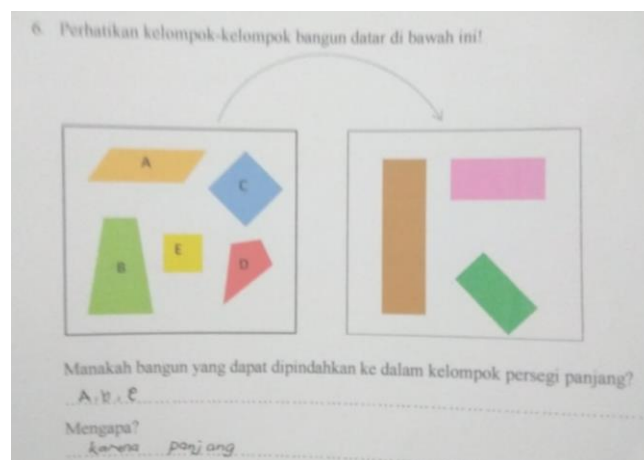

Figure 1. Autistic Students with Geometry Thinking Level 0

Based on Figure 1, it appears that a subject with a 0 geometry thought level cannot provide the correct answer in the existing object grouping in the column that one to fit into the rectangle group. Also, the subject at this level is not yet able to provide reasons for the answers they provide. According to research conducted by Estes et al. (2011) Explains that students ' mathematical skills with spectrum autism are the difference between mathematical performance and the general cognitive level of students.

Autistic Students with Geometry Thinking Level 1

Subjects belonging to the category of geometry thinking Level 1 are subject A.03, A.05, A.06, A.07, and A.08. Subject A.03 is a subject with a low IQ category, while subjects A.05, A.06, A.07, and A.08 are subjects with a medium IQ category. These subjects went into level 1 because they were able to mention the attributes of the geometry objects. In addition, subjects are already able to mention the properties of each geometry object. However, subjects have not been able to explain the relationships of the various objects of geometry they learned. It appears in Figure 2 as follows.
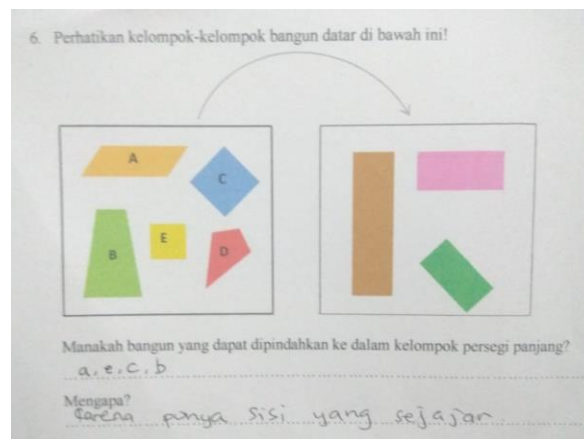

Figure 2. Autistic Students with Geometry Thinking Level 1

Based on Figure 2 above, it appears that the subject has not been able to correctly answer the object of which geometry can be categorized in a rectangular group. The subject is already able to identify the properties of the geometry objects in the left column, but can not explain the relationship of various geometrical objects. The subject has not been able to conclude that the square (object C and object E) is a part of the rectangle.

Autistic Students with Geometry Thinking Level 2

Subjects belonging to the Category 2 geometry thinking are subjects A. 09 and A. 10. Both subjects were subject to high IQ categories. The subjects went into Level 2 because the subject was aware of the classification and hierarchy of the various geometric objects he learned. Both subjects A.09 and A.10 have been able to identify traits in one object or between objects.
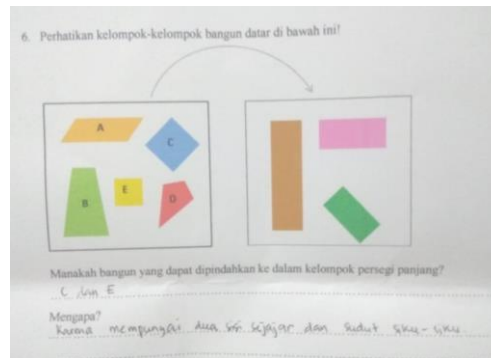
Figure 3. Autistic Students with Geometry Thinking Level 2

Based on Figure 3 above, it is apparent that the subject can correctly answer the object of which geometry is categorized in a rectangular group. Subjects can identify the properties of the shape of C and E so they can be classified in rectangular groups. The subject can conclude that the square is part of the rectangle. Subjects have been able to study geometry to achieve the goal of geometry learning at the middle school level. According to Dina Van Hiele (Usiskin, 1982), the purpose of geometry learning is at this level.

Based on the test results of the geometry thinking level, there is one subject in the low IQ category but the level of geometry thinking is at level 1. According to Wei et al (2014), mathematics skills likely vary with cognitive abilities, while IQ alone might out not fully predict mathematics achievement (Gevarter et al, 2016). The math skills of autistic students are unpredictable based on the IQ category. Several factors affect the space perception, visual perception, symbol recognition, linguistic competence, communication, and memory (Charitaki, Baralis, Polychronopoulou, Lappas, & Soulis, 2015). Thus, it can be concluded that the cognitive aspect affects the mathematical abilities of students autistic, but there are still other factors that can influence it. As described by Pooragha et al., (2013), not only are the cognitive aspects that can influence the mathematical skills of autistic students, as the cognitive phenotype exists regardless of the level of intelligence and the deficits in the executive functions do not always affect their general mental function.

CONCLUSIONS

Based on the results of the study obtained data that autistic students have a level of geometry thinking 0, 1, and 2. Autistic students with a low IQ category have 0 geometry thinking levels, autistic students with the IQ category are in geometry Level 1 thinking, and students with high IQ categories have a level of geometry thinking 2. However, the level of geometry thinking is not only influenced by its ability.

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