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Van Hiele's Theory: Transforming And Gender Perspective of Student's Geometrical Thinking

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Abstract. The purpose of this study was to identify the level of geometrical thinking of junior high school students in Bantul District using the Van Hiele test. The research approach was descriptive qualitative. The research subjects were students in grades VII and VIII in 4 junior high schools in Bantul district. The supporting instruments in this study were tests consisting of 25 multiple choice questions developed by Usiskin. Data were analyzed descriptively and qualitatively through several basic statistics. The results showed that there were 59.15% of students at the visualization level, 8.62% of students at the analysis level, and 1.42% of students at the informal deduction level. While the remaining 30.81% is in the previsualization category. In addition to the above categories, there were several students whose geometric thinking level was in the transition level category. The number of students who meet the criteria for the pre-analysis level and pre informal deduction level was 9.33% and 2.72% respectively. While viewed from a gender perspective. In general, Van Hiele's geometrical thinking level of male and female respondents did not differ much but male respondents had the potential to increase their geometry thinking level more than female respondents.

1. Introduction

Geometry is a field of mathematics studies that has existed since BC. The first manuscript describing geometry was entitled the Elements, the famous geometry book written by Euclid around 300 BC. In the prevailing curriculum in Indonesia, Geometry as part of mathematics studies has been taught since elementary school. Even since childhood, students have been taught with geometric structures even though they are still in the form of recognition. If geometry is part of mathematics, geometrical thinking is needed in problem-solving. While problem-solving is the life of mathematics learning [1]. So reversible thinking is important and must be considered so that students' ability to solve problems can be maximized. In learning geometry, a good logic of thinking is needed in order to understand the concepts and rules that exist and to develop the ability to thinking of geometry. Learning geometry can train logical thinking skills, systematic, thorough and creative [1]. These skills are needed to study other fields of mathematics studies and to solve problems in everyday life.

The theory of van Hiele consists of two-part, the first one is the level of thinking and the second one is the phase of learning [2-4]. The level of thinking describes the way of thinking that can be found in the students' geometry. According [2-3], [5-10] the geometry thinking split into five successive levels:

a. Level visualization, which begins with nonverbal thinking. The student identifies, names, compares and operates on geometric figures (e.g., triangles, angles, or intersecting) according to their appearance
b. Level Analysis. In this level, Figures are the bearers of their properties. A figure is no longer judged because "it looks like one" but rather because it has certain properties. The student analyzes figures in terms of their components and relationship among components and discovers properties/rules of a class of shapes empirically (e.g. by folding, measuring, using grid or diagram).
c. Level Informal deduction. The student logically interrelates previously discovered properties/rules by giving or following informal arguments.
d. Level Deduction. The student proves theorems deductively and established interrelationships among networks of theorems.
e. Level Rigor. The students establish theorems in different postulation systems and analyze/compares these systems.

There is two types of numbering level of geometry thinking [9], van Hiele level 0 to van Hiele level 4 is according to the original work by Van Hiele, anda van Hiele level 1 to van Hiele level 5 which was adopted by Americans. In the letter case, Clement and Batista [8] suggested the existence of van Hiele level 0 called pre-recognition. Which student couldn't fulfill all levels 1 -5 [4]. In this level, students couldn't distinguish shapes due to the limited spatial visualization ability [8-9].

The second part of the van Hiele theory, the phase of learning, is a suggestion on how to organize the teaching of geometry. The phase of geometry learning in the van Hiele model are information, guided orientation, explicitation, free orientation and integration [9].

Several researchers report that geometry learning is still far from expectations which are characterized by a low understanding of students [11]. Empirical evidence in the field shows that there are still many students who lack an understanding of the concepts of geometry [1],[12]. This is reinforced by the level of students' geometrical thinking that has not been satisfactory in some school [11], this is like in junior high school in Ghana which there are 61,91% students in van Hiele level 1 (analysis) [4]. All of the research focuses on leveling students' geometry thinking according to Van Hiele theory both as a whole and at the grade level. Not many discussions about Van Hiele's geometry thinking level were seen from a gender perspective [13]. Therefore, it is necessary to identify the level of geometry thinking of junior high school students from a gender perspective.

2. Method

This research is a quantitative descriptive study. The research subjects were taken from students of class VII and VIII of 4 junior high schools in Bantul Regency totaling 847 students consisting of 495 male students and 352 female students. Data collection used test questions that were adopted from the van Hiele geometry (VHGT) test developed by Usiskin [14]. Many researcher [1],[4],[9],[13] used this VHGT.The test was designed to measure the order of geometry thinking levels based on van Hiele's theory and was constructed to classify students into five levels of geometrical thinking. The test consists of 25 items which every 5 items measure the level of Van Hiele's geometry thinking from level 1 – 5 [14]. The criteria for determining geometry thinking level are set by the following rules [1], [15]:

(1) Students are classified at the n^{th} level if: at least 3 out of 5 items are answered correctly at the n^{th} level and each previous level.
(2) Students are classified as transition levels between n^{th} and $(n + 1)$ levels if:
    a. at least 3 out of 5 items are answered correctly at the n^{th} level and each previous level, and

b. 2 of the 5 items answered correctly at the level (n + 1)

(3) Students can't be classified at the n^{th} level if only correct maximum 1 except on the visualization test (number 1 to 5) then students will be classified at the pre-recognition level.

Research data were analyzed descriptively using basic statistics.

3. Result and discussion

After analyzing the data from the Van Hiele geometry thinking test results and calculating the results of each level of thinking, the results obtained were that the level achieved by the respondents was at the level of visualization, analysis, and informal deduction. The following is the result of the respondent's overall geometry thinking level.

Table 1
Student's geometry thinking level

Level	%
Pre-recognition	30,81
Visualization	59,15
Analysis	8,62
Informal deduction	1,42
Deduction	0,00
Rigor	0,00
Total	**100**

Based on table 1 above shows that more than half of the respondents are still at the visualization level (59.15%). The level of analysis was only achieved by 8.62% of respondents. While the highest level achieved by respondents is the level of informal deduction where there are only 12 students who meet this level (1.42%). As for 30.81% of respondents still did not meet the criteria of geometry thinking leveling according to Van Hiele so that they were categorized as a pre-recognition level category. This is because the respondent's answer results are not consistent towards a certain level so that their level cannot be categorized according to the Van Hiele geometry thinking category [1],[4]. This inconsistency is possible because respondents did not seriously answer the Van Hiele Geometry thinking test, cheat other friends or answer carelessly.

Table 1 indicates that the average development of geometry thinking of junior high school students in Bantul is still at the visualization level. This reinforces the findings [4] that junior high school students have not yet reached the Van Hiele level of thinking that should be achieved, namely at the level of informal deduction. This finding also increasingly emphasizes that for the level of students in higher education the level of thinking geometry is still at the level of analysis [1]. Of course, this is not an encouraging result. Therefore, it is necessary to improve geometry learning by referring to the Van Hiele theory.

In addition to the above levels, there are 12.05% of respondents whose geometric thinking ability is between two levels and almost rises to the next level so that it is included in the transition level category. The following is the percentage of respondents who have the ability to think geometrically to enter the transition level.

Table 2
The transition level in geometry thinking

Level	%
Pre-analysis	9,33
Pre informal deduction	2,72
Total	**12,05**

From table 2 it can be seen that the number of respondents at the transition level was the biggest at the pre-analysis level (9.33%) while the pre-informal deduction transition level was achieved by 2.72% of the total respondents. With appropriate geometry learning, the level of thinking of the geometry of respondents who are at this transition level is possible to be upgraded to a level above it. In addition to categorizing geometry thinking above, if viewed from a gender perspective it is found that there is generally no significant difference between male and female respondents. Following is the percentage of geometry thinking levels reviewed from a gender perspective.

Table 3
Levels of geometry thinking are reviewed from a gender perspective

Level	M	F
Pre-recognition	30,71%	30,97%
Visualization	56,77%	62,50%
Analisys	11,11%	5,11%
Informal deduction	1,41%	1,42%
Total	**100,00%**	**100,00%**

Table 3 shows that the level of geometry thinking of respondents both male and female is dominated at the level of visualization even though the percentage of the female is greater than male. Both of them reach the highest level at the level of informal deduction with a percentage that is not much different. At the analysis level, the percentage of male respondents was almost double the percentage of female respondents. As for the transition level, as many as 23.23% of male respondents and female respondents as much as 19.89%. Both transition levels both pre-analysis and pre- informal deduction, percentage of male respondents (18.38% for pre-analysis and 4.85% for informal pre-deduction) were more than female respondents (17.33% for pre-analysis and 2.56% for informal pre-deduction levels). Thus, in general, Van Hiele's geometrical thinking level of male and female respondents did not differ much but male respondents had the potential to increase their geometry thinking level more than female respondents. This is possible because males tend to have better logic skills while in learning geometry the use of good logic is needed. This finding supports the research findings [13].

4. Conclusion

Based on the description above, we can conclude that the average level of thinking of junior high school students in Bantul is at the visualization level (59.15%). The highest level that can be achieved by students at the level of informal deduction (1.42%). While the analysis level reached 8.62%. The remaining 30.81% is in the pre-visualization category. In addition to the above categories, there were several students whose geometric thinking level almost reached the level above but still did not meet the level criteria afterward so that it was still in the transition level category. The number of students who meet the criteria for the pre-analysis level and pre-informal deduction level is 9.33% and 2.72%. While viewed from a gender perspective, the level of geometry thinking of female and male respondents is not much different. This is indicated by 62.5% of female students at the level of visualization while male students reached 56.77%, at the level of analysis there were 5.11% of female students and male students the percentage was 11.11% of the total male students and at the level of informal deduction is not much difference due to 1.42% female students and 1.41% male students. Thus, in general, Van Hiele's geometrical thinking level of male and female respondents did not differ much but male respondents had the potential to increase their geometry thinking level more than female respondents.

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by Lppm Uniba

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6