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Assessment of the Third Year High School Students' Van Hiele Levels of Geometric Conceptual Understanding in Selected Secondary Public Schools in Lanao del Sur

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Abstract :
This study aimed to evaluate the Van Hiele levels of geometric conceptual understanding of the third year high school students in selected secondary public high schools in Lanao del Sur. There were 409 respondents in this study. Two instruments such as geometry test and an interview containing three activities were used to gather the data. The results revealed that there were 312 respondents belonged to level 0 (pre-cognition), 93 of the respondents reached level 1 (visualization), and 4 of the respondents met level 2 (analysis). Not one of the respondents reached level 3 (informal deduction) which is the expected level of geometric understanding of a student before entering third year high school. These results proved true the findings of many researchers (Dindyal, 2007; Genz, 2009; Tan and Yebron, 2009; Usiskin, 1982) that many third year high school students have levels of geometric thought lower than level 3 (informal deduction).

Keywords :
Van Hiele levels, geometrical conceptuals

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Introduction

The poor performance of Filipino students in the 2003 Trends in International Mathematics and Science Study (TIMSS) which placed them 5th from bottom among 45 participating countries surprised the country (cited in Tan & Yebron, 2009). The study on geometry is necessary since it is a field of mathematics that involves proving theorems; hence, it provides opportunity to develop creative and critical thinking. It is the most essential field of mathematics that students need to be equipped with in preparation for collegiate endeavors. In the Philippine basic educational curriculum, properties of some geometric figures are introduced only in the last part of textbooks in grade six (e.g. Realistic Math 6, 2001), but not in grade one to grade five. However, the last parts of textbooks are not often discussed by the teachers due to the shortage of time. This is one reason why students upon reaching third year high school have insufficient knowledge about basic properties of geometric shapes necessary for students' understanding before learning to prove geometric theorems. According to Guro (2010), the situation is worse in less developed areas in the country like Lanao del Sur.

Statement of the Problem

The main objective of this study is to determine the levels of geometric conceptual understanding of the third year high school students from each of the three selected secondary schools in Lanao del Sur. Specifically, it sought answers to the following questions:

1. What is the level of geometric conceptual understanding of the third year high school students from each selected secondary public high school?
2. How many percent of the respondents from the selected secondary schools are ready and not ready to take the geometry course as required in the secondary curriculum?
3. How do respondents perform when asked questions at different Van Hiele levels of geometric understanding?

Conceptual Framework

The learning of geometry can be enhanced and facilitated if students have fully understood the basic ideas and properties of geometric figures. The difficulty encountered in studying geometry can also be avoided if students know their level of geometric understanding so that, they know where and what they should pursue in learning higher geometry. It can also be minimized if teachers know the levels of geometric understanding of their students, so that they can use methods and strategies of teaching geometry which are appropriate for their students at such levels. The concept learning of geometric shapes is very important because it helps learners to think fast, independently, and creatively. This is always missed by many mathematics teachers in both elementary and secondary level of education. Math teachers have been used to giving students exercises after the discussion of the lesson.

In the next page, Figure 1 presents the research paradigm of the study. After assessing the Van Hiele levels of geometric conceptual understanding of the respondents, they were classified into students' ready to take geometry and students' not ready to take geometry courses in high school. Students are ready to take geometry when their level of geometric conceptual understanding is 3 before entering third year high school. On other hand, students are not ready to take geometry when their Van Hiele levels of geometric conceptual understanding are lower than 3.

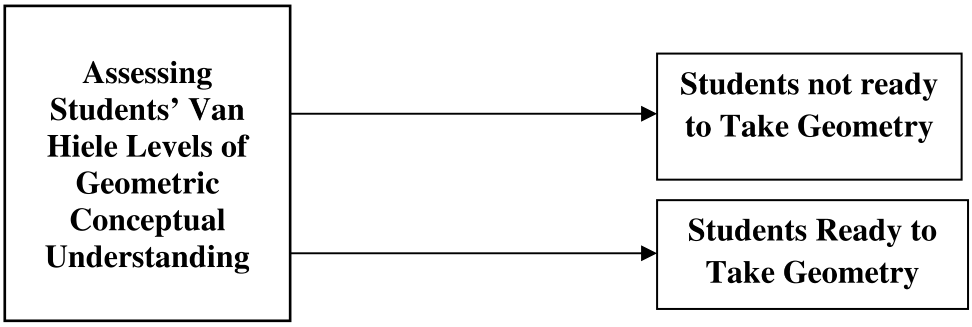

Figure 1. Research paradigm

Methodology, Sampling Techniques, and Procedure

This study applied both qualitative and quantitative designs. Qualitative research described the performance of the respondents on the conducted interview. Quantitative research investigated the Van Hiele levels of geometric conceptual understanding of the respondents. For the selection of the respondents, purposive sampling technique was used because the respondents were selected on the basis of availability, accessibility, functionality, geographical proximity, and sex composition.

Geometry test and interview were used in data collection. Geometry test was used for identifying the individual level of geometric understanding of each respondent, while an interview for verifying the levels of geometric understanding of some respondents. The topic is limited to quadrilaterals, their properties, and relationships. The test consists of 30 items divided into three sub-tests. Item numbers 1 to 10, measure level 1 (*visualization*) of Van Hiele theory; item numbers 11 to 20 measure level 2 (*analysis*); and, item numbers 21 to 30 measure level 3 (*informal deduction*). It was given to the respondents for 20 to 35 minutes. The interview was conducted to document students' use of geometric language, vocabulary, or terms and to verify their levels of geometric understanding. The respondents were given three activities. Activity 1 evaluates level 1; activity 2 measures level 2; and, activity 3 assesses level 3 of Van Hiele levels of geometric conceptual understanding

The total number of sample was 409 respondents. Modified Case and forced level of Usiskin (1982) were used in determining the individual level of geometric conceptual understanding of each respondent.

Results

Results revealed that of the total number of respondents, 312 were at level 0, 93 reached level 1, and only four belonged to level 2. Not one participant reached level 3, the expected level of a student upon reaching third year high school. This result answered the first statement of the problems in chapter 1 of this study. Table 1 shows the distribution of the respondents on the Van Hiele levels of geometric conceptual understanding.

Table 1.
Frequency of all Participants from the Three Sample Schools on the Van Hiele Levels

School	Van Hiele Levels				Total
	0 (Pre-cognition)	1 (Visualization)	2 (Analysis)	3 (Informal Deduction)	
A	105	21	0	0	126
B	177	49	3	0	229
C	30	23	1	0	54
Total	312	93	4	0	409

Concerning the percentages for the number of respondents in Van Hiele levels, 76.3% of them were at level 0 (pre-recognition), 22.7% of them reached level 1 (visualization), and only 1% reached level 2 (analysis). No one reached level 3 (informal deduction,) which is the expected level for secondary students upon enrolling third year high school. Thus, 0% of the total respondents were ready to take the geometry course. Table 2 presents the distribution of the respondents on the Van Hiele levels of geometric conceptual understanding

Table 2.
Distribution of the Respondents in Schools A, B, and C on the Van Hiele Levels of Geometric Understanding

School	Van Hiele Levels			Total
	0 (Pre-cognition)	1 (Visualization)	2 (Informal Deduction)	
A	105	21	0	126
B	177	49	3	229
C	30	23	1	54
Total	312	93	4	409
Percentage	76.3%	22.7%	1.0%	100%

Results of the interview revealed that of the representative sample of respondents not one of them who underwent the said process was able to relate the quadrilateral types with respect to their properties. Some of them were not versed with some geometric terms. They were not able to identify precisely the properties of a certain geometric shapes through visual representation.

Conclusion

The study confirmed the findings of Usiskin (1982) and other researchers (Genz, 2006; Halat, 2008; Salazar, 2009) that none of the sample reached level 3 which is the expected level before a third year high school student takes geometry course. Many of them differ in their levels of geometric conceptual understanding which contradicts the assumption of geometry teachers and geometric curriculum planner that students are more or less on the same level. So the same methodology and the same lessons were given to all students in a uniform manner. Some even have level 0 (*pre-cognition*) which means that they have difficulty in identifying other quadrilateral shapes like trapezoid. Their mean scores showed that they did not reach level 1 (*visualization).* Since 100% of the total number of participants have levels below level 3 *(informal deduction*), then the difficulty of the subject for this population is a forgone conclusion.

Implications of the Study

The main reason for the respondents' lower level of geometric understanding in this research could be the lack of sufficient knowledge of geometric concepts among the respondents. This result agrees with the findings of many researchers (Atebe, 2008; Dindyal, 2007; Frykholm, 1994; Halat, 2008; Knight, 2006; Usiskin, 1982).

Students who intend to enroll in geometry should be evaluated first using Van Hiele Theory so that difficulty of learning the subject can be minimized. Dindyal (2007) stressed that students having difficulty in algebra are likely to encounter difficulty in geometry since algebraic thinking has strong connection to geometric thinking. Thus, the ability of students in algebra must also be properly evaluated and addressed. An enhancement program in the form of remedial classes may be done to supplement inadequate knowledge of geometric concepts among students, hence, develop their reasoning ability in the subject. This can be done after the classes, every week, or during summer before letting the students enroll in geometry course in high school. In accordance with the findings of other researchers such as Halat (2008) and Knight (2006), teachers who will be assigned to teach geometry in high school should have at least level 4 (*formal deduction*) of Van Hiele levels. This is to ensure that teachers have mastery of the subject, so that the teachers know how to find ways of selecting method of instruction that can best develop the students' reasoning even if they have variety of levels or have lower levels.

Standard systematic geometry instruction as being recommended by Usiskin (1982) could also help develop gradually the reasoning ability of students in the subject. If taught in such manner, they can easily relate to the subject matter when they are obliged to do some tasks to explore, investigate, and even experience that will lead to the understanding of the concepts. This is what the other curriculums (Wilson, 2000) are trying to emphasize. Thus, standardized instruction of geometry curriculum should be strictly established. Instructional materials concerning different topics of geometric maybe designed following the Van Hiele Theory. These should be made available to geometry teachers to guide them in teaching. Visual aids are very important in developing concepts in geometry. Teachers must see to it that visual aids are available when needed in teaching. This will fully develop level 1 (*visualization*) of geometric understanding, thereby assisting learners towards attaining level 2 *(analysis).*

Geometry teachers have to strive for on – going training to further develop their critical thinking ability. Their vital role in deep learning of geometry among students cannot be sacrificed. Administrators may organize and conduct appropriate in – service trainings for mathematics teachers to enhance their teaching capacity in geometry. Based on many studies, there are qualified mathematics teachers who graduated from good universities. They must be employed in the Department of Education (DepEd) to replace those who are non – mathematics majors. Department of Education (DepEd) should organize meetings, forums and other activities that will promote and develop mathematics education as a whole. Muslim educators should write modules, books, and other teaching materials reflecting the Van Hiele theory in the context of its unique culture and traditions.

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