

THE GEOMETRIC REASONING LEVELS: GENDER DIFFERENCES IN SOUTH 24 PARGANAS

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ABSTRACT

A country's progress and prosperity depend on the quality of mathematics taught in its school system. The development of the country is possible by ensuring equal opportunities for men and women. The purpose of the study was to investigate gender difference in the level of geometric reasoning. The sample consisted of 428 higher secondary students. The result yielded that only a very small percentage of boys 4.67% and girls 0.46% students could attain highest level 4 with respect to Van Hiele Levels. Further, a Chi-square test showed that Geometric reasoning level was not independent of gender. Male students generally achieve higher geometric reasoning levels than female students. In other words, it was observed that gender was a factor in geometric reasoning.

Keywords: Higher secondary, geometry thinking level, reasoning, gender;

INTRODUCTION

The Government of India gives importance to the learning and teaching of mathematics, science, engineering and technology in its school system because of the significant role which these subjects play in building the nation. Geometry is included as part of the West Bengal mathematics curriculum so that learners can have a wide range of options in choosing careers in mathematics, science, engineering and technology. Most poignant objectives of geometry learning are to develop visualization, critical thinking, intuition, perspective, problem solving, visual spatial abilities, logical reasoning, deductive reasoning and to improve proof skills. Geometric representation can also be used to help students understand other areas of mathematics: fractions and multiplication in arithmetic, relationship between graph of functions, and graphical representations of data in statistics. Research on spatial ability is also rife in the field of psychology (Bishop, 1983).

THEORETICAL BACKGROUND

Van Hiele Model

According to Alex & Mammen, (2016) the most popular established theory of students' level of geometric thinking is based on Van Hiele theory. The theory emerged in 1957 as a product of two mathematics teachers completing their doctoral

studies at the University of Utrecht in the Netherlands (Usiskin, 1982). The theory was developed by Pierre Marie Van Hiele and Dina Van Hiele Geldof (Armah, et al, 2018). Among the studies conducted on geometric thinking and the development of geometric thinking, Van Hiele's theory is the most important (Alex & Mammen, 2016; Armah, et al, 2018). This Van Hiele theory (1986) covers five sequentially and hierarchically thinking, listed as follows:

Level-0: Visualization: The student can merely recognize a shape.

Level-1: Analysis: The student is able to analyse a shape because he/she knows the properties of the shapes in Level 1.

Level-2: Abstraction: The students have learned geometric properties after having attained the first two levels.

Level-3: Deduction: The student is able to construct proofs of geometric properties after having attained the first three levels.

Level-4: Rigor: The student is able to understand the implications of non-Euclidian geometry after having attained the first four levels (Crowley, 1987). Rigor is ascending order of difficulty.

Originally, Van Hiele ranged from level 0 to level 4. Van Hiele explains model geometric thinking using three aspects: the existence of layers, properties of layers, and movement from one level to the next. Currently in the world, there are two basic lines of research based on Van Hiele theory: one is converting Van Hiele theory to other field of mathematics (Boolean Algebra, Functional-Analysis-Calculus), and another is using dynamical geometry to achieve higher Van Hiele theory (De Villiers, 2010).

LITERATURE REVIEW

Gender difference in Mathematics

Gender differences in performance in mathematics have been developing interest of the researchers around the World (Doris, O'Neill & Sweetman, 2013). Notable research studies have proved that gender difference in mathematics learning are not evident in the elementary school years but the females begin to fall behind males at the intermediate level (Mann, Sasanuma, Sakum and Masaki, 1990). Females fall further behind during the high school years (Leder, 1985). The results of many studies have shown that gender differences in mathematics are diverse. Forgasiz (2005) asserts that gender should be a concern in mathematics education because of its importance. He also argued that it is significant to include gender as a variable in research study analysis, even if it is not the main focus of studies on mathematics education. Furthermore, Armstrong (1981), Lloyd, Walsh, and Yailagh (2005) emphasizes that gender is an important factor in learning mathematics that

Halat (2008) cites. This argument has motivated researchers to evaluate this variable. As cited by Halat (2008), research work by the following researchers (Grossman & Grossman 1994) has shown that there are differences in the achievement of male and female students in various content areas of mathematics such as calculation, measurement, problem solving and spatial visualization.

A study by Armstrong found that female students performed better than their male counterparts in computation and spatial visualization. Also, literature elsewhere indicates that female students perform better than their male counterparts (Arnot, David & Weiner 1999). Ezech (2005) reported that when senior secondary school students were tested in sequence and series, male students lagged behind their female peers. Females tend to do better in mathematics and there are no significant gender differences in understanding mathematics concepts.

According to Fox and Cohn (1980), male students performed better than their female peers when they both took scholastic aptitude tests at the high school level. Also, Smith and Walker (1988) found significant sex-related differences for male students in geometry at the tenth-grade level. Randhawa (1994) found that males outperformed females in mathematics during the high school years. Following researchers conducted by (Fennema, 2000; Kaiser-Messmer, 1994) found that male students performed better than girls in mathematics. Similarly, research on standardized mathematics tests by (Fox, Brody & Tobin, 1980) cited by Asante (2010) found that male students generally scored higher than their female counterparts.

According to Halat (2006), there was no statistical difference between male and female students in their geometric level acquisition when VHGT was employed for data collection. Again, Halat (2008) concluded that when the VHGT was used, he did not find a statistical difference between the level and mean of geometric reasoning between male and female students. Also, Arhim and Offoe (2015), concluded that there was no gender difference between males and females in senior high school form one when tested on their problem-solving ability. Armstrong (1981) reiterated his opinion that there was no statistical difference between boys and girls in achievement in the sixth grade when their skills were tested in applied measurement, applied geometry, and statistics and probability.

PURPOSE OF THE STUDY

The purpose of this study was to investigate gender differences in the level of geometric reasoning of higher secondary students using the Van Hiele's theory of geometry thinking level in south 24 parganas district.

RESEARCH HYPOTHESIS

***H₀*:** There is no significant difference in Van Hiele thinking levels among male and female higher secondary students.

RESEARCH QUESTION

What Van level of geometric reasoning do male and female higher secondary students reach and are there any difference between male and female?

METHODOLOGY

Research Design

Survey method was used to investigate gender differences at the Van Hiele geometric reasoning level.

Tool used

The tool used for the study was the Van Hiele Geometry Test constructed by Usiskin (Usiskin, 1982). The test consisted of multiple choice questions, with five questions pertaining to each of the five Van Hiele levels. Each question displayed five options, one correct answer and four distracters. A level is achieved if and only if 3 or more than 3 out of five questions are answered correctly. A participant may be assigned a Van Hiele Level subsequent to his/her achieving all the levels prior to it as well as the assigned level. Each participant may be assigned Levels from 0 to 4, 0 being the lowest level and 4 being the highest. The Forced Van Hiele Level, also developed by Usiskin (Usiskin, 1982), assigns levels from 0 to 4, and in the process manages to include all participants. Thus, the Forced Van Hiele levels were assigned to the participants for the purposes of this study. The Cronbach Alpha coefficient for reliability of the test ranged from .69 to .79.

Population and Sample

The sample consisted of 428 Class XI students – 267 males and 161 females from 12 schools in the district of South 24 Parganas in West Bengal. Two Sub-divisions from South 24 Parganas district were randomly selected. Two Blocks from each of the sub-divisions were randomly selected. Three schools were randomly selected from each of the Blocks. Thus, multi-stage random sampling was adopted to select the sample for the present study.

Table 1. The sample

Level	Boys	Girls	Total
0	53	66	119
1	99	61	160
2	50	19	69
3	45	13	58
4	20	02	22

FINDINGS

The sample was administered and the Van Hiele test and the responses were tabulated accordingly.

The percentage of students who achieved the different Van Hiele levels is shown below. Those who achieved a higher level had also achieved the lower level/s prior to it. The percentage of students in Level 0 includes those who had not achieved the higher levels as well as those who achieved the higher levels. The percentage of students who achieved Level 1 include those who could go no further as well as those who achieved Level 1, 2, 3 and 4.

Table-2. Percentage of students who achieved the different levels

Level	Percentage	Boys(%)	Girls(%)
Level 0	100	44.53	55.46
Level 1	72.19	50.00	22.19
Level 2	34.81	26.86	07.94
Level 3	18.69	15.18	03.50
Level 4	05.14	04.67	00.46

The result shows that while 44.53 boys % and girls 55.46% of the total sample achieved Level 0, only boys 4.67% and girls 0.46 % of the total sample achieved Level 4. Each participant was subsequently assigned a Van Hiele Level based on his/her highest achieved level. The result pertaining to this is shown below:

Table-3. Assigned Van Hiele Levels (VHL):

Level		Boys	Girls	Total
VHL0	Count	53	66	119
	% within Gender	19.9	41.0	27.80
VHL1	Count	99	61	160
	% within Gender	37.1	37.9	75
VHL2	Count	50	19	69
	% within Gender	18.7	11.8	26.8
VHL3	Count	45	13	58
	% within Gender	16.9	8.1	25
VHL4	Count	20	0.2	22
	% within Gender	7.5	1.2	8.7
Total	Count	267	161	428
	% within Gender	100	100	100

The above Table-3 shows that

- The modal Van Hiele level is Level 1 for boys.
- The modal Van Hiele level is Level 0 for girls.
- Many achieved high Van Hiele Levels.
- Few students have achieved Van Hiele Level 4.
- Less percent of girls achieved high Van Hiele Levels.

To find out whether the van Hiele levels are dependent on gender, a Chi square test was carried out. The null hypothesis for this was

H₀: There is no significant difference in Van Hiele thinking levels among male and female higher secondary students.

The result of the Chi Square test is as follows: The data was analysed using SPSS -23. The inferential statistics of the male female result of the independent samples Chi-Square test. The result of the Chi-Square test as ($\chi(4) = 32.496$, $p = 0.000 < 0.01$). The degree of freedom 4, and N of valid cases = 428. Here the Chi-Square value of 32.496 is highly significant at 1% level. Therefore, the H_0 may be rejected. Thus, the Van Hiele geometric reasoning levels are not independent of gender. Rectangular array 3 shows, boys tend to overtake girls in the higher van Hiele levels.

CONCLUSION

The purpose of the study was to investigate male and female higher secondary students Van Hiele Levels of geometric reasoning using Van Hiele level of geometric thinking in south 24 Parganas district of West Bengal. It also sorts to find out the score of gender differences among higher secondary students Van Hiele geometric reasoning level using Van Hiele level of geometric thinking.

Four hundred twenty-eight higher secondary students were used for the study as sample from South 24 district. From the results, only a few students have achieved

Van Hiele Level 4. The modal Van Hiele level is Level 1 for boys. The modal Van Hiele level is Level 0 for girls. The study revealed that there was statistically significant difference in the levels between the male and female higher secondary students in geometric reasoning specifically Van Hiele level of geometric thinking. Many literatures have consistently reported that males perform better in problem solving than females among high ability students on standardized mathematics tests (Zhu, 2007). These gender differences are usually evident in high school and college and vary across mathematical tasks. Gender differences in mathematical problem solving are not biologically determined but are likely influenced by the combined effects that have biological, psychological and environmental origins, promising us that education can play a great role in elimination or reducing gender differences in mathematical problem solving. On the one hand, educators need to think about how to use appropriate instruction to help all female and male students to develop problem solving-skills. Teachers, on the other hand, need to critically consider the positive and negative effects of classroom variables and make conscious efforts to promote gender equality in mathematics education.

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