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Profile of creative thinking ability in junior high school in solving flat-building geometry problems in term of van hiele's level and students visual learning styles

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***Keywords*— creative thinking, junior high school, geometric questions**

***Abstract*—** *The purpose of this study was to describe the creative thinking profile of junior high school grade VIII in solving geometry problems based on van Hiele's level and student's visual learning style. The subjects used were junior high school students in grade VIII. Data collection in this study used tests and questionnaires, the test consisted of the van Hiele test consist of 25 multiple choice questions and 2 geometric questions designed based on indicators of creative thinking, namely fluency, flexibility, originally, and ellaborasy. 1) Students at the visualization level in solving geometry problems are students who are able to meet the fluency indicators, while for the indicators of flexibility, authenticity, and details students cannot fulfill them because the answer sheets are still not visible. In addition, at the time of the interview, the students were also unable to give. 2) Students at the analytical level in solving geometry problems are students able to meet all indicators of creative thinking, namely fluency, flexibility, originality and detail. 3) Informal deduction level students in solving geometry problems are students able to meet the indicators of fluency, flexibility and detail, while the informal deduction level students' authenticity indicators have not been able to fulfill them.*

I. INTRODUCTION

Education is very important and in essence cannot be separated from human life. Education is a conscious effort made by families, communities, and governments, through lifelong guidance, teaching or training activities that take place in schools and outside schools, to prepare students to play roles in various living environments appropriately in the future [1]. The young generation of the Indonesian nation is a layer of society who has a major influence on the progress of the Indonesian nation, besides that, Indonesian youth are also expected to be able to compete in facing the development of science and technology that continues to develop in accordance with the progress of the times. Mathematics is a subject that has a big influence on this. According to Suherman, mathematics grows and develops because of the thought process, therefore logic or thinking is the basis for the formation of mathematics [2]. One of the branches of mathematics, namely geometry, is a very important branch in mathematics, this is because many mathematical materials use geometry.

Geometry is a branch of mathematics that deals with objects, surface area, points, lines, angles and the relationships they create, properties, and all applicable measures, including the positions of points, lines and corner in space.

The ability to think creatively is related to the ability to produce or develop something new, which is unusual and different from the ideas of most people [3]. In working on geometry problems, creativity is needed by students because geometry is abstract.Criteria for the creativity aspects used in this study refer to the criteria of creativity aspects [4]. To find out the creative thinking skills of students, it can be seen from the following creative thinking indicators.

Table 1. Indicators of Creative Thinking

Indicator	Description
Fluency	Students are able to build problem-solving ideas from story problems smoothly
Flexibility	Students are able to seek and find many alternative solutions and different answers
Originaly	Students are able to generate new ideas that are different based on the results of their own thoughts
Elaboration	Students are able to detail the steps for solving the problem correctly

Apart from creativity, student learning styles are an important element that must be considered in the learning process. Each student has a different learning style according to their ability to understand a material. Learning styles refer to the ability of learner to perceive and process information in learning situations. The ability to understand students' learning styles can increase the educational outcomes [5]. Students' favorites and style totheir own learning play an important role in educational consequences and these favorites are conveyed into different learningstyles [6].

Students under visual learning styles, which play an important role in learning are eyes/eyesight (visual), so that the way teachers in the learning process must focus on the media/visuals by showing them directly or draw it on the board. Visual style students must look at the teacher's body language and facial expressions to understand the material. Students with auditory learning styles, which play an important role in learning are ears / hearing, so that the way teachers in the learning process must focus on verbal discussion activities both inside and outside the classroom and the teacher explains the material in a clear voice because students with auditory learning styles listen to what the teacher has to say. Students with kinesthetic learning styles, which play an important role in learning through movement, touch, and practice. Students with this learning style find it difficult to sit still for hours, so the teacher's way of the learning process is not to force these students to study for hours, invite the children to study while exploring the environment.

The formulation of geometry questions in this study chose van Hiele's theory as the basis for classification, the theory was chosen because van Hiele's theory focuses on geometric material, examines levels of understanding in learning geometry, explains general descriptions at each level which are described in a more operational description. Based on the description above, the researcher wants to know how the creative thinking profile of junior high school class VIII in solving geometry problems based on van Hiele level and student's visual learning styles.

II. RESEARCH METHOD

This study used in this research is descriptive research. The approach used is a qualitative approach. Descriptive research is aimed at describing the creative thinking profile of grade VIII junior high school students in solving geometry problems based on van hiele level and learning styles. The subjects used in this study were students of class VIII SMP. There are four instruments used, namely van hiele test from Usiskin, learning style questionnaire, geometry test about flat shapes, and interview guidelines. The validation of the study was carried out by the validator to determine the validity of the geometry test questions and interview guidelines used when collecting data.

The data collection methods used in this study were the test and interview methods. Data collection began by giving van Hiele questions from Usiskin [7] as many as 25 questions in the form of multiple choice, each level divided into 5 questions. Level 0 (visualization) on questions number 1-5, level 1 (analysis) on questions number 6-10, level 2 (informal deduction) represents questions number 11-15, level 3 (deduction) represents questions number 16-20, and level 4 (rigor) on questions number 20-25, then analyzed the van Hiele test questions by looking at the results of the tests that have been carried out by grouping students based on the level that van Hiele has the students. Students who answer questions with at least 3 correct answers from each level will be stated that the student meets that level, if the answer is less than 3 then the student has not been categorized as meeting the level. Following are the research steps used in this study.

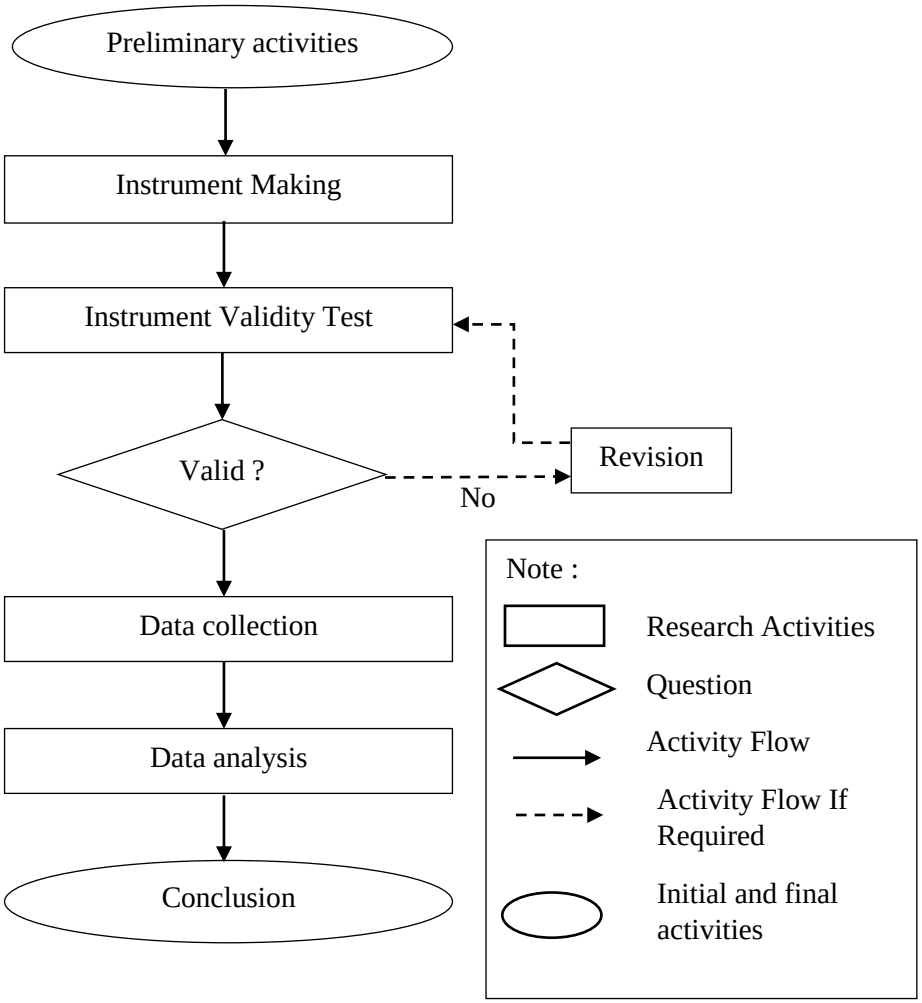

Fig.1. Research Procedure

The second test was conducted using a learning style questionnaire consisting of 30 multiple choice questions to determine the type of learning style of each student. If the highest score is obtained from questions on visual learning styles, then the student has a visual learning style. If the highest score is obtained from questions on the auditory learning style, then the student has an auditory learning style. If the highest score is obtained from questions on the kinesthetic learning style, then the student has a kinesthetic learning style. The last test is a test of flat geometry questions which are arranged based on indicators of creative thinking, then collecting data from the interview results is used for a more in-depth analysis to find something that does not exist or does not appear when working on the problem solving test.

There are three data analysis methods used in this study, namely the analysis of the validity of the instrument, the analysis of the test results, and the analysis of the interview results. The validity analysis of the instruments was carried out by two lecturers from the Mathematics Education at the University of Jember and one mathematics teacher. The analysis of the test results was carried out after the students took the van hiele test, learning style questionnaires and geometry test questions. Students who have a visual learning style are then grouped based on the results of the van Hiele test that the students have done and taken by two students at each level. Then do a geometry test of material based on creative thinking indicators. The next step is to conduct interviews with the five students to find out more detailed information and ensure that the answers are written on the answer sheet. The results of the interviews that have been obtained are then reduced to obtain the desired interview data, then do the presentation of the interview data and make conclusions on the results of the interview. Then triangulation is carried out to check the correctness of the data or information that has been obtained. The triangulation used was method triangulation, namely methods of tests and interviews. In this study, the researcher has a direct role in carrying out research starting from research planning, data collection to the process of

analyzing data that has been obtained through tests and interviews with research subjects.

III. THE RESULTS AND DISCUSSION

Based on research that has been carried out in class VIII A, from the results of the first test, namely the Van Hiele Geometry Test, it was found that 1 student was classified as level 2 (Informal Deduction), 6 students belonged to level 1 (Analysis), and 11 students belonged to level 0 (Visualization) and 3 students are classified as previsualization. The percentage of van Hiele thinking level of students at level 2, 1, 0, and excluding Van Hiele level is 5%, 29%, 52%, and 14%, respectively. This means that most VIII A students are at level 0 (visualization). Based on the results of the first test, namely the Van Hiele Geometry Test which was given to 21 students in class VIII A, the data presented in the pie chart below was obtained.

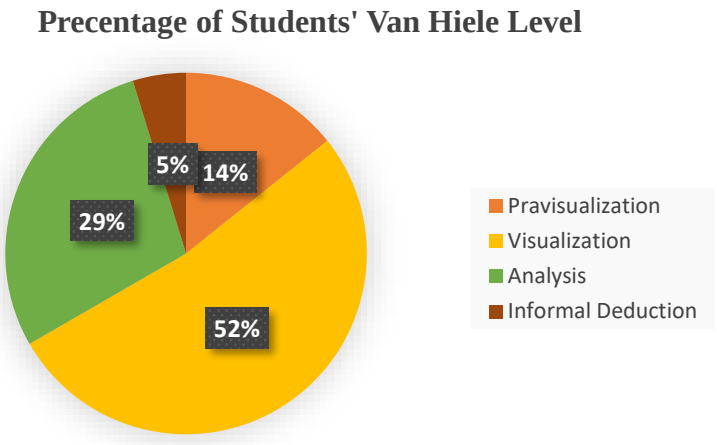

Fig.2. Precentage of Students' Van Hiele Level for Class VIII A

In the diagram above, it can be seen that the thinking level of junior high school students in learning geometry according to Van Hiele's theory has reached the second level, namely the level of informal deductive thinking. This is in line with the opinion of Van De Walle which states that most SMP/MTs students are between level 0 (visualization) to level 2 (informal deduction). This research is also in line with research conducted by Sunardi which states that the level of thinking of students in geometry for junior high school students tends to be at the visualization level [8]. Research conducted by Agustiningsih also shows the same results, namely the Van Hiele Geometry Test results obtained that the percentage of Van Hiele thinking levels of students at levels 2, 1, 0, and excluding Van Hiele Levels are 29%, 10, respectively. %, 48%, and 13%, meaning that the most studied students are at level 0 (visualization) [9]. In addition, research conducted by Sunardi and Yudianto also states that most students in schools are still in the first three levels of student thinking according to van Hiele's theory, namely the level of visualization, analysis, and informal deduction [10].

Based on data analysis that has been carried out on five students who have a visual learning style and have been grouped by van Hiele's level the results show that the students' ability in creative thinking achieved by the five students in solving mathematical problems with geometric material is different. Data collection was obtained from the results of tests carried out by one class of VIII grade students, then the results showed that students who have visual learning styles have different van Hiele levels, in this study the van Hiele level to be analyzed is at level 0, namely visualization, level 1 is analysis, and level 2 is informal deduction. In accordance with the provisions set out in this study, 2 students were taken from each van Hiele level at random. The five subjects in this study were students with the code S1, S2, S3, S4, and S5. The following is the table for the five students' levels of van hiele.

Table 1. Students' Van Hiele Levels

No.	Subjek	No. Soal					Level van Hiele Geometry Test
		1-5	6-10	11-15	16-20	21-25	
1.	S1	3	1	2	1	1	Visualization
2.	S2	4	2	2	2	1	Visualization
3.	S3	5	4	2	1	0	Analysis
4.	S4	4	3	2	1	1	Analysis
5.	S5	5	4	3	0	1	Informal Deduction

The creative thinking profile of the first visualization level student (S1) in solving problem number 1, namely S1 can correctly state the information contained in the problem, namely triangles ABC, BDE, and CEF are isosceles triangles, the length of CF is equal to 10 cm, then the length of side BC is the same with sides DE and EF with a length of 16 cm. S1 can explain the information contained in the questions in his own language, even though the sentences he uses are like repeating sentences in the questions. S1 understands that the Pythagorean formula is used to find the height of a triangle. S1 can also calculate the height of the triangle CEF using the Pythagorean formula with the correct answer of 6 cm. In question number 1, S1 only wrote one alternative answer, namely calculating the total area of the shaded area by calculating the area of triangle ABC and calculating the height of the triangle BDE using the Pythagorean formula, but on the answer sheet S1 did not calculate the area of the triangle BDE and CEF, so the answer he gave writing is still incomplete. At the time of the interview S1 can continue his calculations to calculate the area of the triangle BDE and CEF correctly, so that the calculation of the total area of the shaded area is correctly generated. When asked to look for other ideas, S1 found a second alternative answer, which was to calculate the total area of the shaded area by adding up the area of the triangle ABC and the area of the parallelogram which is a combination of the triangles BDE and CEF, but S1 could not correctly state the formula for the area of the parallelogram. The second alternative answer S1 can only write the steps in general without getting the final result. In question number two, S1 can correctly state the information contained in the question, namely the number of matches of 36 sticks with a length of 5 cm each, the circumference of the shape What will be formed is the number of matches belonging to Pak Khoirul. S1 can also explain questions using their own language, even though it looks similar to the sentences in the questions. S1 only wrote one alternative answer, which was to make a square using 36 matchsticks with 9 sticks on each side, S1 was also able to calculate the actual side length of the square correctly, which was 45 cm. S1 can find the area of a square using the formula and get the correct calculation results. During the interview, S1 found another flat shape that could be formed, namely a rectangle, but when asked to determine the length and width, S1 found it difficult to determine the length and width of the rectangle.

The creative thinking profile of the second level of visualization (S2) in solving problem number 1 is that S2 can correctly state the information contained in the problem, namely triangles ABC, BDE, and CEF are isosceles triangles, the length of CF is equal to the length of the sides BD, BE, and CE which is 10 cm, then the length of the side BC is equal to the sides DE and EF with a length of 16 cm. In question number 1, S2 can write two alternative answers, first calculate the total area of the shaded area by adding up the area of triangle ABC, area of triangle BDE and triangle CEF. Second, add up the area of a rectangle which is another form of triangle ABC by moving half of the triangle to the other side, then the area of triangle BDE and triangle CEF. At first S2 was wrong when calculating the area of triangle ABC, S2 was wrong in calculating multiplication using the formula, finally at the time of the interview S2 was able to calculate the area of triangle ABC using the triangle area formula correctly. S2 can also calculate the height of the triangle BDE using the Pythagorean formula with the correct answer. In the second alternative answer, S2 can calculate the total area of the shaded area with the correct final result. At the time of the interview S2 could not find new ideas to solve problem number one. In question number 2, S2 could correctly state the information contained in the question, namely S2 could state what was known and asked in the question. S2 can also explain questions using their own language. S2 can write two alternative answers, namely making square and rectangular shapes. In the initial square shape, S2 drew the shape with the wrong match position, finally during the interview S2 was able to correct the square shape he drew and was able to determine the length of the side of the square which was 9 sticks, S2 was also

able to calculate the actual side length of the square correctly, which was 45 cm . S2 can find the area of a square using the formula and get the correct calculation results. To get a rectangle, on the answer sheet S2 is also wrong when drawing, he puts the matchstick position not according to the instructions in the question. At the time of the interview, S2 realized that the picture was wrong and could correct the picture, but when asked to determine the length and width he found it difficult so that S2 could not determine the length and width of the rectangle.

The profile of creative thinking of students at the first level of analysis (S3) in solving problem number 1 is that S3 can explain the meaning of the questions using their own language. S3 can correctly state the information contained in the problem, namely triangles ABC, BDE, and CEF are isosceles triangles, the length of CF is equal to the length of the sides BD, BE, and CE which is 10 cm, then the length of side BC is equal to the sides DE and EF with length 16 cm, the height of triangle ABC is 15 cm. In question number 1 S3 can write two alternative answers, first calculate the total area of the shaded area by adding up the left half of the triangle ABC area, the area of the right half triangle ABC, the area of the triangle BDE and the triangle CEF. Second, add up the area of triangle ABC (directly into one shape) and the area of a rectangle which is a combination of triangle BDE and triangle CEF. S3 can also calculate the height of the triangle BDE using the Pythagorean formula correctly. During the interview, S3 can find another alternative answer, namely calculating the total area of the shaded area by adding up the area of triangle ABC and the area of a parallelogram which is a combination of the BDE triangle and the CEF triangle, S3 can calculate a new alternative answer with the correct final result. S3 also found another alternative answer, namely adding up the area of the kite (a combination of triangles ABC and BDE) and the area of the triangle CEF, but he couldn't calculate the area because S3 couldn't correctly mention the formula for finding the area of the kite.

In question number 2, S3 can correctly state the information contained in the question. namely S3 can state what is known and asked in question number 2 smoothly and correctly. S3 can also explain questions using their own language. S3 can write three alternative answers, namely making squares, rectangles and triangles. In the shape of a square, S3 can determine the length of the side of the square, which is 9 bars, S3 can also calculate the actual side length of the square correctly, which is 45 cm. S3 can find the area of a square using a formula and get the correct calculation results. In rectangular shapes, S3 can determine the length and width, namely 11 bars and 7 bars, S3 can correctly state the formula for the area of a rectangle, S3 is able to calculate the area of a rectangle correctly. To build a triangle initially on the answer sheet he could not determine the size of the sides of the triangle, finally at the time of the interview he was able to determine the size of the sides of the triangle, namely 12, 12, 12, but S3 could not calculate the area of the triangle because he found it difficult to calculate the height of the triangle using the Pythagorean formula, S3 has difficulty calculating the size of the sides of the triangle which is substituted in the Pythagorean formula. During the interview, S3 can find alternative answers, namely making a rectangular shape with a length of 12 rods and a width of 6 rods, S3 can also calculate the area of a rectangle correctly.

The profile of students' creative thinking at the second level of analysis (S4) in solving problem number 1 is that S4 can explain the meaning of the question using their own language. S4 can correctly state the information contained in the problem, namely triangles ABC, BDE, and CEF are isosceles triangles, the length of CF is equal to the length of the sides BD, BE, and CE which is 10 cm, then the length of side BC is equal to the sides DE and EF with length 16 cm. In question number 1, S4 can write three alternative answers, first calculate the total area of the shaded area by adding up the area of triangle ABC, area of triangle BDE and triangle CEF. Second, add up the area of triangle ABC and the area of the trapezoid which is the combination of the three triangles below and then subtract the area of the unshaded triangle. Third, add up the area of triangle ABC, the area of the rectangle is subtracted from the area of the unshaded triangle, then the area of the two lower right triangles. S4 can also calculate the height of the triangle BDE using the Pythagorean formula with the correct answer.

When solving problem number 2, S4 can correctly state the information contained in the question. S4 can state what is known and asked in question number 2 smoothly and correctly. S4 can also explain questions using their own language. S4 can write two alternative answers, namely making square and rectangular shapes. In the shape of a square, S4 can determine the length of the side of a square with 9 bars, S4 can also calculate the actual side length of the square correctly, which is 45 cm. S4 can find the area of a square using the formula and get the correct calculation results. In the rectangular shape, initially S4 was able to determine the length and width, namely 8 sticks and 5 sticks, but it turned out that the measurements were still wrong. S4 was able to correct the length and width of the rectangle at the time of the interview, which was 13 bars long and 5 bars wide, S4 correctly stated the formula for the area of a rectangle, S4 was able to calculate the area of the rectangle correctly. During the

interview, S4 found another shape, namely a parallelogram with a base length of 13 rods and a width of 5 rods, but S4 could not calculate the area of a parallelogram because S4 could not determine the height of a parallelogram using the Pythagorean formula. S4 also found another alternative answer, namely making build a rectangle with a length of 14 bars and a width of 4 bars, S4 can also calculate the area of the rectangle correctly.

The profile of students' creative thinking at the informal deduction level (S5) in solving problem number 1 is that S5 can explain the meaning of the questions using their own language. S5 can correctly state the information contained in the problem, namely triangles ABC, BDE, and CEF are isosceles triangles, the length of CF is equal to the length of the sides BD, BE, and CE which is 10 cm, then the length of side BC is equal to the sides DE and EF with length 16 cm. In question number 1 S5, you can write three alternative answers, firstly calculating the total area of the shaded area by adding up the area of triangle ABC, area of triangle BDE and triangle CEF. Second, add up the area of triangle ABC and the area of a parallelogram which is a combination of triangles BDE and CEF. Third, add up the area of the kite (a combination of triangle ABC and triangle BDE) and the area of triangle CEF. S5 can also calculate the height of the triangle BDE using the Pythagorean formula with the correct answer. During the interview, S5 found another alternative answer, namely forming a triangle ABC into a rectangular shape, so to find the total area of the shaded area, namely adding up the area of the rectangle, the area of the triangle BDE and the area of the triangle CEF. Another alternative answer that S5 found was adding up the area of triangle ABC and the area of a rhombus (a combination of triangles BDE and CEF), S5 was also able to calculate the area correctly.

In question number 2, S5 can correctly state the information contained in the question, namely S5 can state what is known and asked in question number 2. S5 can also explain the problem using his own language. S5 can write three alternative answers, namely making squares, rectangles, and triangles. In the shape of a square, S5 can determine the length of the side of the square, which is 9 bars, S5 can also calculate the actual side length of the square correctly, which is 45 cm. S5 can find the area of a square using a formula and get the correct calculation result. In the rectangular shape, S5 can determine the length and width, namely 12 rods and 6 rods, S5 can mention the formula for the area of a rectangle and is able to calculate the area of the rectangle correctly. To build a triangle, S5 can determine the size of the sides of the triangle, namely 12, 12, 12, but S5 cannot calculate the area of the triangle because S5 finds it difficult to calculate the height of the triangle using the Pythagorean formula. At the time of the interview, S5 found a new size of the triangle shape, namely 10,10,16, S5 was able to calculate the height of the new triangle using the Pythagorean formula and calculate the area of the triangle correctly. S5 also found other alternative answers, namely to build a rectangle with a length of 14 rods and a width of 4 rods, and a rectangle with a length of 10 rods and a width of 8 rods, S5 was also able to calculate the area of the two rectangles correctly.

The results of student work based on indicators of creative thinking in solving two problems describing the material for flat triangles and quadrilaterals can be seen in the following table.

Table 2. Results of Analysis of Flat Shape Geometry Test

Research Subject	Question Number							
	1				2			
	A	B	C	D	A	B	C	D
S1	√	x	x	x	√	x	x	x
S2	√	x	x	x	√	x	x	x
S3	√	√	√	√	√	√	√	√
S4	√	√	√	√	√	√	√	√
S5	√	√	x	√	√	√	x	√

Information:

A : Fluency

B : Flexibility

C : Originally

D : Elaboration

√ : Meets

x : Not yet fulfilled

Based on the analysis and discussion that has been described previously, there are similarities between the five students, namely that all students have previously received flat-shaped material, but the questions given are different from the questions in the study. In this study, it was found that students at the analytical level were able to write new alternative answers that were different from other students, while for the level of visualization and informal deduction, there was no update when providing alternative answers. This raises the assumption that the van Hiele level of the students has a discrepancy which is thought to be caused by the test questions used to measure the van Hiele level which are still optional consisting of several multiple choice options. So that it is possible that when students answer the question, they only give answers by trial and error, which causes the ability of students to answer the next question, namely the geometry problem, which is not in accordance with the van Hiele level of the student. This study shows that the creative thinking ability of each student is different. The results of this study are in line with Van Hiele's theory which says that the process of developing students' creative thinking is not determined by age or biological maturity, but rather depends on the teaching from the teacher and the learning process that students go through. In addition, this research is also in line with research conducted by Mukharomah et al which states that not all students who are at a high level in van Hiele, have a high level of creative thinking [11]. Likewise, students at low levels at van Hiele also do not always show low levels of creative thinking.

IV. CONCLUSION

Based on the results of the analysis and discussion of the data, it can be concluded that the creative thinking profile of students who have a visual learning style at level 0 (visualization), level 1 (analysis), and level 2 (informal deduction) in solving geometry problems are as follows. 1) Students at the visualization level in solving geometry problems are students who are able to meet the fluency indicators, while for the indicators of flexibility, authenticity, and details students cannot fulfill them because the answer sheets are still not visible. In addition, at the time of the interview, the students were also unable to give. 2) Students at the analytical level in solving geometry problems are students able to meet all indicators of creative thinking, namely fluency, flexibility, originality and detail. 3) Informal deduction level students in solving geometry problems are students able to meet the indicators of fluency, flexibility and detail, while the informal deduction level students' authenticity indicators have not been able to fulfill them. So it can be concluded that students with different van Hiele levels also have different creative thinking abilities, and not always students who are at a higher van Hiele level can fulfill all indicators of creative thinking and the otherwise. This can be caused by the different experiences of students in solving geometry problems and the level of concentration of students when working on problems. In addition, it was also suspected that when doing the van Hiele test students answered trial and error, so that the resulting van Hiele level grouping was inaccurate. Based on these findings, the recommendation in this study is to make a new VHGT test package (Van Hiele Geometry Test) which is adapted to the situation of students or the existing curriculum in Indonesia.

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