The Thinking Process Of Field Independent Cognitive Style Of Junior High School Student In Defining Quadrilateral Concept

E B Rahaju
Mathematics Department, Universitas Negeri Surabaya
Surabaya, Indonesia
endahrahaju@unesa.ac.id

Abstract: Defining a quadrilateral concept is one part of mathematics learning in junior high school. Defining a concept can be influenced by the concept's image. While the image of the concept is influenced by the experience associated with the concept, the characteristics of the concept, the mental picture of the concept, and the reconstruction of the definition made by the person against a concept. The thinking process of a person in defining a concept is influenced by cognitive style.

This study aimed to describe the thinking process of a student in defining the quadrilateral concept based on her cognitive style. The subject of this research was a student on grade VII with Field Independent cognitive style (FI).

This research concludes that the subject of FI in defining quadrilateral concepts, begins by forming a sense through listing the characteristics of quadrilateral. In determining the characteristics of a quadrilateral, subjects tend to organize all quadrilateral models that have been grouped. This suggests that the subject of FI is easier to capture the similarities found in the models that have been grouped. Based on the characteristics, the subject can conclude to make a simple definition of a quadrilateral by eliminating one by one characteristic are not essential. Subjects can make definitions that meet necessary and sufficient conditions on square, rectangular, parallelogram and trapezoid.

Keywords: thinking process, definition of concept, quadrilateral, field independent

1. INTRODUCTION

Concept is a mathematical object. A concept is a mentally possessed idea or notion that can be used to categorize information or objects (Goldstone, 2010). The concept can be obtained through three stages: (a) the categorization stage, (b) the stage of discarding the inappropriate categories and combining the appropriate categories to form a concept, and (c) concluding a concept by giving examples and non-examples of concepts with its categorization (Sjogren, 2011). Furthermore, Vinner and Hershkowitz (1983) say that there are three elements in identifying concept examples: (1) the concept image, (2) the concept definition, and (3) the rules that connect the properties of the object. While Rosken and Rolka (2007) stated that defining a concept is influenced by the concept image, experience related to the concept, the concept's characteristics, the mental image of the concept, and the reconstruction of the concept definition made by that person.

Based on these opinions, it is important for the student to be define able to a concept (especially the quadrilateral). But the reality of learning in junior high school still shows that the definition of
concepts is only memorized, because the teaching of mathematics in school is more oriented to the learning outcomes and give less attention to how the thinking process of students to get the learning outcomes and how the knowledge of mathematics is interpreted in their mind. Thinking processes are a set of tools and processes that allows an individual or group to solve a problem and/or develop an integrated strategy using the rigor and logic of cause-and-effect, beginning with the symptoms and ending with a detailed action plan that coordinates the activities of all those involved in implementing the solution (Avraham, 2009). While Suryabrata (2006) suggests that there are 3 steps of thinking process: formation of understanding, formation of opinion and drawing conclusions.

The process of thinking of a person to gain new knowledge be different from others. One of the differences is the cognitive style of the person (Tayler, 2003). A cognitive style is characteristic mode of functioning that (is revealed) throughout our perceptual and intelectual activities in highly consistent and prevasive way (Witkin in Nasution, 2006). Cognitive styles are the characteristic, self consistent modes of functioning which individuals show in their perceptual and intelectual activities. Cognitive style represent a person’s typical modes of perceiving, remembering, thinking and problem solving (Adelina, 2007). One of the dimensions of cognitive style is the Field Independent (FI) type. FI to have a tendency using their own perceptions to respond a stimulus, more critical, they are able to choose a stimulus based on the situation so that the perception is not easily influenced by the change of situation (Rahaju, 2016).

2. METHODOLOGY

This descriptive qualitative research aims to know the thinking process of students in defining the quadrilateral concepts based on the cognitive style they have. Classification of student's cognitive style, using GEFT (Group Embedded Figure Test) instrument. In that instruments, the subject thickens a simple image contained in complicated images. While the process of thinking students in defining the quadrilaterals traced through the assignment and interview. Interviews were conducted to explore depth information about how students think in defining the quadrilateral concepts. Subjects in this research was student with cognitive style Field Independent (FI) on grade VII SMPN 1 Surabaya.

3. RESULT AND DISCUSSION

3.1. Result

Defining a square begins by remembering a square characteristic, "a square has four sides equal in length". To determine another characteristics of square, the subject argues the need to look at square models that are already grouped and put them in free positions. Through observing the models, the subject writes the characteristics possessed by all of the square models. So the subject concludes that there are four characteristics of a square, which are "four sides equal in length", "four right angles", “two pairs of parallel sides" and "the sum of all angles is 360°".

To compose a square definition, the subject holds that the characteristic "the sum of all angles is 360°" is the same as the "four right angles" characteristic, so the subject concludes to eliminate such characteristic in defining of square. So the initial definition of square given by the subject contains only three characteristics that "has four sides of equal length, four right angles and two pairs of parallel sides". The subject argues that the characteristic "has 2 pairs of parallel sides", can be eliminate because the parallel in the square can be obtained using a parallel two-sided distance always the same. So the subject concludes to define a square more simply than the previous definition by eliminating one characteristic "having 2 pairs of parallel sides". Recalling the properties of parallel lines that have formed in her mind, the subject argues that the characteristic of "four right angles" can be simplified into "one right angle". The subject may give an explanation that the other right angles in the square can be found even if only one angle is known. The last definitions made by the subject are eligible enough and sufficient terms.

The square definition sequence can be presented in the following diagram.
Defining a rectangle begins by remembering the rectangular characteristic, which is "having four sides". To define another rectangular characteristic, the subject argues the need to see one sample of a grouped rectangle model. Based on a model that has a very striking characteristic on the side-length attribute, the subject can determine the other characteristic of "two pairs of sides equal in length", "two pairs of parallel sides" and "four right angles". The subject concludes that the definition of the beginning of the rectangle without involving the characteristic "has 4 sides", with the reason of that characteristic is excess because it is represented with the characteristic "quadrilateral".

Based on three characteristics (two pairs of sides are the same length, two pairs of parallel sides and four right angles) contained in the initial definition of the rectangle, the subject argues that there is a redundant characteristic, "each angle is right". To convince herself in eliminating the essential characteristic of the rectangle, the subject argues to adopt a model of rectangle (having a different length of side) as representative of group. So the subject concludes to simplify the definition by using the properties of the parallel lines it already has. The subject argues to simplify the characteristic of "four right angles" to characterize "a right angle". The simplification of these characteristics is obtained by using the correspondent angle and the sum of rectangular angles. Hence the subject can concludes that a simpler definition of rectangle can be obtained, which involves the characteristic of "two pairs of sides equal in length", "two pairs of parallel sides" and "one right angle".

To obtain a simpler rectangular definition of a predefined definition, the subject tries to draw a rectangle that has the characteristic "2 pairs of parallel sides and one angle of 90°". This is done by the subject by the reason, the image he gets will be a rectangle, though it does not pay attention to the characteristic "two pairs of sides of equal length". The subject argue to retain the characteristic of "two pairs of parallel sides", since they can be used to prove three right angles if they are known to be one right angle. To draw a rectangle that has characteristics "two pairs of parallel sides and one right angle", the subject takes advantage of the long ruler width and uses the right ruler tip to measure the right angle. Based on the drawings obtained, the subject draws the conclusion that a simpler rectangular definition can be obtained by involving the characteristic "2 pairs of parallel sides and one right angle". According to the subject that the final definition obtained can not be simplified.

Through the rectangular figure obtained, the subject concludes that if the two-sided distance is always the same then both sides are parallel. This suggests an extension of the concept of parallelism in
the mind of the subject. At first the concept of parallelism formed is that two parallel lines always have the same distance, then develop the opposite relationship. Finally the subject can concludes about the definition of rectangle that involves the characteristic "a pair of parallel and equal sides and one right angle". The definition is different from the previous definition.

The rectangle definition sequence can be presented in the following diagram.

![Diagram of rectangle definition sequence](image)

**Figure-2 The order of rectangle definition**

Information:

- Order
- activities
- result

The parallelogram definition given by the subject begins with mentioning of all the parallelogram characteristics. To determine these characteristics, the subject arranges all the parallelogram models he has chosen. The model is lined up to the right. Based on the parallelogram characteristics, the subject makes an initial definition containing the characteristics of "rectangular has 4 sides, the opposite sides has equal length, has equal opposite angles, having two pairs of acute angles and obtuse angle and having 2 pairs of parallel sides". Based on the characteristics contained in the initial definition of the parallelogram, the subject argues that the characteristic of "having four sides" is an exaggerated characteristic because it has been called a rectangular. In addition the subject also believes the characteristic of "having two pairs of acute angles and obtuse angle" is represented by the characteristic of "two pairs of opposite corners have the same size". The subject concludes to simplify the definition of a parallelogram by eliminating the characteristic of "having four sides" and "having two pairs of acute angles and obtuse angle". So the subject can simplify the definition of a parallelogram containing the characteristic "having 2 pairs of parallel and equal length sides and opposite angles is equal". According to the subject the long-sided attributes should not be omitted because those attributes distinguish between parallelogram and rhombus. This shows that in the mind of the subject, the concept of a parallelogram must have 2 pairs of sides of different lengths.
Based on the properties of parallel lines already understood, the subject argues that in order to determine the opposite angle equally, the characteristic "two pairs of parallel sides" should still be used in defining the parallelogram. Therefore, to obtain a simpler parallelogram definition, subject argues that it retains the characteristic of "two pairs of parallel and opposite sides is equal". To prove the correctness of the definition, the subject argues that it is necessary to draw a parallelogram with both characteristics. Subjects describe the parallel side pairs by using the long ruler width and measuring the opposing angle using the protractor. After the image is formed, the subject measures the length of both pairs of sides and is obtained equal length. So the subject concludes that the definition of a parallelogram containing the characteristic "two pairs of parallel and opposite sides is equal" is a simpler definition than the previous definition.

Through the properties of the parallel lines already understood, the subject can show that the opposite angle equally without measurement. Based on the proof, the subject concludes that in defining the parallelogram enough with one characteristic that "has two pairs of parallel sides". The definition is the simplest parallelogram definition.

The parallelogram definition sequence can be presented in the following diagram.

![Figure-3 The order of parallelogram definition](image)

The subject defines the kite through the characteristics of a kite that has a perpendicular diagonals and two pairs of sides of equal length. Based on the kite characteristics, the subject argues for giving an initial definition by mentioning all the characteristics of a kite and replacing the characteristic of "has two perpendicular diagonals". Because that characteristics is also shared by other shape, so the subject draws conclusions to simplify the definition of a kite. Subjects can give a simpler definition of kites taking into account the need to eliminate one characteristic of "has a perpendicular diagonal". Subjects can provide a reason for eliminating such characteristics. With two characteristics (pair of sides of equal length and a pair of opposite angles of equal size) are already representative of kite characteristics. The final definition of the kite given by the subject, has been attentive to the necessary and sufficient conditions.
The kite definition sequence can be presented in the following diagram:

![Figure-4 The order of kite definition](image)

The subject defines the rhombus through the characteristics of the rhombus. In determining the characteristics of the rhombus, the subject is of the opinion to set up the selected rhombus models already chosen. She was written characteristics apply to all models. Finally the subject draws conclusions to define rhombus containing all the characteristics that have been written. Taking into account the characteristic of "has a perpendicular diagonal" is also owned by a kite, the subject is of the opinion to eliminate that characteristic. So the subject can draw the conclusion that the definition without the character of "has a perpendicular diagonal" is a simpler rhombus definition than the previous definition. Since the characteristic "2 pairs of acute angles and obtuse angles" is also present in the parallelogram, the subject is of the opinion to remove the characteristic. By looking back at the characteristics that the written and the rhombus model he has chosen. Finally, the subject can draw the conclusion that the definition of rhombus without the characteristic "2 pairs of acute angles and obtuse angles" is a simpler definition of the previous definition. This latter definition by subject, is the simplest definition.

The order of defining the rhombus can be presented in the following diagram.

![Figure-5 The order of rhombus definition](image)
To determine trapezoid characteristics, the subject arranges all trapezoid models that have been selected. This is done because there are three types of trapezoidal, so it is necessary to see the three types. The written characteristics are appropriate to the three trapezoidal types. The subject writes four characteristics of "having 4 sides, two pairs of pointed angles and a dull angle and there are also brackets, a pair of sides parallel to different lengths". Finally the subject draws the conclusion by giving an initial definition of trapezium by eliminating the characteristic of "has 4 sides" by reason of this characteristic mentioned already that trapezium is a quadrilateral.

Taking into account all three types of trapezoid models, subjects contend to consider the similarities and differences of the three trapezoid types. Finally the subject argues to eliminate the characteristic "parallel sides of unequal length" on the trapezoid. So the subject can draw conclusions to define a simpler trapezoid than the previous definition with one characteristic "has a pair of parallel sides". Through The square and rectangular definition, the subject reinforces the trapezoid definition of a quadrilateral that has exactly a pair of parallel sides. The definition has taken into account the necessary and sufficient conditions.

The order of defining the trapezoid can be presented in the following diagram.

![Diagram of trapezoid definition](Figure-6)

**Figure-6 The order of trapezoid definition**

3.2. Discussion

Based on the way the subject defines quadrilaterals, it indicates that the definition begins with determining quadrilateral characteristics based on a quadrilateral model already grouped. Through these characteristics, the subject tries to define a quadrilateral. In determining the characteristic of a quadrilateral, the subject argues for organizing all previously grouped models. Based on the way the subject uses all the models in identifying characteristics, it appears that the subject of FI is easier to see the difference than the similarity of models that have been grouped. This is seen when determining the quadrilateral characteristics of the subject organizing all models. Specifically in determining the characteristics of the parallelogram and rhombus, the subject arranges all models in a sloping position.
to the right for parallelogram and arranges all models in an upright position for the rhombus. This is done by the subject to facilitate herself in identifying the characteristics of both quadrilateral.

To get a simpler quadrilateral definition, subjects feel the need to look back to the models that have been set. Essential characteristics that are retained are the characteristics that apply to all the models he has chosen in one shape group. Besides to get a simpler definition, the subject tries to draw a specific shape by reducing one characteristic contained in the preceding definition. So the subject of FI can draw the conclusion that the definition made is simpler than in predefined definition and finally gets the definition of eligible needs and sufficient terms. The success of the FI subject in simplifying the definition of quadrilateral, supported by the concept of alignment that has been mastered.

Subjects can make definitions that meet necessary and sufficient conditions on square, rectangular, parallelogram and trapezoid. While the definition of rhombus and kite, still not enough qualified, because the characteristic of the angle is still contained in the definition. With drawing a rectangle that satisfies its characteristics, the subject can create two different definitions for the rectangle, are "a quadrilateral that has two pairs of parallel sides and one right angle" and "a quadrilateral that has a pair of parallel and equal sides and one right-angle".

Based on the way the subject gets quadrilateral definition that meet necessary and sufficient conditions, indicating that the formal definition of a quadrilateral can be formed based on the conceptual image that is in the mind of the subject. The concept image of a quadrilateral is supported by the subject's recall of the shape, the shape characteristic, the shape image, the initial shape definition and the subject's experience of other shape in the quadrilateral. It means that the FI subject thinking process in defining quadrilateral in accordance with the opinion of Rosken and Rolka (2007) which states that the formal definition of a mathematical concept can be formed if the image of the concept has been formed. The formation of a concept image is influenced by the experience associated with the concept, the characteristics of the concept, the mental image of the concept, and the reconstruction of the definition of concept made by that person.

4. CONCLUSION

In defining the quadrilaterals, the subject begins by determining the characteristics based on quadrilateral models already grouped. To determine the characteristics of the quadrilaterals, subjects tend to organize all the models that have been grouped. This suggests that the subject of FI is easier to capture the similarities found in the models that have been grouped. By looking back at the quadrilaterals characteristics, the subject can concludes to defining quadrilaterals by observing essential characteristics and eliminating non-essential characteristics. Subject can provide a reason for the non-essential characteristics eliminated as they are supported by the concept of parallelism and the properties of parallel lines that have been mastered by the subject.

Subjects can draw conclusions to provide a simpler definition for quadrilaterals by eliminating one by one non-essential characteristic. To get a simpler definition, the subject draws quadrilaterals by reducing one of the characteristics contained in the previous definition. This is done to convince herself of the disappearance of the characteristics of the wake. Subjects can make definitions that meet necessary and sufficient conditions on square, rectangular, parallelogram and trapezoid.

5. REFERENCES

[1] Goldstone, L. Robert; et all. 2010. Corsini Encyclopedia of Psychology- Concept Formation. Florida: John Wiley & Sons Inc.

[2] Sjogren, Jorgen. 2011. Concept Formation in Mathematics. Sweden: Acta Universitatis Gothoburgensis

[3] Vinner, Shlomo. 1983. Concept definition, Concept Image, and Notion of Function. The International Journal of Mathematics Education in Science and Technology. Vol 14 (3). 259-391. (http://www.tandfonline.com/doi/abs/10.1080/0020739830140305)

[4] Rosken and Rolka. 2007. The Role of Concept Image and Concept Definition for Student’s Learning Integral Calculus”.TheMontana Mathematics Enthusiast 3

[5] Avraham Y, 2009, The Theory of Constraints and its Thinking Processes, Goldratt Institute, LP.
[6] Suryabrata, Sumadi. 2006. *Psikologi Pendidikan*. Jakarta: PT Raja Grafindo.

[7] Taylor, Lloyd J. Ortega, R David. 2003. *The Application Of Goldratt's Thinking Process To Problem Solving*, Las Vegas: Proceedings of the Academy of Strategic Management, Volume 2 (3). 89 – 104.

[8] Witkin, Herman A. Oltman, Philip K. Raskin, Evelyn. Karp, Stephen A. 1971. *A Manual For Embedded Figures Tests*. California: Consulting Psychologists Press, Inc

[9] Guisande, M. Adelina, et all. 2007. Field Dependence-Independence (FDI) Cognitive Style: an analysis of attentional functioning. *Psicothema* vol. 19(4). 78-109. (http://redalyc.uaemex.mx diakses pada tanggal 15 November 2014)

[10] Rahaju, Endah Budi. 2016. *Proses Berpikir Siswa SMP Ditinjau Berdasarkan Gaya Kognitif Dalam Pemahaman Konsep Segiempat*. Disertasi. Surabaya: Pascasarjana Unesa