# THE HIGHER ORDER THINKING SKILL OF PRE-SERVICE TEACHER ACCORDING TO VAN HIELE'S THEORY OF THOUGHT IN ANALYSIS LEVEL

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*Abstract*

The purpose of this study was to characterize teacher candidate students' higher-order thinking skills (HOTS) using the Van Hiele analysis level. The qualitative descriptive method was employed in this study. The Van Hiele Geometry Test and the HOTS test served as the research instruments. Data were gathered via tests and interviews. Next, two participants who, in accordance with Van Hiele's theory, had attained the analytical level among third-semester primary school teacher education students served as the research subjects. According to Van Hiele's theory, the research's findings indicated that the students who attained the analysis level were unable to meet HOTS indicators including analysis, evaluating, and creativity indicators. Since the students did not state proper reasons to support the conclusion, which it was used during the process of conclusion.

**Keywords:** *HOTS, Van Hiele, Geometry*

## INTRODUCTION

Achievement in higher education learning requires the graduates to have work abilities like application, assessment, design, and use of science and technology in order to solve procedural problems (Ristekdikti, 2014). Therefore, the students need to have an adequate basic thinking ability. According to the primary goal of education in the twenty-first century, which is to help students improve their higher order thinking skills (HOTS), students are expected to possess higher-order thinking skills (HOTS) (Yen & Halili, 2015).

Higher order thinking skill (HOTS) includes critical, logical, reflective, metacognitive, and creative thinking. According to King et al., (2018), the higher-order thinking ability is activated when the individual encounters a foreign problem, uncertainty, or dilemma. Moreover, higher-order thinking ability (HOTS) has been defined by Anderson et al., (2001) as the

highest three-level thinking skill in the revised edition of Bloom's Taxonomy which includes analyzing, evaluating, and creating. Then, HOTS is explained as a thinking skill at a higher level relating to complex issues by involving a sort of interpretation.

Mohamed & Lebar (2017) have found characteristics of the HOTS test: 1) a stimulus that elicits conclusions and critical reasoning abilities, 2) it integrates multiple cognitive domains through multimodal thinking, 3) it is related to novel contexts, 4) it is relevant to real-world situations, and5) it is not repetitious. Therefore, the HOTS test is a novel task for the students that calls for some level of thought to solve. It is also a non-routine test.

Students' higher-order thinking skills (HOTS) require a strategic approach to be improved. For example, an arithmetic issue presented as a HOTS exercise test. A math question or query that requires HOTS components is known as a HOTS exam (Bakry & Bakar, 2015). The test involving the HOTS type is likely to be intricate and have numerous answers. Based on the previous research done by Bakry & Bakar (2015), they have written that the high, mediate, and low instruments are able to result different measures of student thinking while working their HOTS test. Students with a high level of thinking are able to express their opinions, recognize the creative aspect, and form conclusions. Further, the students with a meditative way of thinking are able two aspects, but not on conclusion aspect. Meanwhile, the students with a low way of thinking are not able to realize two factors, but they can state their opinions.

Geometry is one of many math problems that offer the students an opportunity to use higher order thinking skill (HOTS). Asis et al., (2015) has asserted that geometry is an abstract representation of spatial and visual experience, for example on domain, pattern, mapping, measurement, etc. In 2000, the National Council of Teaching Mathematics (NCTM) declared that in general, students should have the following geometry skills: (1) the ability to analyze geometry characters and traits either in two or three dimensions, and the ability to build math arguments concerning to the relation between geometry and the other; (2) ability to determine position of a point more specifically and description of spatial relation by using geometric coordinate and connecting with the other system; (3) transformation application and its symmetrical usage which aims to analyze math situation, use visualization, draw spatial reasoning, and geometry model for problem solving (NCTM, 2000).

Apart from assigning geometry problems in the form of HOTS exercises, teachers must also provide distinct instruction for the pupils. Even if each student has a unique learning style and way of thinking, the instructor can nevertheless identify treatments (learning models, methods, or approaches) that are generally comparable for each student. A quality geometry lesson should be tailored to the aptitude and proficiency of the students. The teacher should take into consideration the students' skill level when presenting the topic. Along with determining the mental growth of each student and how the learning process should be carried out following that level, the instructor must also. Van Hiele adalah salah satu spesialis pendidikan yang juga prihatin dengan tingkat keterampilan siswanya. Pitadjeng (2015: 55) explains that students move through five Van Hiele thinking levels during the learning process, particularly in the geometry sector. Introduction (level 0), analysis (level 1), informal decoction (level 2), deduction (level 3), and rigor (level 4) (Burger & Shaughnessy, 1986; Kim, 2016; Škrbec & Čadež, 2015; Wu & Ma, 2006). Students will pass each of Van Hiele's thinking levels in order, according to Abdussakir (2009). The pupils must then carefully complete each level before moving on to the next.

Many researches on Van Hiele's thinking level on students have been conducted, a research done by Umar et al., (2020) has referred that the geometric thinking level of students in primary school teacher education according to Van Hiele's theory is at following levels: (1) 32% of students are at the thinking level pre 0 or they have not reached level 0 (visualization), (2) 38% of students are at thinking level 0 (visualization), (3) 30% of students are at thinking level 1 (analysis), (4) no students who reach geometric thinking skill level 2 (informal deduction), level 3 (formal deduction), and level 4 (rigor). In the meantime, level 1 (analysis) is the greatest geometric thinking level among math students, according to another earlier study by Putri & Nopriana (2019).

Based on the explanation above, the researchers aim to identify the higher-order thinking skill of students on the highest geometric thinking skill, level 1 (analysis). Therefore, the researchers decided on the research title "The Higher Order Thinking Skill of Teacher Candidate Students According to Van Hiele's Theory of Thought in Analysis Level".

**METHODS**

The research subjects were taken from third-semester students of primary school teacher education. The research was conducted in the Department of Primary School Teacher Education, State University of Gorontalo. The descriptive qualitative

method was employed in this study. Van Hiele's level of thinking should be taken into account while choosing a research topic. Two students who had attained level 1 (analysis) of Van Hiele's theory were selected by the researchers after the pupils had been categorized according to their thinking levels. One of the elements that should be taken into account while choosing the research subjects is the degree to which students were able to communicate clearly and smoothly.

Tests and interviews with the chosen research subjects served as the methods of data gathering in this study. This study employed the HOTS and VGHT test types. Students' geometric thinking level was assessed using the Usiskin (1982) VHGT test. The VHGT test was subsequently translated into Indonesian by the researchers for ease of usage. Two participants, MU and DM, who had advanced to level 1 (analysis) of Van Hiele's theory were chosen based on the results of the VHGT exam. Subsequently, the investigators administered the HOTS exam and had interviews to elucidate the outcomes of the students' responses to the test. Data reduction, data display, and conclusion were the three stages of the data analysis process (Sugiyono, 2013). The researchers used the following test types:

**Cognitive Level: Analyzing (C4)**

1. Bumbungan is Sasak traditional house in Lombok. Bumbungan has steep roof type, made of thatch with a thickness of 15 cm. The roof is intentionally left to stretch towards the lower wall and almost cover the wall as seen in this figure below.



**Figure 1.** Bumbungan

The lower part of the roof has a length of 5,2, while the upper part of 5/13 of the lower part. The height of the roof is about 3/2 of the top. So, what is the perimeter of the house roof?

**Cognitive Level: Evaluating (C5) and Creating (C6)**

2.    A carpenter has about 32 meters of wood and wants to make a fence around the garden. He is considering the design of a garden fence. Please, answer "Yes" or "No" and give the reason for every garden design below:
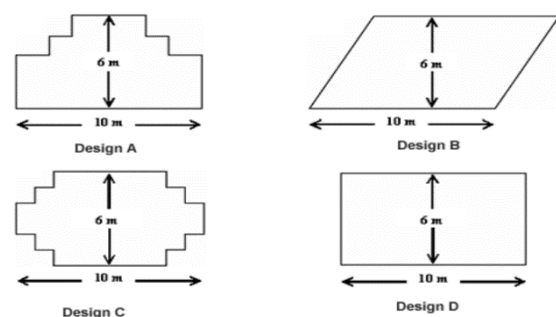
**Figure 2.** Design of garden fence. Which garden designs can be made of 32 meters of wood? Please, explain design A Yes/No, design B Yes/No, design C Yes/No, and design D Yes/No.

## RESULTS AND DISCUSSION

The Van Hiele Geometry Test was used on all samples to gauge each student's level of reasoning. Based on this data, the researchers have identified two participants who are qualified to take the geometry skill exam and have attained level 1 (analysis) of Van Hiele's theory. The following phase was a direct interview by the researchers with the subjects after they finished the test. The researchers chose two subjects who had advanced to level 1 (analysis) of Van Hiele's theory based on the analysis results. MU and DM are the initials of the research subjects.

Based on the research result of the HOTS type geometry test, it was used for analyzing category, the subjects MU and DM have not been able to perform the step well so far. Thus, the subject MU was only able to understand what is known about the question, but in connecting between ideas and the meaning of the question was inappropriate. Whereas, subject DM was not able to understand what is known about the question and could not relate between ideas and meaning of the question properly. This is following research conducted by Noriza & Kartono (2016), level 1 students (analysis) have not been able to plan problem-solving correctly. Students at level 1 (analysis) also cannot mention the formulas used to solve problems correctly. This is because according to Crowley (1987) students at level 1 (analysis) cannot answer the problem correctly because they cannot develop a problem-solving plan correctly.

In the evaluation category, subject MU did not fulfill the "evaluating" indicator, the subject could answer design A properly, but the true reason was not written without answer proof and no solution method was taken by students, and the testing process which was aimed to answer every problem. On the other hand, the subject DM was able to answer design A, design B, design C, and design D correctly, however, in design B, the subject did not explain that the length of the sloping side was more than 6 meters, so the length of fence of 32 meters would not be adequate to fence design B. This is following the opinion of Unaenah et al., (2020) that level 1 students (analysis) have not been able to prove their answers. This can be done if students are at level 3 (deduction). At this level, students have begun to be able to compile evidence formally. This means that at this level students already understand deductive-axiomatic thinking processes and can use these thinking processes (Crowley,

1987).

In the "creating" category, both subjects DM and MU have not been able to fulfill creating indicators, because they did not have problem-solving methods, formulate a new structure or way to solve the problem, and generalize an idea or point of view to a problem. Based on the opinion of Noriza & Kartono (2016) students at level 1 (analysis) cannot answer the problem correctly because they cannot develop a problem-solving plan correctly. Therefore, according to Crowley (1987) students at level 1 (analysis) cannot write the conclusion of problem-solving. Level 1 students (analysis) also cannot check results.

Based on the result of test number 1 and 2 along with the interview, the subjects in level 1 (analysis) did not fulfill all HOTS indicators (analyzing, evaluating, and creating). Since the students did not state proper reasons to support the conclusion, which was used during the process of conclusion.

## CONCLUSIONS

Based on the discussion, the researchers concluded that the higher-order thinking skill of students in completing geometry HOTS test according to Van Hiele's thinking theory at the analysis level has not been able to fulfill HOTS indicators

(Krathwohl, 2002). Through geometry HOTS test type, this research referred that the students with analysis level have not been able to fulfill HOTS indicators (analyzing, evaluating, or creating).

This research result is hopefully used as a source of information for other researchers who will do further investigation on the higher-order thinking skill for the higher thinking level based on Van Hiele's theory.

## REFERENCES

Abdussakir. (2009). Pembelajaran Geometri Sesuai Teori Van Hiele. *Jurnal Kependidikan dan Keagamaan. 11*(1).

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (2001). *A Taxonomy for Learning, Teaching, and Assesing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Addison Wesley Longman, Inc.

Asis, M., Arsyad, N., & Alimuddin. (2015). Profil Kemampuan Spasial Dalam Menyelesaikan Masalah Geometri Siswa Yang Memiliki Kecerdasan Logis Matematis Tinggi Ditinjau Dari Perbedaan Gender (Studi Kasus di kelas XI SMAN 17 Makassar). *Jurnal Daya Matematis*, *3*(1), 78–87.

Bakry, & Bakar, M. N. bin. (2015). The Process of Thinking among Junior High School Students in Solving HOTS Question. *International Journal of Evaluation and Research*

in Education (IJERE)*, *4*(3), 138–145. http://iaesjournal.com/online/index.php/IJERE

Burger, W. F., & Shaughnessy, J. M. (1986). Characterizing the van Hiele Levels of Development in Geometry. *Source: Journal for Research in Mathematics Education*, *17*(1), 31–48.

Crowley, M. L. (1987). The van Hiele model of the development of geometric thought. *Yearbook of National Council of Teachers of Mathematics*, 1–16. http://www.csmate.colostate.edu/docs/math/mathactivities/june2007/The van Hiele Model of the Development of Geometric Thought.pdf

Kim, Y. R. (2016). Analysis of Teaching of Van Hiele Geometry In Schools In Korea. *Proceedings of 4th International Congress of Educational Sciences and Development*, 21–25.

King, F., Goodson, L., & Rohani, F. (2018). *Higher-order thinking skills: Definition, teaching strategies, and assessment*. Center for Advancement of Learning and Assessment, Florida State University. www.cala.fsu.edu

Mohamed, R., & Lebar, O. (2017). Authentic Assessment in Assessing Higher Order Thinking Skills. *International Journal of Academic Research in Business and Social Sciences*, *7*(2), 466–476. https://doi.org/10.6007/IJARBSS/v7-i2/2021

NCTM. (2000). *Principles and Standars for School Mathematics*. The National Council of Teachers of Mathematics, Inc.

Noriza, M. D., & Kartono. (2016). Kemampuan Pemecahan Masalah Dan Disposisi Matematis Berdasarkan Tingkat Berpikir Geometri Pada Model PBL Pendekatan Van Hiele. *Seminar Nasional Matematika X Universitas Negeri Semarang*, 347–355. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/21608

Pitadjeng. 2015. *Pembelajaran Matematika yang Menyenangkan*. Yogyakarta: Graha Ilmu.

Putri, L. A., & Nopriana, T. (2019). Tingkat Berpikir Geometri Van Hiele Mahasiswa Pendidikan Matematika. *Prosiding Seminar Nasional Pendidikan Matematika*, 156–165.

Škrbec, M., & Čadež, T. H. (2015). Identifying and fostering higher levels of geometric thinking. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(3), 601–617. https://doi.org/10.12973/eurasia.2015.1339a

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif dan R & D*. Alfabeta.

Umar, U., Maulyda, M., Erfan, M., Hidayati, V., & Widodo, A. 2020. Profile Of Thinking Geometry Levels of PGSD Student Programs Based On Van Hiele Theory. *Integral : Pendidikan Matematika*, *11*(1), 33-41.

Unaenah, E., Anggraini, I. A., Aprianti, I., Aini, W. N., Utami, D. C., Khoiriah, S., & Refando, A. (2020). Teori Van Hiele Dalam Pembelajaran Bangun Datar. *Jurnal Pendidikan Dan Ilmu Sosial*, *2*(2), 365–374. https://ejournal.stitpn.ac.id/index.php/nusantara

Usiskin, Z. (1982). *Van Hiele Levels and Achievement in Secondary School*

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*Geometry*. Department of Education, University of Chicago.

Wu, D.-B., & Ma, H.-L. (2006). *The Distributions Of Van Hiele Levels Of Geometric Thinking Among 1$^{St}$ Through 6$^{Th}$ Graders* (Vol. 5).

Yen, T. S., & Halili, S. H. (2015). Effective Teaching Of Higher-Order Thinking (Hot) In Education. *The Online Journal of Distance Education and E-Learning*, *3*(2), 41–47. www.tojdel.net