Anxiety: how was the process of the undergraduate students who were in visualization level in constructing the definition?

R C Purnomo[1], Sunardi[1], N Yuliati[1], E Yudianto[1], M Mahfut[1] and C Sa'dijah[2]

[1] Mathematics Education Department, University of Jember, Kalimantan Road 37, Tegalboto Campus Jember, East Java, Indonesia 68121
[2] State University of Malang, Malang, East Java, Indonesia

Email: riskycahyop@gmail.com

Abstract. Definition is important mathematical construction which had been recorded as a challenging topic for teacher and students. This research showed the illustration of anxiety that happened to undergraduate students of Mathematics education who were in visualization level of thinking in constructing quadrilateral definition and definition form that had been successfully recorded. The analysis was done to determine the anxiety's indicator that appeared and indicators of quadrilateral's definition. Triangulation method was done to compare subjects' worksheet, observation, and interview. The results showed that anxiety appeared when subjects started to construct the definition of quadrilateral so that the definition that had been defined was not efficient.

1. Introduction

Anxiety is one factor that influences the success level of studying mathematics[1]. Mathematics anxiety is a psychological obstacle that undergraduate students face when they do mathematics assignment[2]. It had been found that mathematics anxiety would hamper someone's performance[3]. These cases about anxiety will influence teacher's psychological development in finding and developing his knowledge. Geometrics anxiety relates with the teacher's degradation in managing the class activity, such as in learning about constructing the definition of quadrilateral that is one of geometrics studies.

Research showed that mathematics anxiety and mathematics' performance present a challenge for teachers, especially elementary teachers whom usually have lower knowledge in content and their mathematics anxiety are higher than undergraduate students in average[3]. In other words, mathematics anxiety become one factor that makes someone avoid mathematics. It surely will influence mathematics teachers' service to students. At the end, it also influences students' understanding towards mathematics' concept.

Turkey's education system shows that Geometric is important topic in mathematics, even mathematics and geometrics are two separate subjects. Results of research showed that higher success level was achieved by mathematics than geometrics. Saglam said that anxiety was the variable that influences the success[1]. It showed that mathematics anxiety and geometrics anxiety could be observed separately. Someone's solicitude will be indicated by indications that appear. The indications are tense muscle, trembling, sweating, and fast-beating heart[2]. Other research also found that undergraduate students who faced anxiety gave indications such as fear when they didn't find a

solution, distracted in thinking when they saw their friends submitted the works, or feeling nervous when they didn't know what they should do[4]. These indications will be the indicators of anxiety. Stuart said that someone's anxiety can be expressed directly through physiological, cognitive, and affective response[5]. Indicators of geometrics anxiety in this research were some indications from each those responses because not all indicators could be observed by researcher. The used indicators are in Table 1.

Table 1. Indicators of geometrics anxiety

Responses	Indicators of Anxiety
Physiology	- Fast-beating heart
	- Tense face
	- Sweating (hand palm)
	- Odd movement
	- Itchy
	- Trembling
Cognitive	- Forgetful
	- Confused
Affective	- Shy
	- Nervous
	- Worry

Definition is essential for mathematics and mathematics education. Soedjadi said that definition is an expression that limits a concept[6]. Someone will be able in illustrating a concept that is defined by using definition. Definition give restrictions about a concept. As the result, the concept will be clear and easy to understand. Definition roles are; (1) introducing a theory and get an essence of concept by delivering the characteristics, (2) fundamental component to construct a concept, (3) constructing base for proof and solving problem, (4) creating uniformity in concept's meaning, which enable us to communicate easier mathematics' ideas[7]. In definition, we will see its elements, such as background, the genus, defined term, and the attribute[6]. Definition is important to explain and limits the concept. Definition must be efficient, explain the indication of a concept but it is available for the elements of that set so definition can explain and differentiate from other concept[8].

This research wanted to see type of quadrilateral's definition which could be constructed by undergraduate students of mathematics' education. Types of definition that were used in this research were analytic and genetic definition. The indicators of definition in this research were shown in Table 2 that was adapted from[6].

Table 2. Indicators in Constructing Geometrics' Definition

Type of Definition	Indicators
Analytic Definition	- stating proximum genus (closest genus), or
	- stating special differentiation, or
	- stating characteristics that were only owned by quadrilateral practically and efficiently.
Genetic Definition	- stating the process of quadrilateral efficiently, or
	- stating the way to construct quadrilateral efficiently

Van Hiele is one of people who has important role in geometrics. Van Hiele categorized someone's geometric ability into some level, such as visualization, analysis, informal deduction, deduction and rigor[9]. Level 1, visualization, is a place for students who can only recognize the shape. On level 2, analysis, individuals can analyze shape because they know the characteristics of shape in level 1. Level 3, informal deduction, is a level where students had learnt the characteristics of geometrics. On level 4, deduction, students can make proof of geometrics' characteristics. Finally, on level 5, rigor,

students can understand the implication of non-Euclidian geometrics[10]. Zalman Usiskin from University of Chicago developed test which will determine van Hiele's level where a student works[11].

There were many research about anxiety, mathematics' definition, or geometric thinking level. However, there were still a few research that discussed about anxiety in defining geometrics' elements based on van Hiele's theory, whereas anxiety influences in learning. It is in line with Roick's research[12] that relation between mathematics performance and the way teacher coordinated the activity in class. Saglam stated that there were some factors that caused anxiety on someone, such as geometrics anxiety about geometrics' perception and geometrics anxiety which was based on social environment[1]. Geometrics is one of the study in mathematics. Constructing definition is important in mathematics and it is within geometrics. Definition is essential in mathematics and mathematics education. Therefore, undergraduate students in mathematics are expectedly able in constructing a definition.

From the description above, this research would see the anxiety of undergraduate students in mathematics education who were in visualization level when constructing the definition about quadrilateral and types of definition that could be constructed by those students. The aim was to illustrate the anxiety of undergraduate students in mathematics education who were in visualization level in constructing quadrilateral's definition and types of definition that were constructed by them.

2. Research Method

This research used qualitative approach. Data that had been collected was explained in the form of sentences, so it was not only in the form of number and score. The used analysis was analytical descriptive which means interpretation towards the content was made and compiled thoroughly and systematically. This research described the anxiety of undergraduate students in mathematics education who were in visualization level in constructing the definition of quadrilateral. The describing process was based on stage of thinking of Van Hiele's theory.

Methods that were used in this research were observation, test, and interview. This research used two types of test. The first test was Van Hiele Geometry Test (VHGT) which was for categorizing undergraduate students based on their thought and the result was used as basic reason in choosing the research subject. The second test was constructing quadrilateral's definition and contained questions which asked subjects to construct definition of various quadrilateral and also making mind mapping of those rectangles' concept. Observation was done by observer to observe the indicators of anxiety that appeared on the subjects when doing the second test. Meanwhile, interview was done to browse the unrevealed anxiety's indicators and indicators of definition so that the types of definition that had been constructed by the subject could be found.

2.1 Subject

In achieving the goal of this research, the chosen subjects were undergraduate students of mathematics education of Faculty of Teacher's Learning and Education of Jember University who had visualization level. Subjects' determining was started by giving Van Hiele Geometry Test on 128 undergraduate students. From that test, it showed that 21 students were in visualization level, 42 students in analysis level, 61 students in informal deduction level, 4 students in deduction level, and none students in rigor level. Next, 2 students from visualization level were chosen as research subjects. The choosing was based on the students' willingness to be the research subjects, fluent in communication, and flexibility in time.
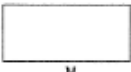
2.2 Data Analysis

Collected data were quadrilateral's definition that had been constructed by the subjects, interview's transcription between researcher and subjects, and observation result from observer. Those three data were combined so that the position of anxiety on the subjects was determined by observing appearing indicators and types of definition that were used by using definition's constructing indicators. Then,

the data were compared with the data from second subject. If the data had similarity, then the result could be said as saturated. However, if the data were different, then the third subject would be chosen to the same process as what had been done to the first and second subject.

2.3 Question

There are two questions that had been given to the research subjects. The first was Van Hiele Geometry Test which contained 25 question that was adapted from Watson[13] to categorize the subjects based on their geometrics' thinking level. Then, subjects were given second test where they should construct the definition of quadrilateral to see their anxiety and types of definition that constructed. Question that had been given can be seen in Table 3.

Table 3. Questions

3. Results of Research

Results of VHGT showes that there were 21 students who were in visualization level. From those 21 students, 2 of them were selected as research subjects since they agreed to be subjects, communicated fluently, and they had flexible time. After having constructing definition test, observation, and interview, it showed that the result from two subjects had similarity in anxiety or definition. Therefore, it could be said that the data is saturated and subjects' further selection was not needed.

3.1 The Anxiety of Undergraduate Students in Visualization Level

S1 Subject was a subject in visualization level. The result of VHGT showed that S1 answered the questions rightly all first five questions, 1 question on the second five questions, 2 questions on the third five question, 1 question on the fourth five questions, and 2 questions on the fifth five questions.

Physiological response that appeared on S1 was odd movement. It was showed on the first five minutes by fixing her hijab. Then, on the second five minutes, S1 fixed her hijab three times and looked around. On the third five minutes, S1 fixed her hijab again three times while tapped on the table. Physiological responses on the S2 were tense face, itchy in head, and did odd movement. When

the researcher distributed the test sheet, S2 was nervous and her hands were trembling. On the first five minutes, S2 was calm in doing the test. However, she was scratching her head and her foot while doing some movement sometimes.

Cognitive response was showed by S1 and S2 was confused. Subjects were confused in constructing definition about trapezoid because they forgot its characteristics and trapezoid is varies in type, so that they were confused to define which trapezoid. The excerption of the interview between researcher and S1 about cognitive condition is below.

> R : ..., why were you confused in defining trapezoid?
>
> S1 : I forgot its characteristics and since there are kinds of trapezoid so that I didn't know which one I should define.

And here is the excerption between researcher and S2 about cognitive condition above.

> R : I saw you flipped over your answer sheet. Why?
>
> S2 : I was confused in defining the trapezoid.
>
> R : Why were you confused?
>
> S2 : I didn't know which trapezoid I should define and also I forgot its characteristics.

Affective response on S1 was nervous when she mind mapped the concept of quadrilateral. S1 was nervous because she was not sure in placing the order of quadrilateral in mind map she made. Here is the excerption between researcher and S1 about the affective condition.

> R : Why were you nervous when you were mind mapping the concept?
>
> S1 : I was not sure with my concept map.
>
> R : Did that thing make you nervous?
>
> S1 : Yes, I was not sure about the order of quadrilateral in my concept map whether it was right or wrong.

Meanwhile, S2 was worried if she made wrong concept map about quadrilateral since S2 was not sure when she categorized the rectangle. Here is the excerption between researcher and S2 about her affective condition.

> R : why did you made two concept maps?
>
> S2 : I made them because I was afraid the first one was wrong, so I remade the second one
>
> R : why were you afraid?
>
> S2 : Because I was not sure in categorizing the rectangles rightly.
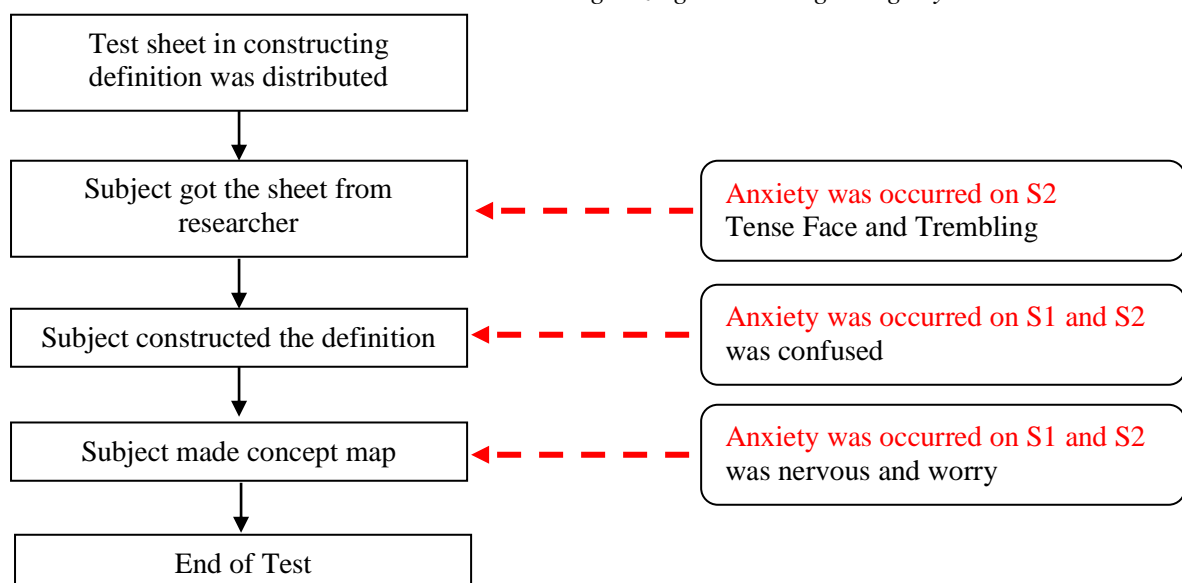

Figure 1. Anxiety of Undergraduate Students in Visualization Level in Constructing Definition

3.2 Type of Quadrilateral's Definition from Undergraduate Students in Visualization Level

S1 and S2 had constructed quadrilateral's definition such as rectangle, square, rhombus, parallelogram, trapezoid, and kite. Each subject gave one definition on that plane. Here are the definitions from S1.

Rectangle definition*:*
A plane that has four sides, two face to face sides are same in length, each angle is perpendicular and its two diagonals have same length.

Square definition*:*
Plane that has 4 sides that same in length and 4 angles are right angle.

Rhombus definition*:*
- Plane that has 4 same length sides
- Plane that has 2 same diagonals
- Plane that has 2 same angles

Parallelogram definition*:*
- Plane that has 4sides, face to face sides are parallel
- Plane that has same length face to face side
- Plane that has same angle face to face angle

Trapezoid definition*:*
Plane that has 4 sides two parallel sides and other sides have same length

Kite definition*:*
Plane that has 4 sides that close each other is same in length
Plane that has 1 symmetrical axis and couple of angles that face to face is same

Figure 2. Definitions of quadrilateral from S1

S1 constructed quadrilateral's definition using plane as a basic and S1 constructed definition of quadrilateral by mentioning all its characteristics. However, S1 was wrong in stating the trapezoid's and parallelogram's characteristics. S1 stated that trapezoid's sides which were face to face and had same length, whereas face to face side in trapezoid is not always in the same length. S1 stated that rhombus' diagonal had same length and each its angle had same degree, whereas rhombus' diagonal is not always in the same length and its angles are not always the same. Meanwhile, the concept map about quadrilateral that constructed by S1 is on Picture 3.
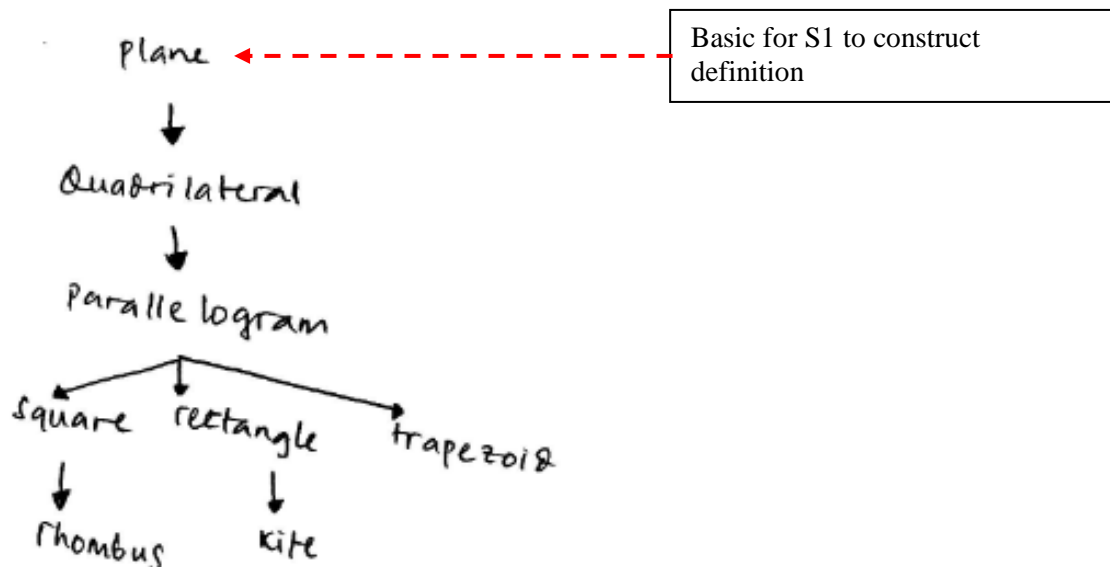

Figure 3. Concept Map from S1

Result of quadrilateral's definition from S2 is on Picture 4 below.

Rectangle definition:
A quadrilateral which has face to face side that is same in length

Square definition:
A quadrilateral which has two side in the same length and has 4 symmetrical axis

C. Belah Ketupat

Rhombus definition:
- *A quadrilateral which its two sides made 45º and other two sides made angle >90º which is rotated as much as 90º*
- *A quadrilateral which has shape kite like with same length side and same two symmetrical axis*

D. Jajar Genjang

Parallelogram definition:
A quadrilateral which its four sides are same in length but two face to face side are not in line but it tilted bit.

E. Trapesium

Trapezoid definition:
A quadrilateral which has two tilted side that same in length and other sides are half of its front side

F. Layang-layang

Kite definition:
A quadrilateral that is rotated 90º and had symmetrical axis which its two face to face sides are longer

Figure 4. Quadrilateral's definition from S2

S2 constructed quadrilateral's definition using quadrilateral as basic and constructed quadrilateral's definition by stating its characteristics. However, S2 was wrong in stating rhombus', parallelogram's, and trapezoid's characteristics. S2 stated that rhombus' angle were 45º and more than 90º, whereas the angle is not always 45º and more than 90º. S2 also stated that four sides of parallelogram had the same length, whereas it is possible for only face to face side in parallelogram which is same in length. S2 also stated that trapezoid's side, exclude its long-titled side, was half of its front-side. Trapezoid's characteristic that was stated by S2 was hardly understood and its characteristic was not owned by trapezoid. S2 also made concept map about quadrilateral that is showed in Picture 5.
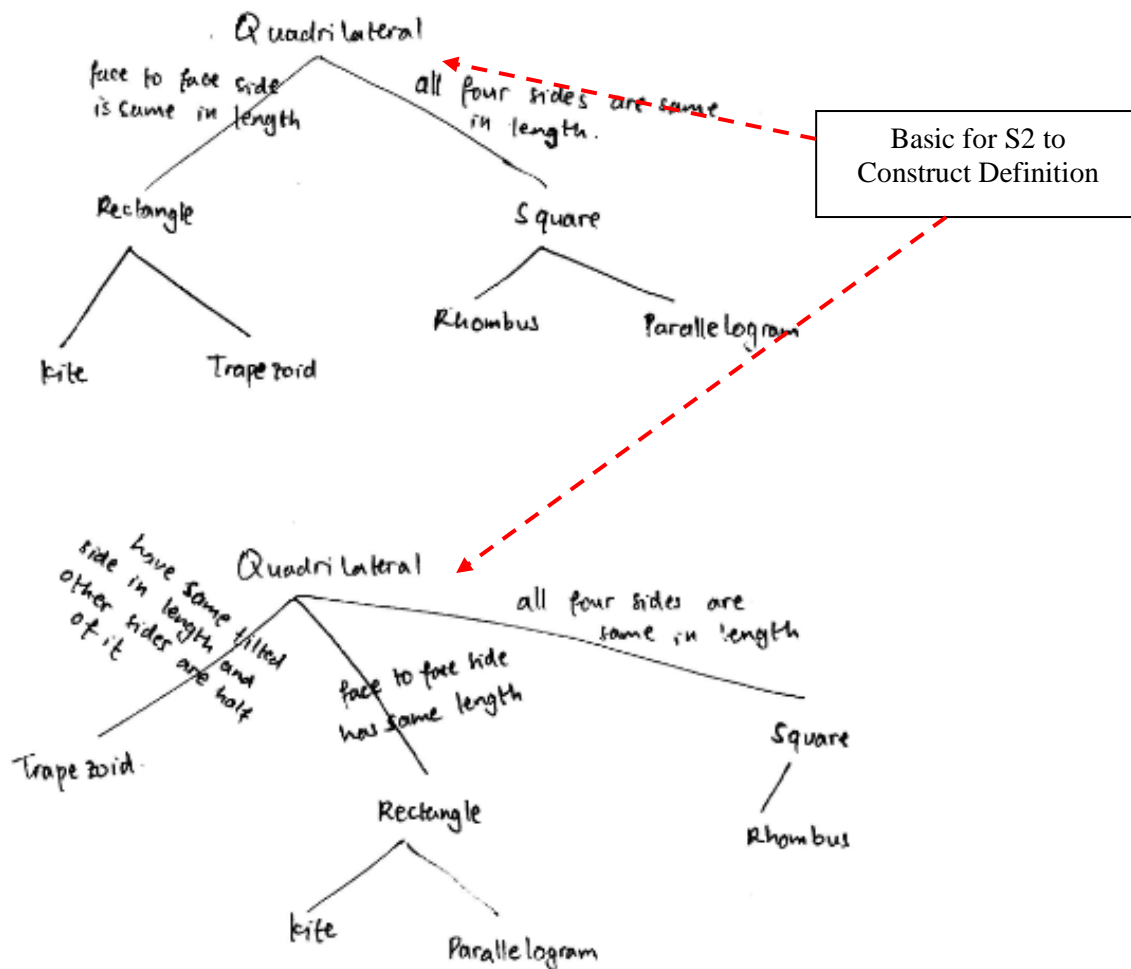
Figure 5. Concept Map from S2

4. Discussion

Subjects were undergraduate students who had visualization level based on van Hiele's theory. Based on van Hiele's thinking level descriptor, undergraduate students in visualization level can only know shape[10]. In visualization level, someone can recognize shape and characteristics of it but he didn't realize yet that it was its characteristics[14]. However, research subject could state the characteristics of quadrilateral to construct definition. The problem was subjects stated the characteristics not accurately and not efficiently so that subjects could be categorized in visualization level but not in analysis level, yet. In other word, subjects were on between analysis and visualization level.

From the observation and interview, it could be seen that subjects faced anxiety indicated by physiological, cognitive, and affective responses. Subjects tended to have confusion when construction definition because they forgot its characteristics so that they nervous and worried about the definition they constructed. Therefore, subjects did odd movements such as fixing their hijab, tapping table, and looking around.

Subjects constructed definition of quadrilateral using analytical definition which is by stating characteristics that are had by quadrilateral. However, the definition was not effective and not accurate since the anxiety that faced by the subjects so that it was hard to be understood and also it was hard to be used to illustrate quadrilateral had defined. It showed that anxiety will disturb someone's performance[15]. Anxiety that causes concern on undergraduate students will make them not sure with their work[16]. At the end, it will influence the successful of their learning[1].

5. Conclusion

From the data above and the discussion, it can be known that undergraduate students in visualization level faced anxiety when they started to construct definition about quadrilateral by showing physiological, cognitive, and affective responses. The responses that being showed were increasing in line with more quadrilateral should be defined. It happened because they forgot the characteristics so that they had difficulty in in categorizing and ordering the quadrilateral. Therefore, undergraduate students in visualization level tended to use analytical definition but the definition was not accurate and was not effective. From these conclusions, we recommend the importance of learning strategies to construct accurate and effective definitions of geometric shapes given the importance of definitions in mathematics to constrain concepts.

Acknowledgments

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