

**EFFECT OF VAN HIELE MODEL ON PEDAGOGICAL ABILITIES OF
UNDERGRADUATE MATHEMATICS EDUCATION STUDENTS IN NIGER
STATE, NIGERIA**

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Abstract

This study aimed at investigating the effect of van Hiele's geometric model on pedagogical abilities of undergraduate mathematics education teachers (pre-service teachers) in Niger state, Nigeria. Two research questions and two hypotheses were formulated to guide the study. The design adopted for the study is a quasi-experimental, specifically, static group comparison design was used in the study. One hundred (56 males and 44 females) university undergraduate mathematics education students from two selected universities in Niger state were used as research sample. The sample universities were selected using purposive sampling technique. Geometry Teaching Practice Assessment (GTPS) was the instrument used for data collection for the study. It consisted of two parts. Part one evaluated the geometry lesson structure consisted of instructional units in line with van Hiele's phase-based instruction while Part two, evaluated the teacher's presentation of the geometry lesson in classroom. A reliability coefficient of 0.81 was obtained. The data was analyzed using independent samples t-test. The hypotheses were tested at 0.05 level of significance. The findings of the study revealed that significant difference exists between the mean scores of undergraduate mathematics teachers with geometric pedagogical abilities and those without geometric pedagogical abilities. However, no significant gender difference exists among male and female undergraduate mathematics education teachers with geometric pedagogical abilities. It was recommended among others, that emphasis should be laid on continued training of university undergraduate mathematics education student on geometry pedagogy even, after graduation so as to keep them well-informed of existing researches in geometry teaching and learning practices.

Keywords: abilities, model, pedagogical, undergraduate, van Hiele.

Introduction

It is evident world over that the skill of conveying knowledge to learners has been one of the central educational activities in the teaching and learning process. This is made possible by the effort of the teacher. Teachers are indeed saddled with the responsibilities of imparting information to the learner using most effective strategy Biong'ahu and Hyuwal (2017). Bello and Musa, (2017) asserted that the training of teachers' at whatever level have gone through a series of change as the need for teachers is very necessary and important at all times most especially that Mathematics as a subject is generally accepted as an important area to be studied, according to them, mathematics is the wheel in which science and technology move, meaning if there is no mathematics there will be no science and technology. In another related development, Amoo and Efunbajo (2004) stressed that a solid training in Science, Technology and Mathematics Education is vital for many vocations and job opportunities in today's increasing technological society, as a result, Abdullahi (2017) in turn affirmed that the fact that more opportunities are coming up through mathematics education then, mathematical knowledge and indeed as a discipline has subsequently spread across all domain of human endeavor.

Wasagu (2017) on this note stressed that, in recognition of the vital role mathematics as an area of study played that, country like China and Japan today has made it not only the second largest economy but threatening even the world's robust economy, the United States of America (USA) which has remained the most prosperous in the harnessing of collective scientific and technological development for the attainment of its national objectives. Supporting the above assertion, Bot and Iliya (2015) opines that the advancement of any nation is determined by its scientific and technological growth and development which is erected on sound mathematical knowledge. For this reason, Iyekekpolor and Bulus (2009) stressed that any nation that treats mathematics education of her youths with levity does so at the detriment of her science and technology. When one think of the technological and communications infrastructure that under girds our lives, you realize that we are in fact in a "Mathematical universe", thus, in an attempt to seek a teaching strategy that can improve technological development and indeed mathematics teacher academic achievement, led to the desire to employ van Hiele's geometric model.

The van Hiele's geometric model describes how children learn to reason in geometry. It consists of five levels and five phases of instruction which have been applied in many studies (Abdullah & Zakaria, 2013b; Abu et al.,2012; Alex & Mammen 2016; Atebe, 2008; Chew, 2007; Erdogan & Durmus, 2009; Fuys et al., 1988; Hoffer, 1983; Usiskin, 1982) that are related to teaching and learning of geometry and it was however found to be effective in developing students' academic achievement. The model was developed by two Dutch mathematicians in the 1950s, Pierre van Hiele and his wife Dina van Hiele-Geldof. The five levels according to van Hiele (1986) are: Recognition, Analysis, Order, Deduction and Rigor. Pedagogical knowledge and abilities which is to be observed using van Hiele model in view of Guerriero (2012) is a specialised knowledge of teachers for producing effective teaching and learning environments for all students, it includes all the required cognitive knowledge for creating effective teaching and learning environments. Research suggests that this knowledge can be studied. Identifying the content of this knowledge base, however, is a complex issue. Examining the knowledge of teachers as 'learning specialists' Guerriero (2012) said that teachers' knowledge consist of understanding how this knowledge functions in the teaching-learning process; more specifically, how teachers apply their knowledge in making decisions, for example, about lesson design or making on-the-spot judgments in the classroom. He maintain that a set of research studies conceptualizes the teaching profession as a 'clinical practice profession' and compares it to the medical profession. Some argue that decision-making is actually a basic teaching skill – decisions are made regularly by teachers while

processing cognitively complex information about the student in order to decide alternatives for increasing their understanding. In contrast, general pedagogical knowledge has not been the object of many research studies even though several studies indicate that it is essential for developing quality teachers. To develop quality teacher is paramount to create conducive atmosphere. One possible way to achieve this, as reported by Johnson, (1999), is by giving the students the opportunity to communicate mathematically, reason mathematically and develop self- confidence to solve mathematics questions. One of the ways this can be accomplished is through Van Hiele's Geometric model.

Gender issues have been associated with achievement of students in academic tasks in numerous studies but without any definite conclusion Gambari (2014). Some findings show that male students performed better than females in science. However, Egorova and Chertkova (2016), Orabi (2007), and Iwendi and Oyedum (2014) found no gender difference in the performance of male and female students in school mathematics. Conflicting these reports, Gimba (2006) found that female students performed better than male students while exposed to geometry, mensuration and 3-dimensional mathematics instructional materials respectively.

In view of the above, The principal concern of teacher training is to create qualitative education, but the reverse is the case because majority of Mathematics teachers trained in teacher training institutions cannot provide any substantial progress, re-orientation and change from ineffective and unworkable instructional practices in the teaching and learning of geometry in our school. As a result, the teacher issue is very important catalyst if success is to be achieved in any educational programmes. The frequent failure in mathematics is always been associated to a number of factors. Such factor most reported in literatures is incorrect method of teaching and learning Mathematics. These problems according to Hassan (2015) seem to emanate from teachers colleges, faculty of education in universities to student teachers, then to Primary school pupils and Secondary School students.

Hence it has become very necessary to examine the state of Mathematics teacher preparation in University with special focus on pre-service university Mathematics education Teachers' Pedagogical ability in geometry.

Objectives of the study

The general objective of this study is to determine the effects of Van Hiele's Geometric Model on Pedagogical Abilities of Undergraduate Mathematics education Students in Niger state. Specifically the research is carried out to determine:

1. The effect of Van Hiele's Geometric Model on the Undergraduate (pre-service) Mathematics Students Pedagogical abilities in teaching Geometry.
2. The effect of Van Hiele's Geometric Model on the Undergraduate (pre-service) Mathematics Students Pedagogical abilities in teaching Geometry based on gender.

Null Hypotheses

The Null hypotheses were formulated from the corresponding research objectives raised above.

HO₁: There is no significant difference between the mean score of Undergraduate Mathematics Students with geometric pedagogical abilities (knowledge of Van Hiele's geometric model) and those without the knowledge of van Hiele's geometric model.

HO₂: There is no significant difference between male and female Undergraduate Mathematics Students geometric pedagogical ability with the knowledge of Van Hiele's geometric models.

Methodology

The study adopts a quasi-experimental research design. Specifically, Static Group Comparison design was used in the study. This design used two pre-existing or intact groups, only one of which was exposed to the experimental treatment. The subjects were not randomly assigned to the groups. The researcher believed that the groups were equivalent in all relevant aspects and they only differed in exposure to treatment (training on van Hiele's Geometric Model).

The population for the study comprises of 400 level Undergraduate Mathematics education Students from the two universities situated in Niger State namely, University A and University B respectively. The universities were tagged A and B in other not to respectively affect their standard. The sample consisted of one hundred (100) Undergraduate Mathematics education Students (UMES) from two purposively selected universities from Niger state, Nigeria. The purposive sampling was used based on the fact that only one hundred Undergraduate Mathematics education Students were qualified to go for teaching practice in the two sampled universities and, most importantly, the study involved observing Undergraduate Mathematics education Students in their respective places of teaching practice. There were 58 UMES in the experimental group and 42 in the control group. The two universities were then grouped by gender into experimental and control group

Geometry Teaching Practice Assessment (GTPA) adapted from Hassan (2015) was used for data collection. The instrument consisted of two parts. Part one evaluated the geometry lesson structure consisted of instructional units in line with van Hiele's phase-based instruction while Part two, evaluated the teacher's presentation of the geometry lesson in classroom. This serves as a check list of what constitutes evidence of the Van Hiele's phases in an instructional setting. Hundred was the maximum score for this instrument.

The tests instrument was validated by a team of two experts, one each from sampled universities. The test item were corrected and modified on the basis of suggestions and recommendations by the experts. The reliability coefficient for the GTPA was found to be 0.81 after using test retest method. Descriptive statistics such as mean and standard deviation was used to answer all the research question while independent sampled t-test at 0.05 level of significance was used to test hypothesis formulated for the study.

Results

Table 1

Summary of the t-test Analysis of Geometric Pedagogical Abilities of Experimental and Control Groups

Group	N	Mean(X)	SD	Df	t-value	P-value
Experimental group	58	61.62	7.70	98	11.75*	.002
Control group	42	45.83	5.19			

* Significant at 0.05 level

Table 1 shows the t-test comparison of achievement scores of experimental and control group. The table reveals that the calculated t-value ($t=11.75$, $df=98$, $p<0.05$) was significant at 0.05 alpha level. This implies that there was significant difference between the experimental and control group on Geometric Pedagogical abilities of undergraduate mathematics education graduates.

Table 2

Summary of t-test Analysis of Geometric Pedagogical Abilities of Males and Females of Experimental Group.

Group	N	Mean(X)	SD	Df	t-value	p-value
Male	32	61.94	7.04	56	.342*	.164
Female	26	61.23	8.67			

* Not significant at 0.05 level

Table 2 shows the t-test comparison of achievement scores of male and female of Undergraduate Mathematics Students with geometric pedagogical abilities. The table reveals that the calculated t-value ($t=.342$, $df = 56$, $p>0.05$) was not significant at 0.05 alpha level. This implies that there was no significant difference between male and female Geometric Pedagogical abilities of undergraduate mathematics education graduates. This implies that the use of van Hiele model in teaching is gender friendly.

Discussion

The results of hypothesis one reveals that there was significant difference between the experimental and control group on Geometric Pedagogical abilities of undergraduate mathematics education students in favour of the experimental group. This results agreed with findings of Alex and Mammen (2016), Chew and Noraini (2012), Atebe (2008) which in their previous studies found that that experimental group performed better than their counterparts in the control group. The findings also support the earlier findings of Chew and Lim (2013) who reported that the intervention (treatment) significantly enhanced the pupils' geometric thinking about the regular polygons. The superiority of van Hiele model may be attributed to assertion of Van Hieles (1986) who said and believed that cognitive progress in geometry can be fast-tracked by instruction, as such he suggested learning phase that are able to support in assisting learners to move from van hiele level of geometric thinking to a higher level.

The results of hypotheses two shows that was no significant difference between male and female Geometric Pedagogical abilities of undergraduate mathematics education graduates. This result differs with the findings of Kovas et al. (2015) Musa et al. (2016) and Preckel et al. (2012) who reported that male students performed better than females in science. It also disagrees with the findings of Kuruma (2004) and Gimba (2006) who reported that female students performed better than male students. This result is however in agreement with the findings of Egorova and Orabi (2007), and Iwendi and Oyedum (2014) who found no gender difference in the performance of male and female students in school mathematics.

Conclusion

The finding of this study has created awareness and seems to provide answer to the poor performance problem. The model proved to be more effective in teaching the mathematical concept of geometry. The model has also proved the capability of removing gender inequality as observed in the treatment group as such, the model is gender friendly.

Recommendations

Based on the findings of this study, the following recommendations are made.

1. van Hiele model of instruction was found to be effective as a teaching strategy for geometry instruction when compared with conventional method of instruction. Therefore, mathematics teachers should be encouraged to use it.
2. Male and female student pedagogical ability was affected positively and evenly by the use van Hiele model. Therefore, mathematics teachers should employ this strategy to improve male and female pedagogical ability of undergraduate mathematics students' in mathematics at university level in particular and other levels in general.

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