# Epistemological Obstacle Of Students In Solving Hots Questions In Terms Of Van Hiele's Theory In Analysis Level

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**Abstract:** Lack of information regarding mathematical knowledge obtained by students can result in these students experiencing epistemological obstacles. The main goal of this study is to describe the epistemological obstacle faced by students Van Hiele's level of analysis when attempting to solve HOTS Questions. This study uses a qualitative, descriptive methodology. The instruments used are Van Hiele Geometry Test and HOTS questions. Data is collected through interviews and student work. the research subjects were two participants who have reached analysis level according to Van Hiele's theory in the 4th grade. In this study the data were analyzed by identifying the answers of 2 respondents to the indicators of epistemological barriers that had been done by the students, then interviewing the respondents. The results of this study were students who reached the level of analysis according to Van Hiele's theory encountered epistemological obstacles, such as conceptual, procedural, and operational technical obstacles, for various indicators. The difficulties and obstacles that these students encountered can be used as a guide when creating learning strategies, particularly for the content of geometry.

**Keywords:** Epistemological Obstacle, HOTS, Van Hiele.

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## INTRODUCTION

The evaluation that is being done should be able to demonstrate that the learning process from the previously prepared learning objectives has been successful. The assessment procedure used by instructors is outlined in the ministry of education's guidelines. According to the Ministry of Education's assessment rules, every test administered in schools must have helped students enhance their higher order thinking skills. his is not without reason, considering the achievements of Indonesian students showed unsatisfactory results on evaluations on an international scale.

Anderson & Krathwohl (2001) explained that higher order thinking skills (HOTS) are part of Bloom's Taxonomy which has been revised, which includes the ability to analyze (C4), evaluate (C5), and create (C6). The application of HOTS in learning activities in schools is a strategy that teachers can use to improve students' ability to make decisions and solve problems. Therefore, HOTS is also defined as the higher level of thinking process relating to complex matters by involving a lot of interpretations.

Mohamed & Lebar (2017) have asserted that the characteristics of HOTS test: 1) involving stimulus to induce conclusion drawing skill and critical reasoning, 2) involving more than one thinking to combine cognitive domains, 3) relating to unfamiliar contexts, 4) relating to real world situation, and 5) not repetitive. Hence, HOTS test is a collection of non-routine questions and a new problem for students which may need a sort of thinking to solve it.

Concerning to the higher order thinking skills (HOTS), the students need a way to develop their skills. For instance, to give the students math problem in form of HOTS type exercise. HOTS test is a collection of non-routine math questions or problems which demands HOTS components (Bakry & Bakar, 2015). The question that involves HOTS type tends to be complex and may intend to have a lot of solutions. Based on the preliminary research done by Bakry & Bakar (2015) in their research, the instruments of low, medium, and high power measurement can measure the student thinking while doing HOTS test that really differs. The students with a high order thinking

skills are able to realize creativity aspects, state opinion, and draw conclusion. The students with medium order thinking skill are able to realize two aspects, but not on conclusion drawing aspect. Meanwhile, the students with low order thinking skill are not able to realize two aspects, but they are able to express opinion.

The other previous research done by Ichsan (2019) has written that the higher order thinking skill of students is still at a very low category in all educational degrees. The other research done by Fani, Fauziana & Rahmiaty (2021) have concluded that the students encounter difficulties in answering HOTS test. It is because the students answer questions in a hurry, do not understand how to answer the question, and are not used to answer question, the low level of student concentration during learning process, the low level of student interest and knowledge in accomplishing HOTS (Higher Order Thinking Ability) type question, and the class condition which is not conducive that it will affect their concentration, also the lack of motivation from parent and the unsupported condition of family economy.

A lot of problems that can raise student difficulty in understanding the material are the examples of epistemological obstacle. According to Brousseau (2002), the cause of student learning difficulty may come from these three factors: ontogeny obstacle (mental readiness to learn), didactic obstacle (as the result of teacher teaching), and epistemological obstacle. The epistemological obstacle is a barrier in which the student knowledge has a limited context of application. The student who has a limited context of knowledge application will find difficulties in receiving new knowledge, since the student is only based on the existing knowledge he has. Moreover, the epistemological obstacle is a kind of obstacle that is hard for the students to avoid, because the epistemological obstacle itself is tied up in the concept or knowledge and this kind of obstacle can be analyzed from concept history or knowledge.

Another opinion stated by Elfiah, et al. (2020) that epistemological obstacle may grow due to the lack of student insight into a particular concept when receiving incomplete knowledge, so it can be a trouble for them to examine the concept relation or interrelation.In addition to giving geometry problem in form of HOTS type exercise, the students also need different treatment from the teacher. The teacher may distinguish treatments (learning model, method, or approach to the students) which usually tend to be similar for every student, even though the students have different learning and thinking method. A good geometry teaching should be in accordance to the level of student ability and skill.

To convey learning material, the teacher should put attention to the level of student skill. The teacher must also identify and recognize the level of student mental development and how the learning process should be implemented according to the student development level. One of education experts who has also concerned on the student skill level is Van Hiele. Musser, Burger & Peterson (2011) stated that the process of learning geometry at the elementary and secondary schools is inseparable from Van Hiele's theory. Van Hiele was a mathematics teacher who wrote a dissertation on teaching geometry in 1954. He came to the conclusion that there are five levels of understanding of geometry with each level is a prerequisite for rising to a higher level of thinking. The students will go through five thinking levels of Van Hiele: level 0 (introduction), level 1 (analysis), level 2 (informal deduction), level 3 (deduction), and level 4 (rigor) (Wu & Ma, 2006; Burger & Shaughnessy, 2016; Škrbec & Čadež, 2015).

According to Abdussakir (2010), every thinking level stated by Van Hiele will be passed by the students sequentially. Then, the students must pass each level carefully before they can continue to the following level.According to Van Hiele's theory, the higher order thinking skill of fourth grade students of elementary school in learning geometry has reached level 1, which is called as step of analytical thinking. This statement is based on Kim's opinion (2016) which has asserted that the majority of fourth grade students of elementary school have reached level 0 until level 1. The students who have reached level 1 of Van Hiele's theory are considered as passing level 0, thus, it refers that the students who reached level 1 of Van Hiele's theory also acquire knowledge containing in level 0. Shortly, it is denoted that if the students in level 1 at developmental level of thinking according to Van Hiele might also acquire skill in level 0, it is the skill to identify geometric shape and appearance (Vojkuvkova, 2012).

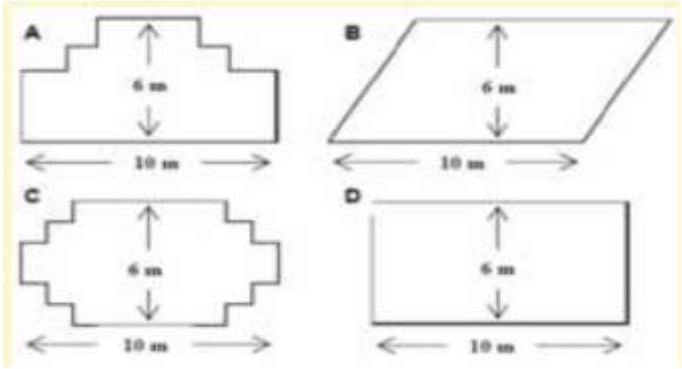
Based on the explanation, the researchers are intended to find out epistemological obstacles in answering HOTS test at the highest level of geometric thinking in fourth grade of elementary school, particularly in level 1 (analysis).

## METHOD

The research subjects were fourth grade elementary school students. The research was conducted in SDN 10 Batudaa. This research used descriptive qualitative method. The selection of research subject should consider Van Hiele's thinking level. After the students have been categorized in Van Hiele's thinking level, the researchers took two students who have reached level 1 (analysis) of Van Hiele's theory. The point in which student had a fluent and smooth communication was one of factors that should be considered in order to determine the research subjects.

The techniques of data collection in this research were test and interview given to the selected research subjects. This research used VGHT and HOTS test types. VHGT test was used to determine geometric thinking level of students developed by Usiskin (1982). The researchers then translated VHGT test to Indonesian, so it could be used easily. Based on the result of VHGT test, about two subjects who have reached level 1 (analysis) of Van Hiele's theory were selected, MU and DM. Next, the researchers gave HOTS test and conducted interview in order to clarify the student answer in answering HOTS test. The interview was aimed to find any epistemological obstacles that might be encountered by the research subjects. The activity in data analysis was divided into three steps: data reduction, data display, and conclusion (Sugiyono, 2015). The researchers used following test types:

A carpenter has about 32 meters of wood and wants to make fence around the garden. He is considering the design of garden fence. Please, answer "Yes" or "No" and give the reason for every garden design below




Which the garden designs that 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.

The indicators of epistemological obstacle that were used in this research:

**Table 1.** Indicators of Epistemological Obstacle

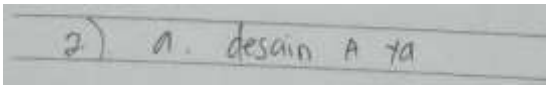
| No | Aspect Valued | Indicator | Code |
|---|---|---|---|
| **1** | Conceptual Obstacle | Inability to identify information from the question given | HK1 |
| | | Inability to determine the concept that fits to the problem | HK2 |
| | | Inability to convert the question into math model | HK3 |
| **2** | Procedural Obstacle | Inability to accomplish or answer the question as requested | HP1 |
| | | Inability to draw conclusion or even incorrect conclusion | HP2 |
| **3** | Operational Technique Obstacle | Do not recheck the result of work | HT1 |
| | | Make mistake in calculation | HT2 |

Source: (Muslich, 2022)

**RESULTS**

All samples given in Van Hiele Geometry Test are aimed to examine Van Hiele's thinking level of students. Based on this information, the researchers determine about two research subjects who have reached level 1 (analysis) of Van Hiele's theory to receive HOTS test. After the subjects doing the test, the next step is a direct interview conducted by the researchers. Based on the result of analysis, the researchers take about two subjects who have achieved level 1 (analysis) of Van Hiele's theory. The selected subjects are RH and AI. The following table will show the result of HOTS test of students who have reached level 1 (analysis) according to Van Hiele's theory (Table 2)

**Tabel 2.** Result of Geometric HOTS test of students in level 1 (Analysis)

| Subject's Answer | |
|---|---|
| **Subject RH** | **Subject AI** |
|  |  |

The following is an analysis which is aimed to define epistemological obstacle of students in doing HOTS test who have reached level 1 (analysis) according to Van Hiele's theory.

***Conceptual Obstacle***

On the indicator of conceptual obstacle, the researchers have only found this indicator in subject RH. The indicator of conceptual obstacle experienced by HK2 is found when the subject is not able to determine the concept that fits to the problem, while the subject RH is able to answer design A correctly, but reason is not written correctly and absence of answer evidence. This condition shows the lack of understanding of subject RH on the concept.

***Procedural Obstacle***

The indicator of procedural obstacle is found in subject RH. Two indicators of procedural obstacle which has been experienced by the subject RH are HP1 and HP2, in which the subject does not answer the question as requested and write or even make mistake in conclusion drawing. Next, on the indicator HP1, the subject answers question within design A correctly, but the subject does not answer questions for design B, C and D. On the indicator HP2, referring to the result of answer, subject RH is not able to draw conclusion.

***Operational Technique Obstacle***

Indicator of operational technique obstacle is found in both subjects RH and AI. The indicators of operational technique obstacle that has been experienced by subject RH are HT1 and HT2. On the indicator HT1, subject RH does not recheck the work because the subject is confident with the answer that might result in a mistake in drawing the conclusion, even though recheck activity is an important thing to ensure the correctness of written answer. On the indicator HT2, subject RH does a mistake in calculation, thus the subject cannot answer correctly for design B, C, and D. Further, the indicators of operational technique obstacle that has been experienced by subject AI are HT1 and HT2. On the indicator HT1, subject AI does not recheck steps of question solving which then results in a mistake in determining the answer for design B. Meanwhile on the indicator HT2, subject AI does a mistake in calculation while determining the answer for design B. the subject AI does not explain that the length of slanted side is obviously more than six meters, therefore the length of fence which is around 32 meters will not be enough to fence design B. Moreover, the subject AI admits the lack of thoroughness in calculation, which is the reason the subject AI does not recheck the answer.

## DISCUSSION

Based on the description result from two research subjects, it refers some epistemological obstacles made by fourth grade students of elementary school in answering HOTS test. This result shows that fourth grade students of elementary school might find difficulty in solving HOTS question. Moreover, this result is in line with the opinion stated by Fani, Fauziana, and Rahmiaty (2021) that the difficulty encountered by students in answering HOTS test is affected by the situation that the students answering question in a hurry also a lack of student concentration and knowledge in answering HOTS test.

Relating to conceptual obstacle, the students are not able to determine concept that fits to the problem. This situation is caused by a lack of student understanding on the concept of geometric materials. As in line with a preliminary research done by Sholihah & Afriansyah (2017), the students who have reached level 1 (analysis) might find difficulty in understanding quadrilateral concepts and properties, a lack of understanding of prerequisites, and a lack of skills in using geometric ideas in order to solve math problems that are relating to quadrilateral.

Procedural obstacle which is found in this research refers to the subjects who do not accomplish the question as requested. This finding is in line with previous research done by Fitriani (2020) which has written that the students who reach level 1 (analysis) might find difficulty skill hierarchy problem. This kind of mistake is related to student skill and competence in accomplishing the test. This matter is correlated to the result of answer that is not accordance to the question order, in which the students do not write answer perfectly. The following procedural obstacle found in this research is that the subjects are not able to write conclusion or making mistake in conclusion drawing at the end of answer. This finding is in line with another previous research done by Ain, Baidowi & Hapipi (2020) which has referred that although the students are able to write conclusion, there are still many inaccurate conclusions.

The last epistemological obstacle is operational technique obstacle. Particularly, the indicator of operational technique obstacle discussed in this research relates to the students who do not recheck their answer and even make a mistake in calculation. The indicators in this obstacle are interrelated, since the calculation error is occurred because the students do not recheck their answer. This finding is in line with the research result concluded by Ain, Baidowi ,& Hapipi (2020) that the students who reach analysis level according to Van Hiele's theory are already able to do steps of problem understanding, planning, and practice of the plan. However in the recheck step, the students are not able to reexamine the result of their question solving and convince themselves that the result of question solving is done correctly.

## CONCLUSION

Based on the research result and discussion that have been described above, epistemological obstacle in answering HOTS test according to Van Hiele's thinking theory, especially analysis level is experienced by this research subjects. The research subjects

experience conceptual, procedural, and operational technique obstacles in different indicators. The epistemological obstacle encountered by students refers to conceptual obstacle, in which subject RH is not able to determine concept that fits to the problem. On the procedural obstacle, subject RH is not able to accomplish the question as requested and write or make a mistake in conclusion drawing. Next, on the operational technique obstacle, either subject RH or AI does not recheck the result of work and make error in calculation. The suggestion that can be given concerning to this recent research result, within mathematic learning, the teacher should provide a special concern and focus to students based on Van Hiele's thinking order theory by frequently giving HOTS questions. Moreover, epistemological obstacles that have been found in this recent research can be used to do evaluation of math learning, especially in order to improve skills in answering HOTS test.

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