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An analysis of the students' anxiety in solving creative thinking problem on geometry according to van hiele's theory

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Abstract. This research aimed at describing the students' anxiety in solving the creative thinking problem in geometry according to Van Hiele's theory. This is a descriptive research with qualitative approach. The data were collected by using test, observation, and interview methods. The subjects of the research were 249 VIIIth grade students of SMP Negeri 1 Cluring. The subjects were selected by using classification test of Van Hiele's level. The results of this research showed that the students of visualization level were at the level of creative thinking (TKBK) 3 or creative level and showed the anxiety symptoms in the components of psychological and physiological. The students of analysis level were at the level of creative thinking (TKBK) 3 or creative level and showed the anxiety symptoms in the components of psychological and physiological. The students of informal deduction level were at the level of creative thinking (TKBK) 4 or very creative level and showed the anxiety symptoms in the components of psychological.

1. Introduction

Mathematics is a compulsory subject in all levels of education. One branch of mathematics sciences is geometry. The figures who are directly related with geometry learning are Pierre Marie Van Hiele and Dina Van Hiele-Geldof. According to Van Hiele's theory, someone will go through five hierarchical levels of understanding in learning geometry [1]. Those five levels are level 0 (visualization), level 1 (analysis), level 2 (informal deduction), level 3 (deduction), level 4 (rigor). Many students get difficulties in understanding geometry. This can be seen from the results of TIMSS 2011 review which assessed their mathematical skills and science class 8 showed that the achievement score of geometry was still low that was 39% compared to other mathematical content in various countries including Indonesia. The mean score of mathematics in class 8 of the Indonesian students is only 386 of international scale which is 500. Several factors that influence the low achievement of geometry are the less understanding of learning geometry that many students fail to develop adequate understanding of geometry concept, geometry reasoning and problem solving skills of geometry [2].

In the current era of globalization, creative thinking skills in solving mathematical problems are required in the education world. Creative thinking is a mental activity related to the sensitivity of a problem, consideration of new information and unusual ideas with an open-minded thinking as well as



being able to create connections in solving a problem [3]. Creativity is a habit [4]. While, creativity in mathematics and science is the ability to solve problems given with a new way by implementing fact, concept, principle and thinking strategy own by the students [5]. The importance of mathematics does not only produce a correct answer but creative thinking [6].

Three key components of creativity assessed by Torrance Test of Creative Thinking (TTCT) are fluency, flexibility, and novelty [7]. Whereas, three key components of creativity in solving a problem [8] are as follows:

- 1) Fluency in solving a problem refers to the students' ability in giving diverse and correct answers of the problem.
- 2) Flexibility in solving a problem refers to the students' ability to solve a problem in various different ways.
- 3) Novelty in solving a problem refers to the students' ability to answer a problem with several different answers but true or one answer which is "unusual" done by the individual (student) at the level of their knowledge.

There are five levels of creative thinking skills [9]. Every level of creative thinking skills has several characteristics. The characteristics can be seen from the Table 1.

Table 1. Criteria of Creative Thinking Skills Level (*TKBK*)

TKBK	Criteria
TKBK 4 (Very Creative)	The students are able to show fluency, flexibility and novelty. Or novelty and flexibility only in solving a problem.
TKBK 3 (Creative)	The students are able to show fluency and novelty. Or fluency and flexibility only in solving a problem.
TKBK 2 (Fairly Creative)	The students are able to show novelty and flexibility in solving a problem.
TKBK 1 (Less Creative)	The students are able to show fluency only in solving a problem.
TKBK 0 (Not Creative)	The students are not able to show three aspects of creative thinking indicators.

Based on the characteristics of creative thinking explained [7] above, then indicators were made for each component of creative thinking for this research as listed in the Table 2.

Table 2. Indicators of Creative Thinking in Solving a Problem

Components of Creative Thinking	Indicators
Fluency	<ul style="list-style-type: none"> • The students are able to solve a problem fluently. • The students are able to produce correct and relevant ideas/answers.
Flexibility	<ul style="list-style-type: none"> • The students are able to give more than one answers to a problem.
Novelty	<ul style="list-style-type: none"> • The students are able to provide correct answers. • The students are able to give different and unique solutions, which are not usually done by other students. • The students are able to provide correct answers.

Learning geometry can improve the students' thinking skills by using visual pictures [10]. Moreover, the students' creative thinking can be developed through mathematics problem solving [11,12].

Anxiety is found as one of common emotional problems related to mathematics [13]. The feelings of anxious and frustrated are still the obstacles in learning mathematics [14]. Anxiety is a tense, unsafe feeling, insecurity that appear because of such feeling that something inconvenient happens [15].

Mathematics anxiety is the feeling of anxious, insecure, or afraid which disrupts mathematics performance [16]. The students who experience mathematics anxiety tend to avoid the situation where they should learn and do mathematics questions. The students who are low achievers would face more anxiety compared to other students in common [17]. The symptoms of anxiety can be viewed from three components [18]. The three components can be seen in Table 3.

Table 3. The Indicator of Anxiety Components

Anxiety Component	Indicator
Psychological	<ul style="list-style-type: none"> • Restless. • Nervous. • Tense. • Afraid
Physiological	<ul style="list-style-type: none"> • Heart beating. • Cold sweat on the palms. • Peristaltic movement (unconscious redundancy movement) increase. • Respiratory symptom (breathing). • Gastrointestinal symptom (digestion). • Urogenital symptom (urinary and genitalia).
Social	<ul style="list-style-type: none"> • A behavior showed by individual in his environment. It can be in the form of attitude and sleep disorder.

The students' anxiety greatly affects their creativity. This is in line with the research [19] that there was high correlation between creative thinking and anxiety. Based on the explanation, the aim of this research was to describe the students' anxiety in solving creative thinking problem in geometry according to Van Hiele's theory.

2. Research Method

The aim of this research was obtaining information about the students' anxiety in solving creative thinking problem in geometry according to Van Hiele's theory. The type of this research was descriptive with qualitative approach. The methods used in this research were test, observation, and interview. The test was in the form of Van Hiele level classification and creative thinking. The observation was used when the subject did the creative thinking test to know the students' anxiety. The interview was used after the subject did the creative thinking test to know the students' anxiety and creative thinking level. The subject in this research were the eighth grade students of junior high school as many as 249 students who had administered the test of Van Hiele level classification. After that, 2 students were chosen from visualization, analysis, and informal deduction levels.

After having 2 students from visualization, analysis, and informal deduction levels by using Van Hiele level test, the students were given a test of creative thinking ability containing 2 questions. The time allocation was 40 minutes.

First question

A square has 8cm side length. Mention other rectangular figures that have the same circumference with the square as well as its size!

Second question

A rectangle has 18cm length on its length and 8cm length on its width. Mention a square that has the same are with the rectangle area as well as its size!

3. Result and Discussion

The data of the research were the results of the students' works in doing the test of creative thinking skill. From the results of Van Hiele test for 249 students, it was obtained that 62.2% students were visualization, 24.1% students were analysis, and 1.2% students were informal deduction and 12.5% students did not fulfill all the requirements. The results of Van Hiele test is presented in the Figure 1.

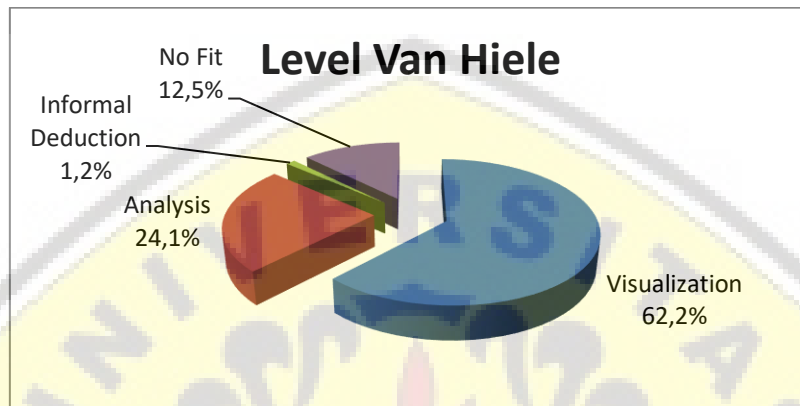


Figure 1. The Diagram of Geometry thinking Ability Level

3.1 Creative thinking according to Van Hiele

3.1.1 The students of Visualization Level

The analysis of the students' works from visualization level showed that the subjects fulfilled the criteria of fluency and flexibility in the components of creative thinking. The results of the subject's works can be seen in the Figure 2 and Figure 3.

1). Persegi
 $s = 8 \text{ cm}$
 $k = 4 \times 8 = 32 \text{ cm}$
 Bangun yang memiliki keliling yang sama persegi panjang,
 panjang 5 cm, lebar 11 cm
 $k = 2(5 + 11) = 32 \text{ cm}$
 Belah ketupat, panjang sisi 8 cm
 $k = 8 + 8 + 8 + 8 = 32 \text{ cm}$

2) Persegi panjang dengan panjang 18 cm, lebar 8 cm
 $L = 18 \times 8 = 144 \text{ cm}^2$
 Bangun yang memiliki luas yang sama
 Persegi = $12 \times 12 = 144 \text{ cm}^2$
 Jajar genjang = $16 \times 9 = 144 \text{ cm}^2$

From this Figure 2, it is known that this student wrote down all of the known things in the given problem and what is asked. In question number 1, students mention 2 rectangular shapes, namely rectangles and rhombus. In question number 2, students mention 2 rectangular shapes, namely square and parallelogram.

Figure 2. The work result of the visualization level student of the first subject (S1)

1. Ukuran sisi Persegi = 8 cm . keliling : ?

$$k : 4s = 4 \times 8 = 32 \text{ cm}$$

a. Belah Ketupat

$$K : a+b+c+d = 8+8+8+8 = 32 \text{ cm}$$

b. Jajar Genjang = k : a+b+c+d = 5+11+5+11 = 32 cm

c. layang - layang = k : a+b+c+d = 4+12+4+12 = 32 cm

2. Panjang = 18 cm lebar = 8 cm luas = ?

$$L : P \times L = 18 \times 8 = 144 \text{ cm}^2$$

a. Persegi = L = s \times s = 12 \times 12 = 144 \text{ cm}^2

b. Jajar Genjang = L = a \times t = 36 \times 4 = 144 \text{ cm}^2

c. Persegi Panjang = L = P \times l = 24 \times 6 = 144 \text{ cm}^2

Figure 3. The work result of the visualization level student of the second subject (S2)

From figure 2 and 3, it can be seen that the first (S1) and the second (S2) subjects answered smoothly and correctly. Thus, (S1) and (S2) fulfilled the fluency criteria in the component of creative thinking. Then, from the students' answers, it also can be seen that (S1) and (S2) provided more than one answers and it was correct. This showed that (S1) and (S2) met the flexibility criteria in the component of creative thinking. Since (S1) and (S2) fulfilled two components of creative thinking in the forms of fluency and flexibility, the level of creative thinking skills of (S1) and (S2) was in TKBK 3 or students were in the creative level. This also can be seen in the following interview excerpt.

This is also supported by the results of interviews between researchers with (S1) and (S2). At the time of interview (S1) and (S2) answered the researcher's questions about two-dimensional figure smoothly and correctly. Then (S1) and (S2) also gave more than one correct answers. This showed that (S1) and (S2) fulfilled 2 components of creative thinking skills, namely Fluency and Flexibility.

3.1.2 The Students of Analysis Level

The analysis results of the students' answers to the level of analysis indicated that the subjects met the criteria of Fluency and Flexibility in the components of creative thinking. The results of the subjects' works can be seen in Figure 4 and Figure 5.

From this Figure 3, it is known that this student wrote down all of the known things in the given problem and what is asked. In question number 1, students mention 3 rectangular shapes, namely rhombus, parallelogram, and kite. In question number 2, students mention 3 rectangular shapes, namely square, parallelogram, and rectangle.

① Diket : sisi persegi = 8 cm
 Keliling : $8 \times 4 = 32$ cm

Bangun yg memiliki keliling sama dan berbentuk segi empat : persegi panjang ukuran panjang = 10 cm lebar = 6 cm keliling : $2(10+6) = 32$ cm

Belah ketupat : panjang setiap sisi = 8 cm
 keliling : $8 \times 4 = 32$ cm

Trapezium : panjang garis yang sejajar 10 cm dan 8 cm panjang garis miring 7 cm dan 7 cm keliling : $10+8+7+7 = 32$ cm

② Diket : Persegi panjang mempunyai panjang 18 cm dan lebar 8 cm, Luas : $18 \times 8 = 144$ cm²

Bangun yg ~~sama~~ memiliki luas yg sama dan berbentuk segi empat : persegi dengan panjang sisi 12 cm Luas : $12 \times 12 = 144$ cm²

Trapezium dengan panjang garis sejajar 10 cm dan 14 cm, dan tinggi = 12 cm
 Luas : $\frac{(10+14) \times 12}{2} = 12 \times 12 = 144$ cm²

Layang-Layang dengan panjang diagonal 12 cm dan 24 cm Luas : $\frac{12 \times 24}{2} = \frac{288}{2} = 144$ cm²

From this Figure 4, it is known that this student wrote down all of the known things in the given problem and what is asked. In question number 1, students mention 3 rectangular shapes, namely rectangle, rhombus, and trapezoid. In question number 2, students mention 3 rectangular shapes, namely square, trapezoid, and kite.

Figure 4. The work result of the analysis level student of the third subject (S3)

3.1.3 The Students of Informal Deduction Level

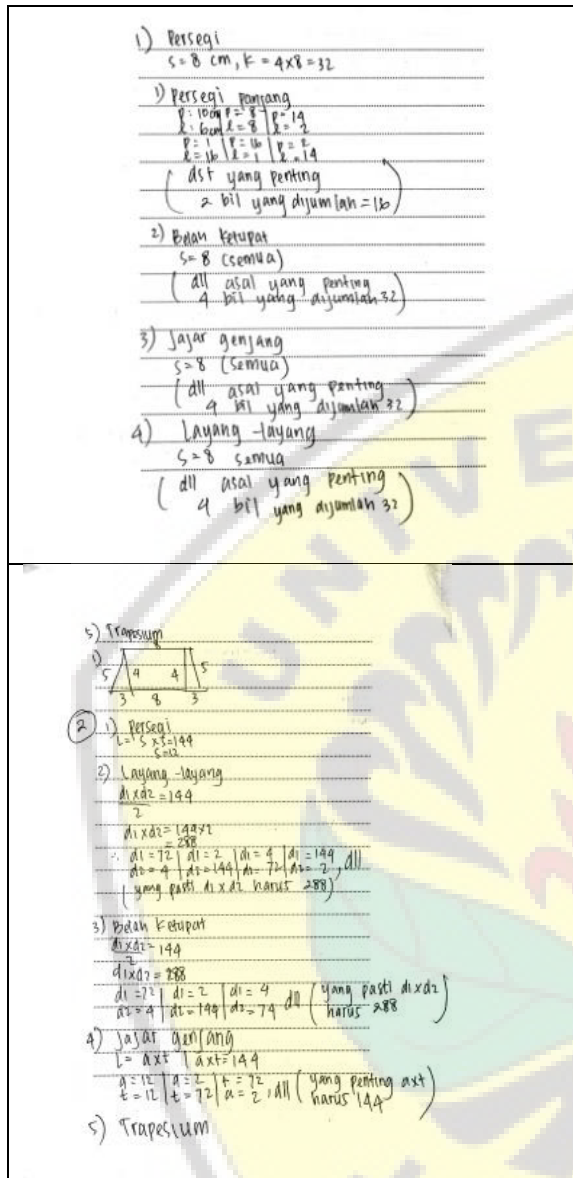
The analysis results of the answers to informal deduction level students found that the subjects met the criteria of Fluency, Flexibility and Novelty. The results of students' works can be seen in Figure 6 and Figure 7.

1. Sisi persegi = 8 cm keliling = $4 \times 8 = 32$ cm
 Persegi panjang = $2(p+l) = 2 \times (13+7) = 32$ cm
 Belah ketupat = $a+b+c+d = 0,06 \text{ m} + 0,08 \text{ m} + 0,06 \text{ m} + 0,08 \text{ m} = 0,32 \text{ m}$
 lajang lajang = $a+b+c+d = 10 + 6 + 10 + 6 = 32$ cm
 $= 0,1 + 0,06 + 0,1 + 0,06 = 0,32$ cm

2. Panjang Persegi Panjang = 18 cm lebar persegi panjang = 8 cm
 luas persegi panjang = $p \times l = 18 \times 8 = 144 \text{ cm}^2$
 Persegi = $s^2 = 12^2 = 144 \text{ cm}^2$
 Persegi Panjang = $2 \times \text{luas Segitiga} = 2 \times \frac{1}{2} \times a \times t = 2 \times \frac{1}{2} \times 24 \times 6 = 144 \text{ cm}^2$
 Jajar genjang = $a \times l = 18 \times 8 = 144 \text{ cm}^2$
 Persegi Panjang = $p \times l = 36 \times 4 = 144 \text{ cm}^2$

From this Figure 6, it is known that this student wrote down all of the known things in the given problem and what is asked. In question number 1, students mention 3 rectangular shapes, namely rectangle, rhombus, and kite. In question number 2, students mention 3 rectangular shapes, namely square, rectangle, and parallelogram.

Figure 6. The work result of the informal deduction level student of the fifth subject (S5)



From this Figure 7, it is known that this student wrote down all of the known things in the given problem and what is asked. In question number 1, students mention 5 rectangular shapes, namely rectangular, rhombus, parallelogram, kite, and trapezoid. In question number 2, students mention 4 rectangular shapes, namely square, kite, rhombus, and parallelogram.

Figure 7. The work result of the informal deduction level student of the sixth subject (S6)

Figure 6 is the work result of the informal deduction level student of the fifth subject (S5). From the picture, it can be seen that (S5) provided answers smoothly and correctly so that (S5) met the Fluency criteria. Then (S5) also gave more than one correct answers, so that (S5) met the Flexibility criteria. (S5) also gave new answer by changing units from cm to m, so that (S5) met the criteria of Novelty.

This is supported by the results of interviews between researchers and (S5). The interview results showed that (S5) answered the researcher's questions smoothly and correctly. Then (S5) also mentioned more than one correct two-dimensional figures. Furthermore (S5) associated two-dimensional figure material with unit material. So that (S5) met 3 creative thinking criteria in the forms of Fluency, Flexibility and Novelty. Since (S5) met 3 components of creative thinking, thus (S5) had a very creative level of thinking or (TKBK) 4.

Figure 7 is the work result of the informal deduction level student of the sixth subject (S6). From the picture, it can be seen that the student answered smoothly and correctly, so the student met

the fluency criteria in the component of creative thinking. Then student answered with more than one correct answers. This showed that the student met the flexibility criteria in the component of creative thinking. Furthermore (S6) provided answers in new way, in which by giving correct conclusion, while the other students never give the same conclusions as (S6). At the time of the interview, the students answered smoothly and correctly, then students also mentioned more than one correct two-dimensional figures. Furthermore, the researcher's question to (S6) about the conclusions given by (S6), (S6) explained smoothly that to reach this conclusion did not have to use only integers, but could also use fractions and decimal numbers. This showed that (S6) associated the two-dimensional figure material with other materials. Since (S6) met 3 components of creative thinking, the level of creative thinking ability of (S6) was very creative or TKBK 4.

3.2 Mathematics Anxiety According to Van Hiele Level

3.2.1 The student of visualization level

The analysis results on the first subject's observation sheet (S1) showed that (S1) experienced anxiety symptoms in the form of nervous; restless; scratching the head; scratching forehead; glancing; playing lips; looking all around; supporting the head with one hand. This is also supported by the results of interview between researcher and (S1), which showed that (S1) felt nervous, *ndredek* (heart beats faster than usual) and also performed repetitive movements without realizing such as glancing, scratching his head and looking all around.

The analysis results on the second subject's observation sheet (S2) showed that (S2) experienced anxiety symptoms in the form of nervous; looking all around; moving feet; scratching the head; holding forehead. This is also can be seen in the results of interview between researcher and (S2), which showed that (S2) felt nervous and did repetitive movements without realizing it like looking all around, moving feet, holding forehead and scratching head.

After doing the observation and interview to (S1) and (S2), the obtained data are as follows (1) The subjects showed the symptoms of anxiety on the psychological components. (2) The subjects showed the symptoms of anxiety on physiological components.

3.2.2 The student of analysis level

The result of the analysis on the third subject's observation sheet (S3) reported that (S3) experienced the symptom of anxiety such as nervous; looking all around; moving feet; holding the nose; glancing right, left, up; moving the chair; holding his chin and cheeks; scratching his head; holding lips. These symptoms were also found in the interview results between the researcher and (S3) who felt nervous; his heart beat (faster than usual); afraid; moved his limbs unconsciously like scratching head; glancing; moving chairs and others.

The results of the analysis on the fourth subject's observation sheet (S4) showed that (S4) experienced the symptom of anxiety such as playing a bulletin board. During the interview with (S4), he explained that he was nervous; afraid and moved his limbs without realizing it like playing ballpoint.

After doing the observation and interview to (S3) and (S4), the obtained data are as follows (1) The subjects showed the symptoms of anxiety on the psychological components. (2) The subjects showed the symptoms of anxiety on physiological components.

3.2.3 The student of informal deduction level

The results of the analysis on the fifth subject's observation sheet (S5) showed that (S5) did not experience any symptoms of anxiety while working on the problem. During the interview with the researcher, (S5) explained that he had experienced nervousness and fear when he was given creative thinking questions.

The results of the analysis on the sixth subject's observation sheet (S6) revealed that (S6) did not experience any symptoms of anxiety as he was calm while working on the problem. But at the interview, (S6) explained that he felt nervous when working on creative thinking questions.

After doing the observation and interview to (S5) and (S6), the obtained data are as follows (1) The subjects showed the symptoms of anxiety on the psychological components.

The results of the analysis on the students' anxiety in solving creative thinking problem in geometry according to van Hiele's theory, it was known that the subjects with visualization thinking stages and analytical thinking stages had the same levels of creative thinking ability in which it was at the creative level since they fulfilled the inner components of creative thinking on fluency and flexibility. Whereas, the ones on the stage of informal deduction thinking had the level of creative thinking skill at very creative level since they reached 3 components of creative thinking. The more components of creative thinking were fulfilled, the higher the creativity of the students who were able to reach the components of creative thinking. This finding is in accordance with a research [8] showed that the students with high level of creative thinking, whose indications were many components of creative thinking fulfilled, categorized as good Problem Solvers.

The results of the researches [7,12,20] showed that problem solving programs enhanced the students' creative thinking. This research also showed that the students who possessed higher creative thinking skills than others had better mathematical problem solving skills. It can be seen from the students' answer sheets indicating their skills in solving the problems. Problem solving was also related to students' anxiety, if the students mastered the problem solving, they were able to solve the problems well. It is proved by the results of the research [21,22] that there was a relationship between mathematics anxiety and problem solving skill. In reducing the students' anxiety, high creativity was required. This research showed that the more creative the students were, the students' anxiety decreased. It is in line with a research [23] stated that the students with lower anxiety tended to be more creative.

4. Conclusion

Based on the results of this research on the students' anxiety in solving the creative thinking problem in geometry according to Van Hiele's theory, the conclusions drawn are as follows (1) The students of visualization level reached the level of creative thinking ability (TKBK) 3 or the students were creative and they showed the symptoms of anxiety on psychological and physiological components. (2) The students of analysis level belonged to the creative-level students as they met the creative thinking components on fluency and flexibility. The students also showed the symptoms of anxiety on psychological and physiological components. (3) The students of informal deduction level belonged to very creative students as they fulfilled all components of creative thinking. They also showed the symptoms of anxiety on psychological components.

Based on the results of this research on the students' anxiety in solving the creative thinking problem in geometry according to Van Hiele's theory, the researcher gave a suggestion to the teacher to familiarize the students with creative thinking by presenting the questions that have open solutions or steps in solving diverse problems.

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