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THE VAN HIELE MODEL IN TEACHING GEOMETRY

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ABSTRACT

The primary purpose of this study was to determine the effectiveness of the Van Hiele model in teaching Geometry to Grade 8 students as the basis for designing instructional materials using the Van Hiele model. This study used the quasi-experimental group design to assess whether there was a significant difference between the pretest performance to the posttest performance of the control and experimental groups. The results revealed that both groups had established a significant mean gain difference from Pretest to Posttest, although the experimental group, taught using the Van Hiele model, performed better than the control group. The teacher and the students encountered many challenges in each phase, but undeniably, the students enjoyed the activities. The majority of the students found that it is interesting to learn Geometry using the phases of the model. The instruction using the Van Hiele model is thus considered an effective way of teaching Geometry and an alternative teaching strategy to the traditional method. Therefore, this method is proper when teaching Geometry, especially to students with different learning needs, because of the presence of various geometric experiences.

Contribution/Originality: The study contributes to the existing body of language in terms of the lesson designs created using the phases of the Van-Hiele model addressing the challenges encountered by the teachers and the students of Bohol, Philippines, to make the learning of Geometry more meaningful.

1. INTRODUCTION

Geometry is one of the most integral components not just in the Philippine Mathematics curriculum but in other countries as well. It is an integral part of a student's curriculum from Kindergarten to 12th grade and continues through college and post-graduate studies. Geometry plays a vital role in the primary and secondary mathematics curricula for, without it, mathematics education's goal of developing mathematically empowered citizens will never be realized.

Students need to be equipped with the necessary Geometry skills which include identifying characteristics and analyzing properties of geometrical shapes, execution of transformations, symmetry, spatial reasoning, visualization and solving problems through geometric modelling for them to become successful learners (Executive Summary Principles and Standards for School Mathematics, 2000).

Geometry is the branch of Mathematics with the lowest student score and the only branch in which students performed poorly which is below the average scale score based on the result of TIMSS (2011).The latest key performance indicators showed a depressing picture of students' performance in Mathematics. The Philippines continues to struggle, which is evident in its poor performance in national and international assessment tests. In the Department of Education (2019) test results showed that among 79 countries tested, the Philippines ranked second lowest in Mathematics literacy. Among 5 Filipino students, only 1 of them (19.7%) reached level 2 in mathematical literacy, which is at least the minimum proficiency level.

Research has been done to address those problems. Researchers used one of the essential models in teaching Geometry, the Van Hiele (1986) Model. It is a learning model which comprises of five levels of understanding. The learner must be given suitable educational practices to be able to pass through these levels and a learner cannot advance to another level without going through the prior levels. The student thinking advancement guides him in encapsulating new knowledge and applying it in his daily life. Teachers have been employing many strategies for the students to learn; however, it has been observed that in a certain high school in Ubay, Bohol, Philippines, where the researcher is currently teaching, students in Grade 8 are low in performance in Geometry. Based on their Third Quarter performance (S.Y.2018-2019), 45 out of 150 students in Grade 8 got a very low average grade, which ranges from 68-71 in the said subject. This situation encouraged the researcher to design instructional materials using the Van Hiele model to help these students improve their mathematics performance, specifically in Geometry; thus this study was conducted.

2. THE VAN HIELE MODEL

This study is anchored on the Van Hiele (1986) developed by Dina van Hiele-Geldof and her husband, Pierre Marie van Hiele. This theory emphasizes that there are five levels of geometric thinking that students go through as they advance from solely identifying a figure to being capable of writing geometric proofs. According to Van Hiele, as cited by Mason (2002) student's advancement through each level is dependent on the instruction given that is arranged into five phases of learning. Paja (2005) also added that the model describes how the understanding of a new topic may develop and attest that the learners move successionally through five levels of learning.

According to Van Hiele (1986) "the transition from one level to the following is not a natural process; it takes place under the influence of a teaching-learning process". The development of a higher level of geometric thinking in each learning period will be achieved through the five sequential phases of learning, which the Van Hieles model proposed. Numerous studies have shown that this model effectively increases the students' thinking level compared with traditional instruction. However, what is true in the West may not be accurate in the Philippines.

Initially, the Van Hiele model comprised five levels of understanding. Van Hiele (1959) speaks about the five levels, and at first, there are only four, but eventually, the fifth level appears (Colignatus, 2014). However, there had been revisions in the number of levels, from five to three. According to Brodie (2004); Van Hiele (1986) mentioned that there had been revisions in the number of levels from three then two until it became five and more. He also mentioned that there is an alternative set that is composed of three levels. As stated by Teppo (1991) Pierre van Hiele presently identifies it in three levels of thought instead of five namely, visual, descriptive, and theoretical. Lawrie (1998), as cited by Brodie (2004) stated that through personal communication in 1994 at Hague, Dr. Van Hiele confirmed the existence of last model, which comprises the three levels and once more at the University of England, Armidale.

The Van Hiele model of geometric thinking enumerated the five levels of understanding in which students advance when learning Geometry. See Figure 1. It comprises five levels: visualization, analysis, informal deduction/abstraction, deduction, and rigor. Howse and Howse (2014) describe the ability of students exhibited in each level. In the visualization level (Level 1), the student classifies and identifies figures based on their appearance. Student in the analysis level (Level 2) classifies shapes based on their properties. Students recognize the essential attributes, and their relationship, which further helps students in organizing the attributes of shapes logically, is exhibited by the students in the abstraction level (Level 3). Students in the deduction level (Level 4) attain abilities such as logical reasoning and proving theorems deductively. In the rigor level (Level 5), the student demonstrates and scrutinizes theorems in the different mathematical systems.

However, Van Hiles stated that the advancement through the levels relies heavily on the instruction received than maturation (Crowley, 1987). Students advance from one level to the next through carefully planned instruction and are arranged sequentially into five phases (Teppo, 1991).

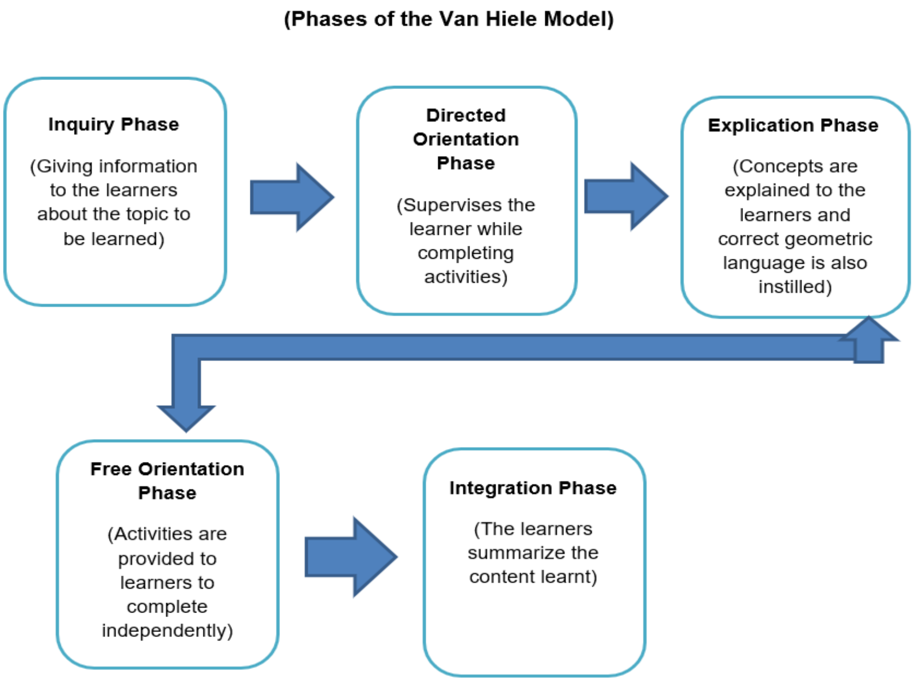

Figure 1. The 5 phases of the Van Hiele model.

In this study, the five sequential phases of learning were adopted in the teaching of Geometry, where the students received instruction based on the suggested activities by Van Hiele (1999). Twelve lesson plans for the intervention program, including the procedure and instruction arrangement, were made and prepared carefully.

The five phases of learning were incorporated into the lesson plans. The activities in each phase followed the suggestions by Van Hiele (1999).

Van Hiele (1999) stated that the inquiry phase is the first step of instruction. The materials prepared should help students explore and discover certain shapes. The dialogue between the teacher and the students regarding the geometric shapes to be discussed is an important task in this phase (Van Hiele-Geldof, 1984). Howse and Howse (2014) elaborated this by describing that in this phase, students learn new vocabulary, ideas, and concepts that are important in accomplishing particular tasks. The teacher carefully assesses student's ability to interpret and reason out. In this phase, students will examine examples and non-examples (Fuys, Geddes, & Tischler, 1988). Materials needed for this phase are given to the students (Teppo, 1991).

In direct orientation, which is the second phase, activities are presented gradually to enable the characterization of the structures to appear to children. An example would be showing symmetry by using puzzles and games such as "feel and find the shape." Directed orientation is distinguished by planned and organized activities that help students thoroughly recognize and discuss the new geometric concepts they've learned in the first phase (Van Hiele-Geldof, 1984).

In the third phase, explication, the presentation of the terminologies and encouraging students to use them in oral and written exercises in Geometry is one of the important tasks of the teacher in this phase. In the free orientation phase which is the fourth phase, the presentation of tasks by the teacher is manifested. The students can accomplish the tasks given in a different manner that is creative and worthwhile to help them become more proficient of their previous learning through explorations or playing cue games. Villamin (1976) as cited by Paja (2001) supported this by stating that learning is more meaningful when children engage in life-like activities, the fact that children are engaged in more worthwhile activities.

In the integration phase, which is the fifth and last phase, students are given a chance to encapsulate their learning through different clue tasks and activities (Van Hiele, 1999).

The phase-based instruction using the Van Hiele (1986) consisting of twelve lesson plans ran for six weeks. The time frame was consistent with the study of Abdullah, Ibrahim, Surif, and Zakaria (2014) in which the main objective was to examine how effective is Van Hiele's phase-based learning to the student's geometric thinking level. After six weeks of study, they found out that students employed with the Van Hiele phase-based learning showed the complete attainment of Level 2. They further concluded that Van Hiele's phase-based learning helps achieve a better level of geometric thinking if applied in the classroom.

The phases of learning of the Van Hiele model guide the objectives and goals of this research. Van Hiele's framework was applied in the development of the lesson design using the phases of the Van Hiele model. Thus this study was conducted.

The main purpose of this study was to determine the effectiveness of the Van Hiele teaching model in the Geometry performance of Grade 8 students in a certain high school in Cagting, Ubay, Bohol, Philippines for the School Year 2019-2020 as a basis for designing instructional materials.

The study answered the following questions:

1. What is the pretest performance of the students in Geometry in the control and experimental groups?
2. What is the posttest performance of students in the control and experimental groups?
3. Is there a significant pre-post difference in the Geometry performance of both groups?
4. Is there a significant mean gain difference between the performance of the control and experimental groups?
5. What are the challenges encountered in the implementation of the Van Hiele model?

The following null hypotheses were tested at a significance level of $a = 0.05$.

1. No significant pre-post difference exists between the Geometry performance in both groups.
2. There is no significant mean gain difference between the control and experimental groups

3. RESEARCH METHODOLOGY

3.1. Research Design

This study utilized the quasi-experimental group design to assess the use of the Van Hiele phase-based learning in teaching Mathematics to Grade 8 students. The experimental group was subjected to treatment using the five sequential phases of the Van Hiele model activities, while the other group was exposed to the traditional method where the activities prepared by the teachers are customarily done to address the general needs regardless of the kind of the learners they have.

Both groups took the Pretest to determine the students' performance in Mathematics before the intervention. After which, the use of the phases of the Van Hiele model activities was employed in the experimental group for 6 weeks. The time frame was consistent with the study of Abdullah et al. (2014). On the other hand, the traditional method was utilized in the control group.

3.2. Research Environment

This study was conducted at Cagting High School, Cagting, Ubay, Bohol, Philippines. Casting High School is a public secondary institution whose Vision, Mission, and Goals (VMG) are aligned with the DepEd's VMG whose dream is to produce students who have a love for their country and are skilled enough to contribute to their country's progress. It is approximately 15 kilometers from Ubay, Bohol, Philippines. The school houses 11 classrooms for Junior High School and four classrooms for Senior High School. It is headed by one Principal who is assisted by an Administrative Assistant II, Guidance Counsellor, and six class advisers. Currently, four teachers are handling mathematics subjects.

3.3. Research Subjects

The subjects of this study were the grade eight students of Cagting High School of Ubay, Bohol, Philippines and who were officially enrolled for the school year 2019-2020. This study consisted of 92 grade-eight students in Cagting High School. They comprised of 27.2 percent of the school population during the School Year 2019-2020.

There were three sections in Grade 8 of which two of them were used for research study while the third section was utilized for pilot testing of the research instrument. The third section consisted of 44 students who were selected to engage in the conduct of the pilot test. One group was randomly assigned as the experimental group in which students were randomly chosen from the three sections, while the other was also randomly assigned as the control group. The remaining section was utilized for pilot testing. The pupils in all sections were heterogeneously grouped.

3.4. Research Instrument

The students' performances in Geometry before and after the intervention were measured with the use of an instrument. A researcher-made instrument was used as Pretest and Posttest to determine the grade eight students' performance in Geometry. It is comprised of five competencies starting from applying triangle congruences, illustrating theorem, proving inequalities, and proving and determining conditions under which conditions are parallel and perpendicular. The test questions were congruent to the table of specifications measured proportionally: the skills of knowledge, comprehension, analysis, application, synthesis, and evaluation. It comprised of the topic of triangle congruence, theorems on triangle inequality, proving inequalities, and properties of parallel lines.

The content validity of the researcher-made test was ensured through the critique of content experts in the field. One of the panel members, who herself is a content expert, an Instructor I and a Mathematics Student Teaching Mentor, and a mathematics educator. A Cronbach alpha of 0.70 was obtained as the instrument's internal consistency. The test's computed reliability coefficient is interpreted as Acceptable. The study was also approved to conduct by the Research Ethics Committee (REC) of the university.

3.5. Research Procedure

The research procedure starts with seeking clearance from the Research Ethics Committee of the university. After permission was approved, a letter to conduct the study was sent for approval to the Principal of Cagting High School, Cagting, Ubay, Bohol, Philippines. Then, all the instruments were prepared. The researcher-made instrument was subjected to a reliability test with a Cronbach alpha of 0.70 and interpreted as Acceptable. The researcher developed the lesson plans for the two groups. The curriculum guide and teaching guide in Mathematics 8 and the module by Fuys et al. (1988) served as a guide in the preparation of the lessons.

3.5.1. The Experimental Teaching

Before the start of the study, a pretest was given to both classes to identify the students' performance in Geometry and to establish comparability of the two groups. The results of the Pretest were collated for test of the significance of the difference. There being no significant difference in the pretest results of the two groups, the conduct of the experiment proceeded. The experimental group was taught employing the activities as mentioned in the lesson plans following the Van Hiele model's sequential phases of learning. In contrast, the control group was taught using the conventional method. After a series of discussions over six weeks, the control and experimental groups were given the Posttest. Data was then subjected to statistical treatment.

3.5.2. Data Analysis

For the profile of the pretest and posttest performance, simple percentages, simple means, and standard deviation were employed. Further, to categorize the performance of the research subjects, expressed in percentage scores (with 0 as the lowest and 100 as the highest possible percentage score), the following was used: Below Average (0 – 59), Average (60 – 75) and Above Average (76 - 100). To determine the significance of the difference between the two groups, the t-test of independent samples was used. The paired t-test and standard deviations were utilized to analyze the data for significant improvement from pretest performance to posttest performance.

3.6. Ethical Considerations

The researchers ensured to manage the conflict that might arise from financial, familial, or proprietary considerations, guaranteed to preserve privacy and confidentiality of information. They applied the principle of respect for persons, followed the proper manner of recruitment, and obtained assent vis-à-vis incompetence to consent. They also followed proper measures to reduce risks, including physical, psychological, social and economic, and found a potential direct benefit to participants. The terms of a collaborative study were followed which includes intellectual property rights, rights to publication, information and responsibility- sharing and transparency and capability building.

4. DISCUSSION AND CONCLUSION

The results on the pretest performance and posttest performance of the control and experimental group, the significance of the difference in the pre-post performance and mean gain are discussed in detail.

4.1. The Pretest Performance of the Control and Experimental Groups

The mathematics pretest performance among Grade 8 students in both the control and experimental groups are shown in Table 1.

Table 1. Pretest performance of the control and experimental groups per competency.

Learning Competency	Mean Percentage Score Control Group	Interpretation	Mean Percentage Score Experimental Group	Interpretation
1. Applies triangle congruence to construct perpendicular lines and angle bisectors.	42.73	Below Average	46.36	Below Average
2. Illustrates theorem on triangle inequalities (Exterior Angle Inequality Theorem, Triangle Inequality Theorem, Hinge Theorem).	39.55	Below Average	43.18	Below Average
3. Applies theorems on triangle inequality.	35.91	Below Average	41.36	Below Average
4. Proves inequalities in a triangle.	41.36	Below Average	43.64	Below Average
5. Proves properties of parallel lines cut by a transversal.	43.64	Below Average	45.91	Below Average
6. Determines conditions under which lines and segments are parallel or perpendicular.	45.45	Below Average	48.64	Below Average
Overall Mean Percentage Score	41.439	Below Average	44.848	Below Average

Note: Below Average (0 – 59), Average (60 – 75), and Above Average (76 - 100).

The overall mean percentage score is 41.439 for the control group and 44.848 for the experimental group. These are both interpreted as Below Average. Most students failed in the Pretest in both groups possibly because of two reasons: First, it is because the students haven't received any discussion from the teacher, and they also lack prerequisite knowledge and skills. The second is due to the lack of knowledge retention in their previous grade level.

In Table 1, the pretest performance of the control group per competency shows that the highest mean percentage score (45.4%) is in competency 6 while the lowest mean percentage score (35.91 %) is in competency 3. It can also be seen from Table 1 that they performed below average in the six competencies. The students have performed poorly in all competencies which implies that the students do not have any background of the topics included in the test. The students' poor performance can also be further attributed to the student's lack of prerequisite knowledge and skills.

The pretest performance of the experimental group in the six competencies shows that the highest mean percentage score (48.6 %) is in learning competency 6 while the lowest mean percentage score is in learning competency 3 which is 41.4%. It is interpreted that the experimental group performed below average in all the competencies in the Pretest. The reason could be that the topic is new to them and there was no discussion yet by the teacher. This implies that the students solely relied on their prior knowledge in which the majority of them probably already have forgotten the lesson. Prior knowledge is important to create connections between the previous information and the new one.

4.2. The Posttest Performance of the Control and Experimental Groups

Similarly, the mathematics posttest performance among Grade 8 students in both control and experimental groups are shown in Table 2. The overall mean percentage score is 41.439 for the control group and 44.848 for the experimental group. The posttest performance of the control and experimental groups per competency is shown in Table 2. The highest mean percentage score (70.45%) is found in learning competency 6; however the lowest percentage score (61.82%) is located in learning competency 3. It is depicted that the overall mean percentage score is 65.076. This means that the students performed average in all six competencies. There was an improvement from below average in the Pretest to average in the Posttest.

Table 2. Posttest performance of the control and experimental groups per competency.

Learning Competency	Mean Percentage Score Control Group	Interpretation	Mean Percentage Score Experimental Group	Interpretation
1. Applies triangle congruence to construct perpendicular lines and angle bisectors.	64.55	Average	72.73	Average
2. Illustrates theorem on triangle inequalities (Exterior Angle Inequality Theorem, Triangle Inequality Theorem, Hinge Theorem).	62.27	Average	70.91	Average
3. Applies theorems on triangle inequality.	61.82	Average	74.55	Above Average
4. Proves inequalities in a triangle.	65.00	Average	77.73	Above Average
5. Proves properties of parallel lines cut by a transversal.	66.36	Average	77.73	Above Average
6. Determines conditions under which lines and segments are parallel or perpendicular.	70.45	Average	80.91	Above Average
Overall Mean Percentage Score	65.076	Average	75.758	Above Average

Note: Below Average (0 – 59), Average (60 – 75) and Above Average (76 - 100).

This implies that the traditional method employed by the teacher in the control group may have contributed to the improvement of the student's performance from the Pretest to the Posttest. The improvement was not that great but this supports that the traditional method of teaching could still be effective and useful in today's education.

Similarly, Table 2 shows the posttest performance of the experimental group per competency. It shows that among the six learning competencies, the experimental group's performance was above average in the four competencies while they performed average in learning competency 1 and 2. There was an improvement from below average in the Pretest to above average in almost all competencies in the Posttest. This implies that the instruction using the Van Hiele model may have contributed to the improvement in the performance of the experimental group. This could potentially mean the instruction using the Van Hiele model has a positive impact to the grade 8 students' mathematical scores and performance.

4.3. Significance of the Difference from the Pretest to the Posttest

The t-test on dependent means was used to test the significance of the difference from the pretest and posttest performance within the groups. Table 3 shows the pre-post improvement profile of the control per competency. It shows the Pretest mean, Posttest mean, mean percentage score, and the corresponding p-values in every competency. The mean percentage difference of the control group is 23.64. It can be seen in Table 3 that the control group significantly improved their performance in all competencies from Pretest to Posttest. The use of the traditional method contributed to the improvement of the control group.

The t-test on dependent means was used to test the significance of the difference from the pretest and posttest performance within the groups. Table 4 shows the pre-post improvement profile of the experimental group per competency. The mean percentage difference is 30.91. It shows that the performance of the experimental group in all competencies significantly improved from below average in the Pretest to above average in almost all competencies in the Posttest.

Table 3. Pre-post improvement profile of the control group per competency.

Learning Competency	Pretest Mean	Posttest Mean	Mean Percentage Difference	p-value
1.Applies triangle congruence to construct perpendicular lines and angle bisectors.	42.73 (Below Average)	64.55 (Average)	21.82	0.000 (Significant)
2. Illustrates theorem on triangle inequalities (Exterior Angle Inequality Theorem, Triangle Inequality Theorem, Hinge Theorem).	39.55 (Below Average)	62.27 (Average)	23.73	0.000 (Significant)
3. Applies theorems on triangle inequality.	35.91 (Below Average)	61.82 (Average)	25.91	0.000 (Significant)
4. Proves inequalities in a triangle.	41.36 (Below Average)	65.00 (Average)	23.64	0.000 (Significant)
5. Proves properties of parallel lines cut by a transversal.	43.64 (Below Average)	66.36 Average	22.73	0.000 (Significant)
6. Determines conditions under which lines and segments are parallel or perpendicular.	45.45 (Below Average)	65.076 (Average)	25.00	0.000 (Significant)
Overall Mean Percentage Score (SD)	41.439 (4.790)	65.26 (6.246)	23.64	0.000 (Significant)

Note: Below Average (0 – 59), Average (60 – 75) and Above Average (76 - 100).

The mean percentage difference of the control group of 23.64 was found to be significant with a p-value of 0.000 which is less than 0.05 level of significance. This situation also happens to the case in the experimental group. The mean percentage difference of the experimental group (30.91) was found significant since its computed p-value is less than 0.05. Thus, both groups have significantly improved their mean performance. The results showed that both strategies, the traditional and the Van Hiele approach help improve the student's performance in Mathematics. The traditional method and the Van Hiele model employed in the control and experimental groups respectively, are both valuable and functional in our education today.

The Van Hiele model contributed to a significant impact on the performance of the experimental group. This model has been proven that is very important to teachers because it helps them to plan instructions to meet classroom goals carefully. The selection and use of activities appropriate to the pupils play a vital role in the improvement of students' performance (Lim, 2013). The use of the Van Hiele model had a positive impact on the student's performance and on the students' geometric ability than conventional learning models (Ramlan, 2016).

Table 4. Pre-post improvement profile of the experimental group per competency.

Learning Competency	Pretest Mean	Posttest Mean	Mean Percentage Difference	p-value (Significance)
1.Applies triangle congruence to construct perpendicular lines and angle bisectors.	46.36 (Below Average)	72.73 (Average)	26.36	0.000 (Significant)
2. Illustrates theorem on triangle inequalities (Exterior Angle Inequality Theorem, Triangle Inequality Theorem, Hinge Theorem).	43.18 (Below Average)	70.91 (Average)	27.73	0.000 (Significant)
3. Applies theorems on triangle inequality.	41.36 (Below Average)	74.55 (Average)	33.18	0.000 (Significant)
4. Proves inequalities in a triangle.	43.64 (Below Average)	77.73 (Above Average)	34.09	0.000 (Significant)
5. Proves properties of parallel lines cut by a transversal.	45.91 (Below Average)	77.73 (Above Average)	31.82	0.000 (Significant)
6. Determines conditions under which lines and segments are parallel or perpendicular.	48.64 (Below Average)	80.91 (Above Average)	32.27	0.000 (Significant)
Overall Mean Percentage Score (SD)	44.848 (1.886)	75.758 (2.316)	30.91	0.000 (Significant)

Note: Below Average (0 – 59), Average (60 – 75) and Above Average (76 - 100).

Mean gain refers to the difference between the mathematics pretest and Posttest means in each group. Based on the results, the students showed improvement between the Pretest and Posttest after employing the phases of the Van Hiele model. The traditional method also showed improvement but has a lesser effect on student's performance. To test whether there is a significant difference between the mean gains from Pretest to posttest scores, a t-test was employed.

4.4. Significance of the Difference in the Mean Gains

The t-test of independent means was used to test the significance of the difference between the mean gains of the two groups. The difference in the mean gains in favor of the experimental group may imply effectiveness in using the phases of the Van Hiele model in teaching Geometry. The results show that there was a significant difference between the mean gains of the two groups. The results are given in Table 5.

The significance of the difference of 7.273 between mean gains of 23.63 and 30.909 for the control and experimental groups, respectively, was then tested using the t-test on independent means. The test gave a p-value of 0.000. Since the p-value is less than the 0.05 level, the null hypothesis is rejected. Hence, the mean gains are significantly different. The results suggest that the experimental group performed better than the control group in Geometry.

The findings show a significant difference between the pretest and posttest scores when pupils were taught in the traditional method and using the phases of the Van Hiele model. The positive gains of the students using the stages of the Van Hiele model show that it helps the students understand the concept of each lesson better. The use of instructional materials using the Van Hiele model contributed to the student's progress (Meng & Idris, 2012).

Table 5. Test of the significance of the difference in the mean gains of the two groups.

Groups	Tests	Mean Percentage Score	Mean Gain (SD)	Mean Gain Difference	p-value	Significance
Control (n=44)	Pretest Posttest	41.439 65.076	23.636 (6.851)	7.273	0.000	Significant
Experimental (n=44)	Pretest Posttest	44.848 75.758	30.909 (10.277)			

4.5. Challenges Encountered in the Use of the Phases of the Van Hiele Model

After the implementation of the instruction using the phases of the Van Hiele Model, challenges were encountered by both the teacher and students. Students were asked how they find learning geometry using this strategy. They, too, were asked about the challenges they faced. Figure 2 illustrates these challenges.

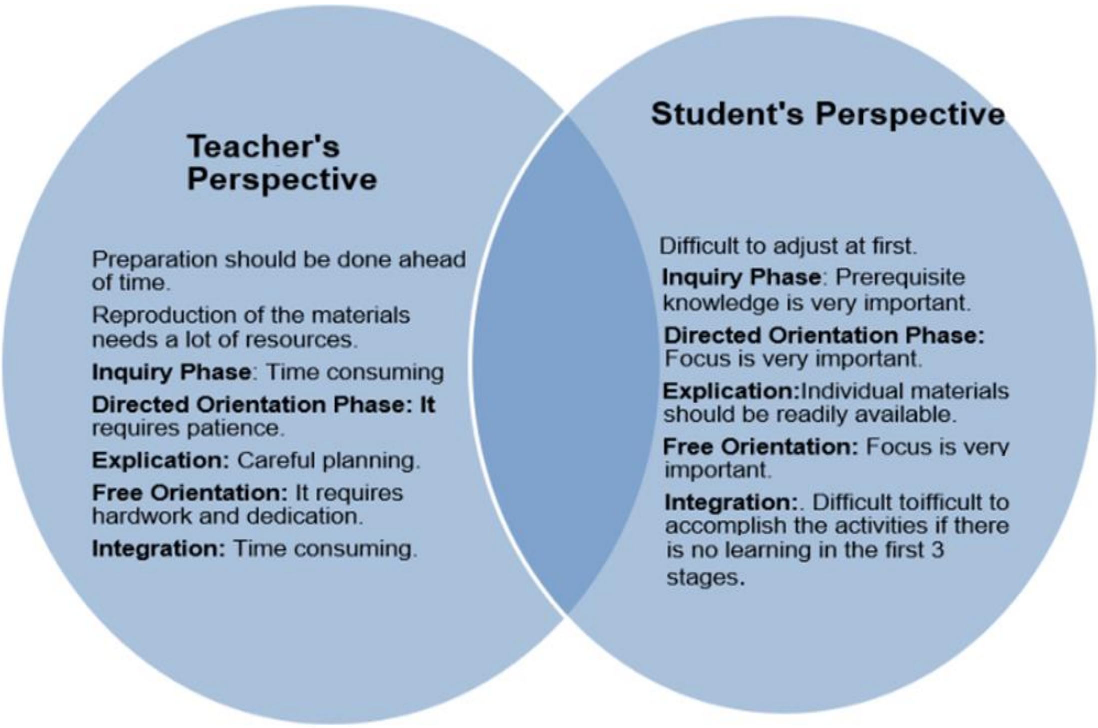

Figure 2. Challenges encountered in the use of the Van Hiele model.

4.5.1. Teacher's Perspective

The teacher gave her inputs as to the use of the Van Hiele method in teaching. There were themes derived and presented in the discussion that follows.

4.5.1.1. Preparation of the Lesson Plans, Materials, and Reproduction

Planning is critical when using the Van Hiele model phases since many activities will be incorporated into each phase. Lim (2013) stated that it is very important that the teacher will be able to select and use activities appropriate to the pupils.

One of the challenges the teacher encountered was preparing the lesson plans, materials, and reproduction. Lesson plans should be carefully planned so students can find the connection in every phase. The experiment ran for six weeks, and every day they had different activities that's why there is a need to prepare them ahead of time. Reproduction also needs a lot of resources.

4.5.1.2. Implementation of the Phases of the Van Hiele Model

Student and teacher activities are being enumerated within the Van Hiele model phase-based instruction. The instruction developed according to this sequence helps students pass on beginning with the present thinking level to the next level (Mostafa, Javad, & Reza, 2016). The phases of the Van Hiele model and the challenges encountered in each phase are as follows:

Inquiry- Finding and planning for the activity in this stage is a big challenge because this activity will determine the student's prior knowledge. It is also the stepping- stone to the next phases.

Directed Orientation- Supervising the student alone was a challenge in this phase. It was very difficult for a big class size since the teacher could not attend to all the students' concerns at once.

Explication- One of the activities in this phase is grouping and reporting. It is a challenge to handle groups since the activities are very interactive, they tend to be excited and talk a lot. Classroom management is essential.

Free Orientation- In this phase, activities are accomplished in different ways. There is a challenge specifically in checking the papers one by one. It requires hard work. Also, ensuring the students' learning environment so they can focus very well is also a challenge.

Integration- This is the last phase and one of the challenges is planning the activity for this stage. Students' learning is also evident in this stage.

4.5.2. Learner's Perspective

In the same manner, the students shared their inputs regarding their learning experience using the Van Hiele method. The following themes were derived and discussed as follows.

4.5.2.1. Starting the lesson

Starting the lesson was a challenge since the learners are used to traditional instruction; this is something new to them. At first, it is very difficult to adjust to the new strategy. Some may feel excited; some may feel afraid.

4.5.2.2. Implementation of the Phases of the Van Hiele Model

Inquiry- Prerequisite knowledge is very important because this will help them connect to the new topic. Self-assessment about what they already know about the topic will require time. Careful listening to the discussions for them to be oriented to the new topic will be a big challenge for them.

Directed Orientation- Asking questions was a challenge since not all of them would be entertained once. Waiting for their turn is very important.

Explication- Group cooperation is challenging since not all of them participated. Even in groupings, materials should be given individually to avoid chaos.

Free Orientation- Focus on the activity is a challenge since the activities are accomplished individually. Students' individual creativity and critical thinking must be observed here since they are encouraged to seek their own solution path. A peaceful and conducive environment is needed for them to be able to focus on their tasks. Thus, a classroom with sixty (60) or more students will be a challenge.

Integration- Communicating towards their learning is important. Stating how they learn in written and oral communication is a challenge because not all of them can express and encapsulate the things they have learned.

The teacher and students encountered a lot of challenges in each phase but undeniably students enjoyed the activities. The majority of the students found that it is interesting to learn Geometry using the phases of the model. One of the things that made it interesting was the different activities they engaged in. According to Van Hiele and Van Hiele- Geldov (1958) effective learning happens when students actively participate and engage themselves in activities that help them discover new things that will lead to discussion and reflection.

This feedback supports that students learn more when they manipulate and are exposed to concrete materials. Learning also becomes more meaningful when the materials being presented are attractive and challenging. Fuys et al. (1988) stated that the materials being used, such as manipulatives help students understand abstract concepts into concrete ones.

Summing it all up, the instruction using the phases of the Van Hiele model play a significant role in teaching and learning Geometry. There might be some challenges that are encountered along the way, but if there is proper planning and preparation, those challenges will be slowly addressed.

5. CONCLUSION

Although there are limitations to this study that have something to do with pedagogical approaches to teaching in the Philippines, specific to Geometry, it is concluded that the instruction with the use of the Van Hiele model is an effective way to teach Geometry as an alternative to the traditional method. It encourages and cultivates the students' attention. This method is useful when teaching Geometry, especially to students with different learning needs, because of the presence of various geometric experiences. Results show that the Van Hiele model is effective compared to traditional instruction.

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