Impact of Van Hieles' Geometric Model on Pedagogical Abilities of Nigeria Certificate in Education Mathematics Students

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Abstract:- **The purpose of this study "The Impact of Van Hieles' Geometric Model on the pedagogical Abilities of Nigeria Certificate in Education Mathematics Students in Niger State Nigeria is an intervention programme oriented towards Mathematics Teacher preparation and professional development in colleges of education. Sixty subjects (30 male and 30 female) were both purposively and randomly sampled from two colleges of education. Two instruments were used for the study, a Geometry Achievement Test (GAT 'A') and Geometry Teaching Practice Assessment with reliability coefficients r = 0.72 and 0.78 respectively. About 300 Junior Secondary School students were involved. Two null hypotheses were formulated and t- test was used to analyze the data. The study revealed that significant difference exists between NCE II mathematics students with geometric pedagogical Abilities and those without. Also, significant difference exists in Geometry performance between JSS III students taught by the Experimental group and Control group. It is recommended that there should be an increased emphasis on continual training of NCE mathematics students on geometry pedagogy even after graduation to keep them abreast of the currents research in geometry teaching and learning practices.**

Keywords: **Van Hieles' Geometric model, pedagogical Abilities and Mathematics.**

I. INTRODUCTION

The approach and methods used in teaching and learning of mathematics in general and geometry in particular have continued to generate interest among mathematicians and mathematics educators in recent years. This is because the approaches and methods have a huge impact on how much students learn in the classroom as well as on the quality of the learning that take place. Also, it is believed that, appropriate teaching methods can improve students' level of understanding and help them master mathematical principles and procedures. The methods used also influence how students engage in and enjoy learning. Which also impacts on how much and how well they learn. This is the reason why van Hieles' Geometric Model stand- out unique today. The model developed by two Dutch Mathematicians Educators in the late 50s was used to find out why many secondary school students have difficulty with the higher order cognitive processes in learning geometry and why teachers find it difficult to teach. They theorized that students who have trouble in geometry were taught at higher Van Hiele level than they were ready for. The theory also offers a remediation: go through the sequence of level in a specific way.

Despite the fact that Geometry is given its appropriate place in mathematics curriculum and that in Nigeria its usefulness is obvious through its inclusion in both primary and secondary schools mathematics curriculum, pupils and students at both primary and secondary levels continue to show poor performance. In both teacher and standardized examinations, (WAEC & NECO, 1995, 1996, 2000, 2003), Why? Many reasons have been advance for this poor state of students' performance in mathematics in general and geometry in particular. Some researchers reported that subject matter incompetence is a contributing factors, Unal, 2005;(Benjamin and Agwagah, 2006): Others like Ishaku (2003); Tahir (2006) attributed this consistent poor performance in mathematics by the students to mathematics teacher' slack of necessary skills and competence in both content and delivery.

Hence, findings have consistently shows that, mathematics teachers do not have the knowledge of mathematics expected as a pre- requisite to effective teaching. In other words, appropriate knowledge for specific knowledge as in pedagogy is said to be lacking by mathematics teachers as rightly observed by Odili (2006) and Ohakwe (2006) who reported that, despite the call to use approaches such as discovery, cooperative activities, individual problem solving and other methods, mathematics teachers skill follow traditional pattern of teaching. In the same vain, Unal (2006) said one possible explanation why students are failing in geometry is that, mathematics teachers' are failing to provide their students with appropriate learning opportunities in geometry. Also Fajemidegba (1989) and from researchers 13 years experience in college of education and 9 years in the university, a cursory look at mathematics education showed that geometry is not emphasized. In a related development, it is a common belief that, if a mathematics teacher knows mathematics very well, he/ she can teach it very well. But research evidence by Unal (2005) showed that, knowing mathematics is only an aspect of

mathematics teaching. There are other knowledge necessary for the mathematics teaching and learning that goes with subject matters such as the knowledge of student cognition and knowledge of teaching. In other words, teachers have not understood the essential characteristics of mathematics (precisely as in geometry in term of precision, ubiquity of logical reasoning and its coherence nation) couple with geometry teaching which has very specific mathematical requirement; but Nigeria certificate in education (NCE) mathematics curriculum tends to show nothing about such requirement. Hence, it could be argued that for effective learning to tack place, there must be an effective teaching.

Therefore, for mathematics teaching to be effective there must be an effective mathematics teacher who must be competent in both subject matter (content) knowledge and knowledge of mathematical presentation. This is because mathematics is a composition of a large set of highly related obstruction and researchers such as (Orton, 1992; Fajemidegba, (1998) and Atebe, (2008) opined that if teachers do not know how to translate these abstractions into forms that enables the learner to translate mathematics to what they already know, they will not learn. Indeed Atebe (2008) buttressed this and said mathematics teachers' competence has been closely linked to their level of geometry understanding.

Also, Lassa (1982) cited in Adetula (1989) and Fajemidagba (1989) reported that mathematics basics level of geometry understanding is low. Specifically, Fajemidagba(1989) and Ohakwe (2006) reported that NCE students of mathematics do not possess adequate knowledge of geometry and its pedagogy hence the teaching and learning geometry is seriously deficient. Also another area of concern for mathematics teaching which requires urgent intervention is the ability of NCE mathematics students to be conversant with in the knowledge of students/ pupils cognitions. This weakness could be link to mathematics teachers' preparation. Research evidence shows that the mathematics teachers preparation with specific form on developing a structure of pedagogical content in mathematics in our colleges of education are grossly inadequate,(Ishaku, 2013; Odili, 2006 and Tahir, 2008). Indeed, it said that, Learning is based on what happens in the classroom and not only what students to because teaching environment is important for learning. psychologists and Educationist believed that learning make sense only when learner can make sense of the world and are able to discover essential relationship through interaction with appropriate environment. For example, Pollard, Collins, Manduch, Sinco, Swaffield, Warisand Warmick(2006) opined that, teaching strategy should be appropriate for the context, age and development stage of the learners.

Therefore, Van Hieles' geometric model can serve as a guide to the mathematics teacher in the geometry aspects of the mathematics curriculum. Hence mathematics teacher with knowledge of Van Hiele's Geometric model can

1. Provide appropriate lesson structure and other apparatus
2. Devise activities and appropriate experience to the learner so that understanding would grow from within.
3. The model provides awareness to mathematics teacher in the sense of descriptive cognitive development in geometry and provide frame work for teaching geometry.

Therefore, it is against this background that this study intends to use Van Hiele's geometric model on pedagogical abilities of Nigeria Certificate in Education Mathematics Students.

Statement of the Problem

The picture emerging from research experts shows that students have difficulty in solving mathematics problem especially those that require mental manipulation, re-arrangement of elements with a visual stimulus pattern just as many teachers have problem teaching that area. The West African Examination Council (WAEC) and National Examination Council (NECO), chief examiners report (1995,1996, 2000, 2005) revealed that students had problem with geometric branch of mathematics and such problem have been traced to lack of essential knowledge of construction rubrics. According to report cited above, students find it difficult to accurately measure, construct, draw and even rearrange objects, which are processes involved in geometry. Geometry is mainly concerned with the study of solid shapes, their properties, classifications and construction of 2 and 3 dimensional objects. Geometry is one area that utilizes visualization in its applications especially in problem solving. The ability to view an object or form visual imagery is necessary for communicating ideas to others and enhances thought pattern. Instructional communication is a crucial aspect of classroom activities. The more effective communication is, the better the chances that learning will take place.

Objectives of the study

The main objective of the study was to determine the Impact of Van Hiele's Geometric Model on Pedagogical Abilities of Nigeria Certificate in Education Mathematics Students. The specific objectives are:

1. To determine the Impact of Van Hiele's Geometric Model on NCE mathematics Students Pedagogical Abilities in teaching geometry.
2. To find- out if the NCE mathematics students with knowledge of Van Hieles' Geometric model will improve the Junior Secondary School Students Performance in geometry.

Research Question

To assess the quality of NCE mathematics students Pedagogical Abilities in geometry teaching, the following research questions were raised.

1. Is there any difference in the Impact of Geometric Pedagogical Abilities of the NCE II mathematics with the knowledge of Van Hieles' Geometric model and those without?
2. What is the difference in Junior Secondary School Students' Performance in geometry when taught by NCE II mathematics students with knowledge of Van Hieles' Geometric model and those without?

Research hypotheses

1. There is no significant difference in geometric Pedagogical Ability of the NCE II mathematics students with the knowledge of Van Hieles, Geometric model and those without.
2. There is no significant difference between Junior Secondary School Students' performances in geometry attributed to NCE II mathematics Students Geometric Pedagogical knowledge (Van Hieles' Geometric Model).

Significance of the study

This study will contribute to the development of knowledge in the following ways.

1. Provide research based information on Nigerian Certificate in Education mathematics students Pedagogical Ability in Geometry.
2. Enable mathematics Teachers knowledge on Van Hiele' Geometric model to provide remedial assistance to Junior secondary school students in geometry to enhance geometry learning.

II. METHODOLOGY

Research design used for this study is Quasi- experimental. Specifically, Static Group comparison design was used in the study. The researcher ensured that the groups were equivalent in all relevant aspects and they only differed in Exposure to treatment (Training in Van Hieles' Geometric model). This is because, the two groups received/exposed to the same MAT 114 content in the NCE mathematics curriculum (Basic concepts in mathematics) which was supervised and monitored by the same agency (NCCE) both in the quality of students intake and implementation of minimum standard curriculum in all colleges of Education in Nigeria. The dependent variable (Geometric Pedagogical Ability), for the Experimental and Control Groups were compared to determine the effect of the treatment. The geometry achievement of Junior Secondary III Students taught by the Experimental Group was compared with that of similar clan, Junior Secondary School III Students taught by the Control group.

Sampling and Sampling technique

A two stage Sampling procedure was used for this study. First a purposive random sampling was used to obtain the twenty (20) subjects from Federal College of Education, Kontagora. Purposive sampling was used based on the knowledge and experience of this group by the researcher. That is, they serve all of the researches' criteria, (Ali, 2006). The reason was that only twenty students (20) were qualified to go for teaching practice during 2008/2009 session, and most importantly; the study involved observing the NCE II mathematics students in their respective place (School) of teaching practice. At the second stage, a random sample procedure was adopted using simple balloting to arrive at forty (40; M= 18, F= 22) NCE II mathematics students from College of Education, Minna. Also a corresponding random sample of 30 junior secondary school students were used in every class observed.

Instrumentation

Two instruments constructed by the researcher were used for collecting data for the study. One is an achievement test on geometry (GAT, 'A') developed by the researcher based on junior secondary mathematics curriculum. While the second instrument is a rating scale, Geometry Teaching Practice Assessment (GTPA).

The instruments were validated by lecturers of mathematics Department in the Colleges of Education and three experts in mathematics Education unit of Science Education, Federal University of Technology , Minna. A reliability coefficient of 0.72 and 0.78 were obtained for Geometry Achievement test and Geometry Teaching Practice Assessment respectively.

III. DATA COLLECTION AND ANALYSIS

1. The instruments were personally administered by the researcher with the help of two research assistants who are academic staff in the Mathematics Department in the colleges of education involved in the study.
2. The data collected were analyzed using mean, standard deviation and t- test.

Table 1. Mean, Standard Deviation of Experimental and Control Groups

Variable	N	Mean ($\bar{X}$)	SD
Experimental Group	30	57.70	5.742
Control Group	30	48.83	2.149

Table 1 presents the mean and standard deviations of NCE II mathematics students with knowledge of geometric pedagogical abilities (Experimental group) and those without (Control group). The experimental group had a mean score of 57.7 and standard deviation of 5.742 while the control group had a mean score of 48.83 and standard deviation of 2.149.

Table 2: Mean, Standard Deviation of student by the Experimental and Control groups

Variable	N	Mean ($\bar{X}$)	SD
Students taught by Experimental Group	150	27.73	8.99
Students taught by Control Group	150	26.23	7.85

Table 2 presents the mean and standard deviation of Junior Secondary School Students taught by the Experimental and Control Group respectively.

The findings from this study indicate that the NCE II mathematics students with knowledge of geometric Pedagogical abilities (Van Hieles' Geometric Model) perform better than those without. Also Junior Secondary School Students taught by the Experimental group perform better than those in the Control group.

Hypothesis

Ho_1: There is no significant difference in geometric pedagogical abilities of the NCE II mathematics students with the knowledge of Van Hieles' Geometric model and those without t- test was used to test the hypothesis.

Table 3: Summary of the t- test Analysis of NCE II mathematics Students' Geometric Pedagogical Abilities (Van Hieles' Geometric Model) of Experimental and Control Groups.

Variable	N	Mean ($\bar{X}$)	DF	SD	t-value	P
Experimental Group	30	57.70	58	5.742	8.280*	0.000
Control Group	30	48.83		2.149		

* Significant at $P \leq 0.05$

The result from table 3 shows that the t- value is significant at P = 0.000 level, thus, hypothesis 1 was rejected. This mean that, there exists a significant difference between NCE II mathematics students with knowledge of Van Hieles' Geometric Model (Geometric Pedagogical Abilities) and those without.

Hypothesis 2

Ho_2: There is no significant difference between Junior Secondary School III Students performance in geometry attributed to NCE II mathematics students with Geometric Pedagogical Abilities (Van Hieles' Geometric Model). t- test was used to test the hypothesis.

Table 4: Summary of the t- test Analysis of Experimental and Control Group Students Performance in Geometry.

Variable	N	Mean ($\bar{X}$)	DF	SD	t-value	P
Experimental Group	150	27.73	298	8.99	1.783*	0.0016
Control Group	150	26.23		7.85		

* Significant at $P \leq 0.05$

Table 4 presents a summary of the means, standard deviations and t- test showing students performance in geometry when taught by the NCE II mathematics students in Geometric pedagogical abilities (Van Hieles' Geometric Model) and those without. This result was significant at P = 0.0016. Thus, Hypothesis 2 was rejected. This means that there exists significant difference between those taught by the Experimental Group and those taught by the Control group.

IV. DISCUSSION AND CONCLUSION

The result of this study showed that significant differences exist in geometric pedagogical abilities of the NCE II mathematics students. The study also showed that, geometric pedagogical abilities of the NCE II mathematics students' influenced junior secondary school students performance in geometry. One can then deduce from the study that, students' improvement on geometry performance is largely determined by the NCE II mathematics students geometric pedagogical abilities.

Therefore, providing mathematics teachers with training on Van Hieles' Geometric model is a better intervention programme oriented toward teacher preparation and professional development. This finding is in consonance with (Van Hilele, 1986; Ohakwe, 2006; Unal, 2006; and Atebe, 2008) that mathematics teacher preparation is a part of the teaching- learning process and those adequately prepared teachers can formulates appropriate learning experiences to help students make orderly progress. Consequently, this will enable them to teach geometry better at junior secondary school level after graduation. This in turn enhance students understanding of geometry.

V. RECOMMENDATIONS

From the findings and conclusion reached in this study, the following recommendations were made.

1. The focus of mathematics teacher education preparation at colleges of education level should be directed towards bridging the gap between theory and practice in the specific content subject matter with pedagogical content area. This is to enable them improve classroom practice after graduation.
2. Similar kind of study be carried out at preparatory stage with the university undergraduates and distance learning mathematics teacher education programme (eg. NTI and Open University).

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