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GRADUATE PROGRAM
University of PGRI Adi Buana Surabaya,
Indonesia
Published by: Jl. Dukuh Menanggal XII/4 Surabaya 60234,
INDONESIA
Telp./Fax: +62 31 8273999
Website: http://www.pps-unipasby.ac.id

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IMPLEMENTATION OF VAN HIELE’S PHASES OF LEARNING MATHEMATICS

Restu Ria Wantika
Mathematics Education Department
Faculty of Teacher Training and Education
University of PGRI Adi Buana Surabaya
resturiawantika89@gmail.com

ABSTRACT
The lack of understanding on the concepts of Geometry from elementary schools to university is presumably because the approach to learning Geometry does not consider the level of students’ progress and the learning materials of Geometry does not correspond to the level of students’ thinking or construction of material classes are not in accordance with the formal geometry construction. One theory which is fundamental for use in learning geometry and the focus of discussion in this study is the use of the Van Hiele Theory. The aim of this paper is to provide an overview of the implications of learning Geometry at the college level based on the phases of learning by Van Hiele. The Van Hiele Theory divides the phases of student into the phases of visualization, analysis, informal deduction, deduction and rigor. While the Van Hiele phases of learning are divided into the stages of inquiry, directed orientation, descriptions, free orientation, and integration. Examples of learning Geometry in this paper is the study of Geometry in universities based on the phases of learning by Van Hiele.

Keywords: Geometry learning, Van Hiele phases of learning

INTRODUCTION
For most, geometry is still among the most dreaded of subjects. There are still many students who have difficulty understanding the concepts of geometry. Budiarto research (2006) showed the results that 22% of the 54 students used “that will be proven as the unknown”, in addition to 19.4% of the 42 middle and high school teachers in Surabaya had difficulty resolving problems "prove that ..." In another study 24% of the data obtained from 62 students in a geometry lesson, they could not write what was known and what was being asked of the problems given and the student misconceptions in understanding the concepts of geometry. The research findings by Budiarto (2006) showed that the students made mistake in analyzing the matter. It is seen from the students’ lack of attention to the presence or absence of information on a given problem. In solving the problem it was not uncommon for the students not to know what was known and what was to be proved on a given problem. The students could not use what was known or used what would prove to be known. The students just understood the geometry in a moment of time.

The Van Hiele theory of geometric thought describes the different levels of understanding through which students progress when learning geometry. The Van Hiele model for the theory of geometric thought consists of five levels: Inquiry / Information, Direct Orientation, explication, Free Orientation, Integration. (Yazdani, 2008: 60). In the first phase, i.e. Inquiry/Information, teachers and students discuss topics and ask a few questions to the students. In the second phase, i.e. Direct Orientation, students explore the topic. In the third phase or Explication students begin to form relationships explication about the topic. In the fourth phase or Free Orientation the students work independently to resolve more complex problems. In the fifth stage or Integration of students summarize and review on a particular topic.

Casbari (2001) conducted a study with the result that the use of the Van Hiele approaches in mathematics learning could improve the students’ learning achievement and motivation and learning of mathematics provided more enjoyable teaching and learning atmosphere (class atmosphere). Husnaeni conducted a research of which the result was that the Van Hiele theory could be applied in learning to stabilize the initial conception of the same.
students with the scientific concept of triangle. The learning implementation in accordance with the theory of van Hiele leads students to change the improper conception of and easier for students to release her intuitive knowledge towards the establishment of the conception of the same geometry with scientific concepts. The purpose of this paper is to provide an overview of the implications of learning geometry in colleges based on the stages of learning of Van Hiele.

RESEARCH METHOD

This study is a literature review obtained by gathering information relevant to the topic that is in line with the purpose of research, in this study the steps being taken is to collect information from journals associated with the Van Hiele theory.

RESULTS AND DISCUSSION

The Implications of the stages of learning geometry by Van Hiele in college are as follows.

A series of learning can be realized with concrete objects, pictures, diagrams and symbols. Students are better able to absorb the formal and abstract concepts of mathematics directly rather than concrete objects having been imagined. Fuys (1988) in Husnaeni (2001) states that to help students pass the stage of thinking of a next step in learning geometry to the necessary learning experience according to the stages of student thinking. The process for control of ideas or mathematical concepts is time consuming and relevant stages. One hypothesis proposed deductively about student progress and related to learning mathematics, especially in geometry is the theory of the development of thought by Van Hiele. According to Van Hiele (Yazdani, 2008: 60-61), a person will go through five stages of development of thinking in learning geometry. The five stages of development of thinking by Van Hiele are visualization, analysis, informal deduction, deduction, and rigor. This shows the characteristics of each stage of the thinking process in understanding the geometry. All the five of these stages can be explained as follows:

1. Level 0 (Visualization), the students see geometric figures as a whole, but they cannot identify the properties or review these figures. The students see geometric shapes as a whole, but they cannot identify the properties of the shapes. The students at this level are familiar with geometric shapes such as rectangular, square, parallelogram, trapezoid, etc. Based on the form of the display of the shapes that are real, the students in this level has not been able to characterize the shapes that are the opposite sides of the rectangle are the same. The students in this level are also unable to accept the properties or geometry concepts in understanding, but they merely rote.

2. Level 1 (Analysis). The students can identify the figures and their properties, but they cannot see the interrelationship between different figures, and they also cannot understand definitions. The students can identify shapes and their properties, but they cannot see the connection between different shapes, and they cannot understand the definition. The students at this level already know the properties of a quadrilateral (rectangular, square, parallelogram, trapezoid, etc.) as the four sides of a square of the same length, the two opposite sides of a rectangle of the same length, but have not been able to demonstrate the relationship that square is a rectangle or a rectangle is a parallelogram.

3. Level 2 (Informal Deduction). The students can use definition but they cannot construct a proof. The students can use the definition, but they cannot establish the proof. The students in this level have been able to demonstrate the relationship between waking up flat like a square is a rectangle, the rectangle is a parallelogram. In this level the students have also been able to determine the structure of the flat rectangular shapes. In addition, the students are able to think deductively and can form a geometric structure which is abstract, although informal nature.

4. Level 3 (Deduction), the students can construct a proof but they cannot understand the rigor of geometrical methods. The students can build evidence but they could not understand the rigor of geometry methods. The students in this level can already be formally invited to think deductively. Evidence of a theorem is no longer proved by using inductive but entirely.
deductive by using elements such as understanding the base of geometry, axioms, definitions and theorems, although not yet truly understand why the axiom is raised. The students in this level have not been able to determine whether the axiom used is appropriate or not in the geometrical structure is concerned.

5. Level 4 (Rigor), the students understand the geometric methods and generalize the geometric concepts at this level. Also they are capable of problem solving. The students understand the geometric method and generalize geometric concepts at this level. They are also able to solve the problem.

Van Hiele believes that a higher level is not obtained through teacher lectures, but through the selection of proper exercise. Therefore Van Hiele offers the five stages of learning sequence and a teacher’s role in managing the learning process, namely (1) Enquiry, (2) Guided Orientation Guided, (3) Description, (4) Free Orientation, and (5) Integration. All of these stages are described as follows: The first phase: Inquiry/Information- teacher and student and teacher discusses the topic and asks some questions from the students. The teachers and students to discuss the topic and the teacher asks a few questions from the students. At the beginning of this level, the teachers and students to use questions and answers about objects studied at the stage of students thinking. The teachers ask questions to students while making observations. The purpose of this activity is: (1) the teacher studies the initial experience of the students on the topics discussed. (2) the teacher in the instructions that appear in order to determine future learning to be taken; The second phase: Direct Orientation- the properties of figures are investigated experimentally. The properties of the form are investigated experimentally. The students explore topics learned through tools carefully prepared by the teacher. This activity will gradually reveal to students the structure of the desired material. The equipment or materials is designed into short tasks that can bring specific responses; The third stage: Explication- the students are beginning to form a network of relations regarding the topics being studied. The students begin to form a network of relationships on the topic being studied. The students express the view that emerges about the structure observed. In addition, to help students use language precisely and accurately, the teacher provides assistance as little as possible. It lasts until the system of relations at the stage of thinking begins to seem real; the fourth stage: Free Orientation- the students work independently more complex problems. The students work independently to resolve more complex problems. The students face more complex forms of tasks that require many steps, a task that comes with a lot of ways, and open-ended tasks. They gain experience in finding their own way, and in completing tasks. Through orientation among students in the areas of investigation, many relationships between objects become clear. This learning phase aims to enable students to gain experience in solving problems and using his strategies alone. The teacher’s role is to choose the material and appropriate issues to get the learning that enhances the acquisition of a wide range of student performances; the fifth stage: Integration- using summaries and reviews, the students integrate reviews of their knowledge about a specific topic. Using the summary and review, the students integrate their knowledge of a particular topic. The students revisit and summarize what they have learned. The teacher can help students in making this synthesis to complement global survey on what they have learned.

The purpose of this learning phase is to interpret the knowledge of what has been observed and discussed. The teacher’s role is to help interpretation of the students' knowledge by asking the students to make a reflection and clarify the knowledge of geometry, as well as strengthen the pressure on the use of mathematical structures.

Here is an example of the implementation of the stages of learning by Van Hiele in parabolic material in the course of Analytical Geometry for class of 2015 to the achievement of the course and the following indicators.

Achievement subjects: Ability to resolve problems related to the parabola

Indicators: The accuracy in determining the equation of the parabola
Table 1 Stages of learning of Van Hiele and learning activities

<table>
<thead>
<tr>
<th>Learning phases</th>
<th>Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 Inquiry/Information</td>
<td>The teacher makes questions and answers exploration or gains knowledge/concepts that students have understood before presenting about parabola. To lead to the learning objectives, the questions are directed at understanding of the parabola that has been studied previously.</td>
</tr>
<tr>
<td>Phase 2 Directional orientation</td>
<td>The students are divided into groups. Each consists of 4-6 students. Each group is given a worksheet about parabolic equation. The teachers lead the students to explore the information contained in the worksheet to identify the components to find the equation of parabola.</td>
</tr>
<tr>
<td>Phase 3 Explication</td>
<td>By using question and answer the teacher asks the students to explain what information is obtained from the worksheet. Together the students identify and find a parabola with a peak (0,0)</td>
</tr>
<tr>
<td>Phase 4 Free orientation</td>
<td>The teacher asks the students to find the equation of a parabola with a peak (a, b) by using the worksheet guided by the information obtained previously.</td>
</tr>
<tr>
<td>Phase 5 Integration</td>
<td>The students summarize and review what has been learned about the parabolic equation.</td>
</tr>
</tbody>
</table>

CONCLUSION
The stages of learning as modeled by Van Hiele constitute a stage of learning in mathematics, especially geometry. The implication of this theory is explained through the example of learning geometry in colleges that are expected to contribute to the teachers or lecturers as one approach to teaching geometry in order to make learning more effective and meaningful.

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Restu Ria Wantika born in Surabaya on November 22, 1989. In 2011 graduated in Mathematics Education in the Department of Mathematics Education, FMIPA, Surabaya State University. In 2015 graduated as a master of mathematics, FMIPA, ITS. Now working as a lecturer of Mathematics Education at the University PGRI Surabaya.

Adi Buana