Junior High School Geometry Visualization Activity

M Prayito¹, Didi Suryadi², Endang Mulyana³

Universitas Pendidikan Indonesia

mprayito@gmail.com

Abstract. There is a series of learning that is rarely done by students to form comprehensive geometry knowledge. Visualization activities in this learning will help students through a series of geometry learning that matches the stages of geometry thinking. This activity has resulted in an increase in visual levels that are owned by students. Visual teaching aids and student activity guidance sheets are used in a series of learning. In this way students not only gain knowledge but do contextual visualization activities. This activity can be easily adapted for use on broader geometry topics.

1. Introduction
Graduates competences of Junior High School (SMP) are about 6 competencies. Two competencies are geometry competence. The six competencies were developed into 25 indicators and 11 indicators about geometry (44%). The percentage of geometry items on National Examination is 45%. Most of these questions are the non-routine problem. The non-routine problem includes solving problems in mathematical contexts or daily life with the aim that learners are accustomed to dealing with similar problems, applying a mathematical procedure in a newly encountered context [1]. We do analysis of the National Exam in 2013, 2014, 2015 and 2016 obtained the data problem geometri as follows:

| No | Year | Amount of Geometry Problem | Items |
|----|------|-----------------------------|-------|
| 1  | 2013 | 18                          | 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34 |
| 2  | 2014 | 16                          | 12, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 |
| 3  | 2015 | 17                          | 2, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 |
| 4  | 2016 | 14                          | 4, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34. |
| 5  | 2017 | 17                          | 12, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34 |

Mastery of geometry material on the National Examination 2014 result is 35.96. The result is the lowest number of mastery material. According to [2], one of the weaknesses that students have low visualization ability. The problem solving process tends to skip the visualization step. Visualization is the first level of thinking on Van Hiele's theory. According to [3], in their class, 95% of students cannot solve the third level of Van Hiele Geometry problem. This is reinforced by the findings [4] that learners cannot do activity at the formal deduction level.

One of the important components in developing students' thinking is visualization ability, ability to visualize abstract forms in solving problems that exist in the real world. [5]. According to [6] Geometry problems in aspects of visualization abilities are often encountered by students in solving problems.
students often have a wrong visual picture in solving problems. Because of different learning practice condition with thinking geometry theory, so research question is how is the geometry visualization activity in junior high school?

2. Literature review
This qualitative research is carried out in line with the viewpoint of thinking geometry. The students as individuals will go through the stages of geometry thinking to be able to understand class VII geometry as a whole. These stages are clearly a hierarchy with visualization as a basic step. This research focused on the foundation of geometry explores geometry visualization activities in the seventh grade junior high school.

According to [7] in learning geometry the development of students' thinking occurs through 5 (five) levels as follows Level 0 : Visualization), Level 1 : Analysis, Level 2 : Abstraction , Level 3 : Deduction and Level 4 : Rigor.

Five levels of thinking of Van Hiele will be passed by students in learning geometry. In the stage of visualization students can create field images in accordance with the concept regardless of the properties of the components. Then in the analysis stage students can make informal analyses of the components and properties of geometry. At the level of abstraction, students can make abstract definitions and distinguish necessary requirements and sufficient terms of a geometrical concept. Furthermore, at the level of deduction, students can make a formal analysis with a complete mathematical system context with undefined terms, axioms, truth logic systems, definitions and theorems. At the rigor level, students can compare systems based on different axioms and can learn geometry variations.

Empirical evidence
Researches about thinking geometry start famous since [7] introduces level thinking in learning geometry.[8] analyse about the “use of mathematical words and substantiation routines related to parallelograms and their properties”, according to him a single van Hiele level of thinking encompasses a range of complexity of reasoning and differences in discourse”. Specifically about visualization, [9] research the figural concepts of personal pre-mathematics associated with quadrilateral hierarchical classification. the results were found that quadrilateral images were known to students personally even though they had formal quadrilateral definitions. [10] research the gap between the concept of personal and formal images that students have in relation to hierarchical quadrilateral classification. According to Fujita and Jones, students often have no difficulty visualizing the basic image that is used as a benchmark so students have difficulty producing a hierarchical definition that is appropriate for the quadrilateral. [11] revealed the amount of research that has been done in the field of education but research on the five-phase approach (van Hiele) is still not widely developed. [12] here are 7 things that have become important contributions in geometry research, according to Sinclair, one of them is that contribution is a progress in understanding visuo's spatial reasoning.

3. Methods
The method used in this research is a qualitative research method. Step of this research includes several stages as follows. First stage is prospective analysis, we start do by analyzing curriculum and material in depth, including student learning obstacle, then make lesson design. Second stage is metapedadidaktic, this stage est the instruments that have been made followed by interviews with several respondents. The focus of this research is to know the visual activity of students about geometry grade VII. The population of this research is seventh grade student in SMP N 2 Limpung, while the sample is student of class VII A. Data collection techniques in this research we used triangulation, observation, and documentation.

4. Results
4.1. How to visualize in grade 7 students
This research is a small part of the research conducted by Prayito in 2016 until 2018. The following are geometric material questions for the class VII given by the students and some examples of how students work on the problem. Geometry questions at numbers 16 and 17 were given to students of class VII A totalling 32 students. Problem number 16 has a trapezoid visual image with feet, the position of two parallel lines is not placed horizontally as in the general trapezium picture, the number used in the problem is still in the tens range. Whereas in question number 17 contains the application of geometry without any visual images, the answer to this problem will begin with information that is known in visual form.

16. Perhatikan gambar berikut!

Bangun ABCD adalah trapesium sama kaki dengan panjang AB = 14 cm, AD = 5 cm, CD = 8 cm dan DE = 4 cm.
Hitunglah:
   a. keliling trapesium ABCD
   b. luas trapesium ABCD

17. Sebuah kolam berbentuk persegi panjang dengan ukuran 14 m x 8 m. Di sekeliling kolam bagian luarnya akan dibuat jalan selebar 1 m. Jika jalan tersebut akan dipasangi keramik dengan biaya Rp120.000,00 per m². Hitunglah biaya yang dibutuhkan seluruhnya untuk pembuatan jalan

18. Segitiga ABC siku – siku di B dengan panjang sisi AB = (x + 3) cm, AC = (x + 6) cm dan BC = x cm. Jika keliling segitiga ABC = 36 cm, maka tentukan:
   a. nilai x
   b. panjang sisi AB, AC, dan BC
   c. Luas segitiga ABC

**Figure 1.** Mathematical questions given by students.

**Figure 2.** Some versions of answers given by students.
The results of the students' answers in solving problems above 47% without analyzing the goals and information they have so they tend to produce wrong results. Students directly write the formula that has been known by them without regard to the object of the problem at hand. Problem number 17 students do not visualize in advance analyzing the problem, even though the type of application questions given will be easier if students do visualization steps to understand the conditions desired by the problem. As many as 53% of students have tried to dig information from the problem and analyze the answers but 34% of students are still wrong in calculating one of the questions and only 19% of students can answer correctly. It illustrates how important visualization is to describe abstract things in geometric problems [5].

Chart 1. Persentation use visualization ini problem solving

The geometry thinking ability test was given to 32 students in the VIIA class. There are 5 questions that are used to measure students' visualization skills. Data from the visualization ability of the visualization level ability test possessed by students was obtained by 22 students in the visualization level, while the other 10 students are at the other level. Students tend to answer questions incorrectly around the number 3,4,5. Questions on these numbers are presented in a visual form but not horizontally.

Chat 2. Visualization Ability

The process of student visualization activities is carried out with a visual display package equipped with student activity sheets. Visual display packages are used by students to visualize abstract geometry objects in the form of a flat plane. In order for activities to be carried out by students on the use of visual aids can be monitored, the student activity sheet is used which must be filled in according to the instructions. The student activity sheet contains 13 steps of activities and 4 questions to determine
students' abilities in analyzing the results of visualization that have been done. The teacher acts as a facilitator in learning activities.

![Figure 3. The teacher provides assistance to a confused group](image)

Students experience different difficulties in visualization activities. Student difficulties are seen in 5 activities, namely numbers 8, 9, 10, 11, 12 which are partly related to diagonal. Each group has had a good discussion. Of the 8 groups as many as 6 groups have divided the tasks effectively. One student records another student holding the display and frame. In the presentation of the results of the discussion students can work together with their group friends to show the results of the disk.

![Figure 4. students doing visualization activities on shape](image)

5. **Discussion**

This study provides empirical evidence about how students visualize, especially when students are doing problem solving on the problem. Besides visualization in the classroom is not just passive visualization, where students only see what is on the board or LCD using a computer. In this study the way that teachers do to help students develop students' visualization skills is by direct activities. This means that students not only see visualization but students are involved in the construction of active science. The results of the study support that visualization activities have an influence in improving student learning outcomes. [13] revealed the findings that visual activities have a significant effect on learning outcomes.

The results of the data obtained by researchers in this study as many as 22 students have arrived at the level of visualization. The ability of students who are already at this level should be able to help students to solve problems in the questions. But because students do not use the visualization step before the analysis causes the process errors in the answers to the questions that are done by students. [14] in his research found the importance of visual abilities that were clearly needed in the engineering and mathematical sciences, especially for visualizing geometric objects correctly.

6. **Conclusions**
In this article, it has been explained how the conditions of visualization that occur in geometry material in class VII. Visualization display package is one tool to help visualization activities in active classes. Following the results of this study, I agree on the management of good visualization in students will help students to reach the next level at the stage of geometry thinking. The importance of understanding the ability of visualization in students will provide an overview for researchers in making a better learning design, so that the implementation of learning can run optimally.

7. References

[1] Suryadi, Didi. 2012. *Membangun Budaya Baru dalam Berpikir Matematik*. Bandung: Rizqi.
[2] Prayito, M. 2017. *Learning Obstacle On The Material Circumference And Area of Triangle in Limpung Junior High School*. International Journal of Science and Applied Science: Conference Series Volume 1 Nomor 1. 64-71. https://doi: 10.20961/ijsascs.v1i1.5116
[3] Gabriele P. dan Julia Z. 2015. *The Attitudes of Students to the Geometry and Their Concepts about Square*. Procedia - Social and Behavioral Sciences 197 (2015) 1907 – 1912
[4] Wu, D. B., & Ma, H. L. (2006, July). The distributions of van Hiele levels of geometric thinking among 1st through 6th graders. In Proceedings 30th conference of the international group for the psychology of mathematics education (Vol. 5, pp. 409-416).
[5] Lavy, I. (2006). Dynamic Visualization and The Case of „Stars in Cages”. Proceedings 30th Conference of the International Group for the Psychology of Mathematics Education, Vol. 4, pp. 25-32. Prague: PME.Lowry, C. M. (2000). Supporting and Facilitating Self-Directed Learning. ERIC Digest No 93,1989-00-00
[6] Bishop, A. J. (1989). A review of research on visualisation in mathematics education. DOCUMENT RESUME Proceedings of the Annual Conference of the International Group for the Psychology of Mathematics Education (12th, Veszprem, Hungary, July 20-25, 1988), Volume 1.p. 187.
[7] Van Hiele, P. M. (1959). The child’s thought and geometry. English translation of selected writings of Dina van Hiele-Geldof and Pierre M. van Hiele, 243-252
[8] Wang and Kinzel. 2014. How Do They Know It Is a Parallelogram? Analysing Geometric Discourse at Van Hiele Level 3. Research in Mathematics Education, v16 n3 p288-305 2014
[9] Ozdemir Erdogan, Emel & Dur, Zeliha. (2014). Preservice Mathematics Teachers’ Personal Figural Concepts and Classifications About Quadrilaterals. Australian Journal of Teacher Education. 39. 10.14221/ajte.2014v39n6.1.
[10] Fujita, T. and Jones, K. (2007), Learners’ understanding of the definitions and hierarchical classification of quadrilaterals: towards a theoretical framing, Research in Mathematics Education, 9(1&2), 3-20. ISSN: 1479-4802; ISBN: 0953849880
[11] Watson, A., Jones, K., & Pratt, D. (2013). Key ideas in teaching mathematics: Research-based guidance for ages 9-19. Oxford: Oxford University Press.
[12] N sinclair et al. 2016. Recent research on geometry education: An ICME13 survey team report. ZDM, 2016, Volume 48, Number 5, Page 691
[13] Harmony, J.,& Theis,R. (2012). “Pengaruh Kemampuan Spasial Terhadap Hasil Belajar Matematika Siswa Kelas VII SMP Negeri 9 Kota Jambi”. Jurnal Edumatika. Vol.2, No. 1.
[14] Nemeth, B. 2007. “Measurement of the Development of Spatial Ability by Mental Cutting Test” dalam Annales Mathematicae et Informaticae, (34): 123-128

Acknowledgments

This research supported by KEMENRISTEKDIKTI for funding the research, all the teachers and headmaster SMP N 2 Limpung for giving us permission our research.