

PAPER • OPEN ACCESS

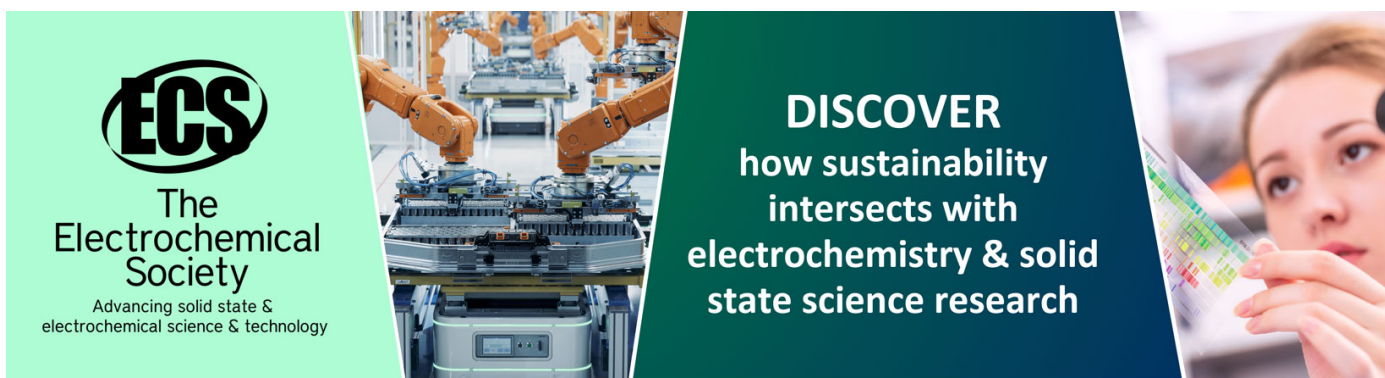
## Analysis Students' Thinking Level with Cognitive Style "Field Independent" Based on Van Hiele Theory

To cite this article: Firdha Razak *et al* 2018 *J. Phys.: Conf. Ser.* **1028** 012161

View the [article online](#) for updates and enhancements.

You may also like

- [Geometric Thinking Skills of Seventh Grade Students on the Topic of Triangle and Quadrilateral Based on Van Hiele Geometry Learning Theory](#)  
Naja Nusaibah, I Pramudya and S Subanti
- [Student creative thinking process in solving geometry problems based on van hiele level](#)  
N Agustiningsih, Susanto and N Yuliaty
- [Analyzing the student's cognitive abilities through the thinking levels of geometry van hiele reviewed from gender perspective](#)  
A Maharani, H Sulaiman, Saifurrohman et al.



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# Analysis Students' Thinking Level with Cognitive Style "Field Independent" Based on Van Hiele Theory

Firdha Razak\*, Ahmad Budi Sutrisno, Zam Immawan, Sitti Busyrah Muchsin

Department of Mathematics Education, STKIP Andi Matappa, Pangkep, 90611, Indonesia

\*firdarazak@yahoo.com

**Abstract.** This is a qualitative descriptive research that aims to describe students' thinking level based on Van Hiele theory on three dimensional materials by considering cognitive style. The subjects of this study were 2 students of class XII in SMAN 1 Pangkajene representing Field Independent (FI) cognitive style. The instruments used were GEFT (Group Embedded Figure Test), geometry test and interview guidelines. The GEFT test distinguished students' cognitive style for finding FI. Geometry test was according to indicators of thinking level which is based on Van Hiele theory. The interview guidelines contained a number of guides that aimed to explore and clarify students' answers in depth. Data were collected through tests and interviews and analysed using Miles and Huberman data analysis model. The result of the study shows that: first subject and second subject (FI-1 and FI-2) are at the "deduction level". The difference between the both subjects is the number of verification method performed. FI-1 was able to verify deductively through two ways while the subject of FI-2 is only capable of one way.

## 1. Introduction

Geometry occupies a special position in the mathematics curriculum, because many concepts contained in it. Based on observations at SMAN 1 Pangkajene (Senior High School in Pangkajene), geometry occupies the position of the most alarming when compared with other mathematical material. One of the geometry materials that students studied in grade XII high school is the three-dimensional in which this material is very difficult to understand. It is because of the abstract concept and also the lack of student's skills in drawing three-dimensional figure.

The theory of Van Hiele [1] describes that students will go through five levels of thinking in studying and understanding about geometry. Each level of thinking has certain criterion which shows the differentiation of students' understanding in solving geometry problems. The difference in students' understanding to compile and process geometry information is due to differences in cognitive levels. The cognitive style refers to the people' way to get information and to use strategies in responding a task. It is called "style" and not as "capability" because it refers to how people process information and solve problems instead of referring to how best they are. Winkel in Abdul Rahman [2] defines that cognitive styles are the typical way used to observe and perform mentally in the cognitive field. Thus, this study aims to analyze the level of students' thinking in geometry based on Van Hiele theory by considering the cognitive style.



## 2. Theoretical Review

### 2.1 Thinking Level in Geometry Based on Van Hiele Theory

Ahmad Syafi [3] describes the thinking level based on Van Hiele theory as follows:

- Level/ Stage 0 (Visualization). This stage is also known as the basic stage, recognition stage, holistic stage, and visual stage.
- Level/ Stage 1 (Analysis). This stage is also known as the descriptive stage. At this stage appears the analysis of the concept and its properties.
- Level/ Stage 2 (Informal Deduction). This stage is also known as abstract stage, abstract/ relational stage, theoretical stage, and linkage stage.
- Level/ Stage 3 (Deduction). This stage is also known as the formal deduction stage. At this stage it contains evidences, not just receiving the slightest evidence.
- Level/ Stage 4 (Rigor). This stage is formal reasoning student in mathematics. They can analyze the consequences of the manipulation axioms and definitions.

### 2.2 Indicators of Thinking on Three-Dimension Material

Alex and Memmen [4] classify the indicators of thinking level on three-dimension as follows:

- Level 0 Visualization. In this level students are able to: a) identify geometry based on the form, b) determine example and non-example, c) draw, write and identify the parts of geometry figure.
- Level 1 Analysis. In this level students are able to: a) describe project points and lines on plane, b) compare the point projection on plane and line in plane, c) solve problems involving project point and line on plane.
- Level 2 Informal Deduction. In this level students are able to: a) determine the distance between point, line and plane, b) understand the equivalent form of a definition, c) use concept of implication, d) solve problems that related to point, line and plane.
- Level 3 Deduction. In this level students are able to: a) understand some mathematical statements such as axioms, definitions, theorems and evidence, b) construct a deductive proof.
- Level 4 Rigor. At this stage, students can reason formally in mathematical systems and can analyze the consequences of manipulation of axioms and definitions. The interrelation between undefined forms, axioms, definitions, theorems and formal proofs can be understood. Students at this stage already understand why something is made to be a postulate or theorem. For example they know the importance of axioms or postulates in Euclid geometry. This level is complex and high order thinking.

The indicators of thinking level base on Van Hiele theory only presented to level 3 (deduction). It is considered because the research was conducted in grade XII of SMA such that it has not been able to understand the material at level 4 (rigor).

### 2.3 Cognitive Style

The cognitive style in this research is Field Independent (FI). According to Winkel in Rahman [2] the characteristics of FI are: a) less affected by the environment and education in the past, b) be educated to stand alone and have autonomy for his actions, c) speak quickly and sometimes ignore the others, d) less concern on social relationships, e) appropriate for positions in mathematics, science, engineering, f) faster choosing the major field, g) more likely to choose individual learning, respond well, and independently, (h) can achieve goals with intrinsic motivation, i) no need for detailed instructions, and (13) accept criticism for improvement.

## 3. Research Method

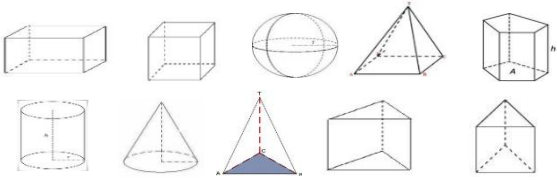
The type of this research is qualitative descriptive research. This research was conducted in SMA Negeri 1 Pangkajene (Senior High School in Pangkajene). The subjects were two students of grade XII. The instruments used in this research were a) GEFT (Group Embedded Test Group), b) geometry

test and c) interview guidelines. The data collection process in this research conducted through geometry test and interview. To get the data validity, the researcher used triangulation method using Miles and Huberman model [5].

#### 4. Result

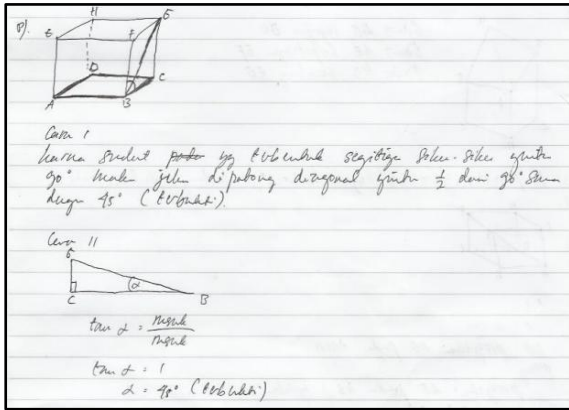
From the result of the research on geometry problems number 1, 2, 3, 4 and 6 it is seen that both FI-1 and FI-2 students are able to mention the name of dimensional figure, differentiate and classify the type of them, give examples of parallel, intersecting and aligned lines. The test of geometry can be seen in the following table.

**Table 1.** Geometry Test

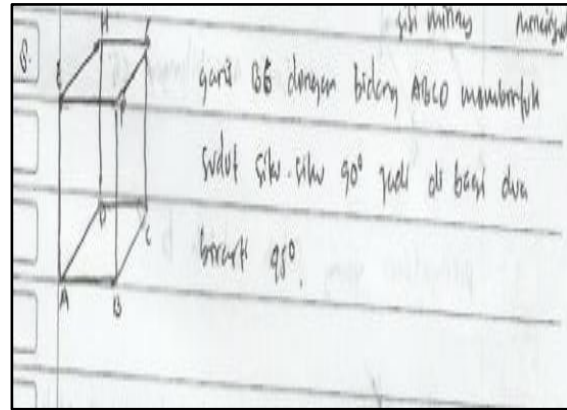
| No | Problems                                                                                                                                                                                                                                                                                                                 |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  |  <ol style="list-style-type: none"> <li>Name all above space.</li> <li>From the space, classify the prism.</li> </ol>                                                                                                                  |
| 2  | Sketch cube ABCD.EFGH, then determine: <ol style="list-style-type: none"> <li>Parallel lines</li> <li>Intersection lines</li> <li>Aligned lines</li> </ol>                                                                                                                                                               |
| 3  | Which are the false statements? <ol style="list-style-type: none"> <li>Projection of line to pale is a dot.</li> <li>Projection of line which intersects to plane is a line.</li> <li>Projection of line which parallel with plane is a line.</li> <li>Projection of line which intersects to plane is a dot.</li> </ol> |
| 4  | Given cube ABCD.EFGH which has length 10 cm. Determine projection AG to ABCD!                                                                                                                                                                                                                                            |
| 5  | Explain how to determine the distance between lines which parallel with a plane?                                                                                                                                                                                                                                         |
| 6  | Given a cube ABCD.EFGH which has length 12 cm. Determine the distance between: <ol style="list-style-type: none"> <li>Line BF to plane ACE</li> <li>Line BG to plane ABCD</li> </ol>                                                                                                                                     |
| 7  | Is it important to understand about definition, theorem, and axioma in determining the angle between line and plane, or between line and line? Give an example!                                                                                                                                                          |
| 8  | Prove that the angle between line BG and plane ABCD is $45^\circ$ !                                                                                                                                                                                                                                                      |

Both of subjects also can distinguish point, line and plane projection, find the length of projection and they were able to find the distance between the line and plane though in different ways but giving correct answer. In question number 5 it appears that both of these subjects were able to explain the

steps of solving the problem even though the FI-2 subject can explain it in a more detailed way. In number 7, it can be seen that both of these subjects were able to give reasons for the importance of definitions, axioms and theorems in determining the magnitude of angles and fields. While on the question number 8, it can be seen that Subject FI-1 can prove theoretically and explain by the theorem.



**Figure 1.** FI-1's answer for question 8



**Figure 2.** FI-2's answer for question 8

## 5. Discussion

Based on the data analysis, the difference of two subjects is the number of ways of verification. The first Field Independent (FI-1) student was able to prove deductively through two ways of verification that is using the concept of angles formed between the diagonal lines of the plane and by using the concept of tan theorem that is (front /side). The second Independent Field (FI-2) subject was only able to prove deductively through one way of verification that is the angle formed between the diagonal lines of the plane.

From the results of the research and also according to Piaget theory, it shown that high school students who have age more than 11 years have been in formal operation stage. This is in accordance with Level 3 in the level of thinking on the Van Hiele theory which is formal deduction. In this level, students have been able to compile the evidence deductively. Besides the age factor, the cognitive development that individuals achieve is influenced by their environment and social life. It causes the level of cognitive development achieved by each individual is different. These affect the differences in the way both subjects studied in the study.

In short, it can be concluded that both subjects of Field Independent (FI) were at the level of deduction because the subject can arrange information to prove deductively. Then, the tendency of high school students for the Field Independent cognitive style tends to be at the level of deduction. So the teacher in the learning process of mathematics especially in teaching the material geometry can consider the level of thinking and cognitive style of students. They can learn mathematics concepts not only by memorizing but the students really can understand the material taught. This is in line with Uno Hamzah [5] opinion that teachers should know the level of mental development of children and how the lessons should be done in accordance with the stages of development.

## References

- [1] Jumriani 2014 *Analisis Tingkat Berpikir Siswa Berdasarkan Teori Van Hiele Pada Materi Pokok Dimensi Tiga Ditinjau Dari Gaya Kognitif* (Makassar: Universitas Negeri Makassar) p 37
- [2] Rahman Abdul 2008 *Analisis Hasil Belajar Matematika Berdasarkan Perbedaan Gaya Kognitif Secara Psikologis dan Konseptual Tempo pada Siswa Kelas X SMA Negeri 3 Makassar Jurnal Pendidikan dan Kebudayaan* p 32
- [3] Ahmad Syafi 2014 *Indikator Berpikir Van Hiele* p 7-30.

- [4] Alex & Memmen 2012 *A Survey of South African Grade 10 Learners' Geometric Thinking Levels in Terms of The Van Hiele Theory* Anthropologist vol **14** p 123-129.
- [5] Uno Hamzah B 2010 *Orientasi Baru dalam Psikologi Pembelajaran* (Jakarta: PT. Bumi Aksara) p 27